Design Guidance Note:

Fire Engineering Design for New Zealand Public Hospitals

Endorsed by: MBIE, FENZ

July 2024

Te Kāwanatanga o Aotearoa
New Zealand Government

Health New Zealand
Te Whatu Ora

Citation: Health New Zealand | Te Whatu Ora. Design Guidance Fire Design Guidance Note: Fire Engineering design for New Zealand public hospitals. Wellington: Health New Zealand.

Published in July 2024 by Health New Zealand
PO Box 793, Wellington 6140, New Zealand

ISBN 978-1-99-106796-8 (online)

This document is available at tewhatuora.govt.nz

Endorsements

MBIE

The Ministry of Business, Innovation and Employment (MBIE) is pleased to support Health New Zealand - Te Whatu Ora developing this Design Guidance Note setting out how to achieve the requirements the owner and operator has for hospital buildings constructed in Aotearoa New Zealand. MBIE commends building owners, operators, and users setting design objectives that better suit their collective needs than the minimums mandated by the New Zealand Building Code.

Users of this guide should always familiarise themselves with the relevant provisions of the Building Act, building regulations, acceptable solutions, and verification methods. This is important because these regulatory instruments are periodically updated, and their requirements may be different to those that were in effect when this Design Guidance Note was published.

FENZ

Fire and Emergency endorses the Design Guidance Note: Fire engineering design for New Zealand public hospitals with an expectation that Te Whatu Ora and Fire and Emergency will further develop the design philosophy of lifts for evacuation with a view to incorporating additional safety and resilience features in line with international design Standards in the future.

Document history

Version	Issue date	Alterations
-	7 July 2023	Document draft and presented for consultation
1	1 July 2024	Approved document published

Document status

This Fire Engineering Design Guide for Hospitals is published by Health NZ to establish a set of minimum requirements for fire safe design of hospital buildings to meet hospital needs and meet, as a minimum, New Zealand Building Code requirements for fire safety. They are to be followed for the design of new public hospital buildings and wherever possible for the alteration of existing public hospital buildings.

Design Guidance is updated on a 3-5 year cycle to keep up to date with changing technological, social and environmental conditions, and will be continuously improved by feedback loops (including post occupancy evaluation and alternative solutions approved by the design governance body). However, for this Fire Engineering Design Guide an initial review will take place a year after the guidance is released.

Please refer to the latest version of this document on www.tewhatuora.govt.nz.

Importantly, this Design Guidance Note does not contain legal advice and should not be read as replacing the relevant legislation. Readers must refer to the relevant fire safety provisions in the Building Act 2004, Building Code, Fire and Emergency New Zealand Act 2017 and Fire and Emergency New Zealand (Fire Safety, Evacuation Procedures, and Evacuation Schemes) Regulations 2018 and be aware that for specific situations or problems, it may be necessary to seek independent professional advice in order to ensure compliance with the relevant legislation.

Fire and Emergency has specific regulatory responsibilities under the Fire and Emergency New Zealand Act 2017 and Fire and Emergency New Zealand (Fire Safety, Evacuation Procedures, and Evacuation Schemes) Regulations 2018 with respect to fire safety'.

While care has been taken in preparing this Guidance and it has been endorsed by MBIE and Fire and Emergency, if there is any conflict or discrepancy between anything in this Guidance note and the relevant legislation, the legislation overrides this Guidance note.

Acknowledgements

Te Whatu Ora Fire Engineering Project Panel

- Martin Feeney (Holmes Group)
- Mike Stannard (Kestrel Group)
- Darryl Carey (Health Design Council)
- Greg North (Beca)
- Saskia Holditch (MBIE BSP)
- Ed Claridge (Auckland Council)
- Etienne Hermouet (FENZ)
- Stephen Reeves (FENZ)
- Brady Cosgrove (Cosgroves)
- Biswadeep Ghosh (WSP)
- Daryn Glasgow (Crossfire/Jensen Hughes)
- Matthew Gray (Powell Fenwick)
- Daniel Nilsson (University of Canterbury)
- Todd Collings (Te Whatu Ora)

International reviewer

- Prof. Brian Meacham (Chair, IAFSS; Past President, SFPE)

Health NZ Management

- Particularly Monique Fouwler, Stacey Marsh

The Ministry of Business, Innovation and Employment Building System Performance Branch (MBIE BSP)

Fire and Emergency New Zealand (FENZ)

UK Department of Health

- Notably: Health Technical Memorandum 05-02: Firecode Guidance in support of functional provisions (Fire safety in the design of healthcare premises) 2015 edition

Contents

Foreword

Health NZ is building the foundations of a new health system. Delivering a unified, sustainable health system includes:

- Delivering equity for all,
- Embedding Te Tiriti,
- Implementing a population health approach, and
- Ensuring sustainability of the health system.

The health estate has an important role to play in delivering these objectives, and infrastructure investment must deliver on the aspirations set out in Te Pae Tata.

Nationally consistent design guidance supports fit-for-purpose facility development and provides clear and consistent design expectations. This will streamline development processes and reduce the risk of time and cost overruns.

Providing nationally consistent design guidance, drawing on the wealth of expertise that exists across New Zealand, guidance that is genuinely informed by the principles of Te Tiriti o Waitangi, will deliver buildings that promote equitable access, that respond to the social, cultural and physical needs of all New Zealanders.

Glossary of terms, definitions and acronyms[1]

Acceptable Solution: means an *acceptable solution* issued under section 22(1) of the Building Act. **C/AS2** is an *acceptable solution* for compliance with Building Code C clauses, Protection from Fire.

AHU, Air handling unit: part of the building services.

Alternative Solution: An alternative solution is all or part of a building design that demonstrates compliance with the Building Code, but differs completely or partially from the Acceptable Solutions or Verification Methods. Designers will need to demonstrate to the *BCA* that the design meets Building Code requirements.

ANARP, As nearly as is reasonably practicable: This term is used in the Building Act, notably sections 112 and 115. Guidance is provided on ANARP by MBIE, refer: https://www.building.govt.nz/building-code-compliance/b-stability/b1-structure/altering-existing-building/demonstrating-and-assessing-compliance-for-buildings-undergoing-alterations/step-3-applicants-assess-anarp-for-outstanding-fire-and-accessibility-building-code-clauses/**.**

ASET, Available safe egress time: Time available for escape for an individual occupant. This is the calculated time interval between the time of ignition of a fire and the time at which conditions become such that the occupant is estimated to be incapacitated (ie unable to take effective action to escape to a place of safety). (source *C/VM2*)

AusHFG, Australasian Health Facility Guidelines: refer https://healthfacilityguidelines.com.au

BCA, Building Consent Authority

BMS, Building Management System: A control system network throughout the building that can be used to monitor and manage the mechanical, electrical and electromechanical services in a facility. Such services can include power, heating, ventilation, air-conditioning, physical access control, pumping stations, elevators and lights.

BoH, Back of House: in a *hospital* context, BoH relates to spaces which are intended to be used by staff (including all types - *clinical*, support administrative, etc.). Access into these spaces is often security controlled, excluding access by patients and public. These spaces do not include patient-access-only areas.

Building importance level: The importance level of the building for the purposes of fire safety is as described in *NZBC* clause A3. Refer also to *Health NZ* guidance for clarification of Building Importance Levels for *hospital buildings*.

Clinical (and non-clinical): For the purposes of this document, *clinical* space is defined as areas where patients are treated or accommodated, including support rooms within *clinical Health Planning Units, HPUs,* not directly accessed by patients. *Non-clinical* space is defined as all other areas, including areas for public, whanau and staff, storage and building service areas.

CPEng, Chartered professional engineer

Design Fire Matrix/Fire Systems Interface Matrix: Integrated building systems table showing the cause-and-effect functionality of various fire protection systems.

[1] Defined terms have been italicised when used in the document text where this guidance relies on them being a defined term. Please also refer to definitions provided in the NZ Building Code or Acceptable Solution C/AS2.

DGN, Design Guidance Note: A suite of design guidance documents developed by *Te Whatu Ora*.

Escape route: A continuous unobstructed route from any *occupied space* in a *building* to a *final exit* to enable occupants to reach a *safe place*, and shall comprise one or more of the following: *open paths* and *safe paths*. Note that doors in an *escape route* are not considered to be obstructions provided they comply with this Acceptable Solution and D1/AS1. (Source: *C/AS2*)

Evacuation Scheme: An *Evacuation Scheme* contains the building's procedures that are designed to enable occupants to evacuate from the scene of a fire or an alarm of fire to a *place of safety* within a reasonable amount of time. In accordance with s. 76 and s. 77 of Fire and Emergency Act 2017, the owner of a relevant building must provide and maintain an *Evacuation scheme.* An application is made to FENZ, in accordance with prescribed requirements, for approval of an *evacuation scheme*. A *hospital building* within the scope of this document is a relevant building. Fire and Emergency New Zealand (Fire Safety, Evacuation Procedures, and Evacuation Schemes) Regulations 2018 provide further detail of requirements.

Evacuation zone: A collection of spaces, which may include one or more *firecells* or *smokecells*, in which all occupants are notified simultaneously of a fire emergency and from which evacuation of all occupants is carried out simultaneously to a *place of safety*. The internal boundary of the evacuation zone shall be fire and smoke separated.

EWIS, Emergency Warning and Intercommunication System: as defined in AS1760.4.

Exitway: All parts of an *escape route* protected by *fire* or *smoke separations*, or by distance when exposed to open air, and terminating at a *final exit*. (Source: *NZBC*)

FAP, Fire Alarm Panel: refer NZS 4512.

FENZ, Fire and Emergency New Zealand: (formerly New Zealand Fire Service)

FEB, Fire Engineering Brief: The *FEB* is a process in which relevant stakeholders are engaged at an early stage in the project to agree on the design methodology, and any specific requirements stakeholders may have. Typically, this will involve the preparation of the *FEB* document at the concept stage, followed by an iterative process to establish and agree the design methodology, inputs and acceptance criteria. The *FEB* process is set out in the International Fire Engineering Guidelines (IFEG).

FEC, Fractional effective concentration: The ratio of the concentration of an irritant to that concentration expected to produce a specified effect on an exposed subject of average susceptibility.

FED, Fractional effective dose: The fraction of the dose (of carbon monoxide (CO) or thermal effects) that would render a person of average susceptibility incapable of escape. (Source: *C/VM2*)

FFCP, Fire Fan Control Panel: Provides manual control and indication of the *smoke control systems* in the building. Typically located in the vicinity of the fire brigade panel.

Final exit: The point at which an escape route terminates by giving direct access to a safe place. (Source: *NZBC*)

Fire and Smoke Damper (Combined): A closure designed as both a *fire damper* and a *smoke damper*.

Fire brigade: A generic term meaning the responding fire service, generally *FENZ* but could occasionally be military or private brigades. The terminology is consistent with the approach taken by Standards NZ in NZS 4510, NZS 4512 and NZS 4541.

Firecell: 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. (Source: *NZBC*)

Fire Damper: A device with a specified *FRR* complete with fixings and operating mechanism for automatically closing off an airway where it passes through a *fire separation*. An airway may be a duct, plenum, ceiling space, roof space or similar construction used for the passage of ventilating air. (Source: *C/AS2*) Fire dampers shall be designed to AS 1682.1-2015 and AS 1530.4-2014.

Fire Door: A doorset, single or multi-leaf, having a specific fire resistance rating, and in certain situations a smoke control capability, and forming part of a *fire separation*. The door, in the event of fire, if not already closed, will close automatically and be self-latching. *Fire doors* shall comply with NZS 4520:2010, NZBC Clause F8 and Appendix C, C6.1.2 of *Acceptable Solution C/AS2*.

Fire Evacuation Matrix: A matrix (or series of matrices) which describe which *evacuation zones* receive 'alerting' or 'evacuate' signals from the fire emergency notification system depending on the location (*firecell*) and type of fire detection. An evacuation matrix may also show how the evacuation sequence progresses over subsequent time intervals. The Fire Evacuation Matrix must be coordinated with the building's fire *evacuation procedure*.

Fire Engineering Report, FER: A document prepared by the fire engineer (sometimes also referred to as the Fire Engineering Strategy or Fire Safety Strategy Report) which outlines the fire safety requirements for a building including the Fire Engineering Strategy. It includes fire engineering sketches and usually describes the basis for the design approach adopted by the design team, details of the fire design solution and specific fire safety requirements necessary to achieve the design objectives. It also includes the fire evacuation strategy, building management and operational requirements as well as any relevant regulatory requirements.

Firefighting Shaft: A *firefighting shaft* provides access for firefighters into the building. It combines the firefighting stair and firefighting lift (if provided) with a firefighting lobby, such that firefighting stairways and lifts should always be approached from inside the building through a firefighting lobby.

FRR, Fire Resistance Rating: The term used to describe the minimum fire resistance required of building elements as determined in the standard test for fire resistance, or in accordance with a 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 structural adequacy, integrity and insulation are satisfied, and is presented always in that order (eg –/60/–).

If the first number (for structural adequacy) is in parentheses, then that rating need only be applied to elements which perform a load bearing function. If the element is not load bearing, then no structural adequacy rating is required. If the last number is '– ', then there is no insulation requirement to the building element.

Noting that standard tests for fire resistance do not measure smoke spread, should a smoke performance also be required to the building element, "Sm" should be added after the three fire resistance numbers (eg (60)/60/60 Sm).

Fire Resisting Closure: A fire rated device or assembly for closing an opening through a *fire separation*. A *fire resisting closure* is intended to include *fire doors*, fire windows or access panels. In this context the opening may be used to permit passage of people or goods, or to transmit light, but does not include an opening to permit the passage of building services. (Source: *C/AS2*)

Fire Safety Stakeholder Team: consists of, but is not limited to:

- client user group – generally involving clinicians, nurses, managers, the fire safety advisor, security management, evacuation consultant, and facilities management/building services, insurer
- design team – architect, engineers, health planners
- building consent authority and associated regulatory peer reviewer, independent inspection authorities
- *FENZ* Fire Engineering Unit and local operational representatives.

Fire Separation: Any building element which separates *firecells* or *firecells* and *safe paths*, and provides a specific *fire resistance rating*. (Source *C/AS2*) A *fire separation* without gaps or penetrations (ie. practicably impervious to smoke) shall meet the requirements of a *smoke separation*. Where gaps or penetrations exist, additional *smoke stopping* treatments are required.

Fire and Smoke Damper (Combined): A closure designed as both a *fire damper* and a *smoke damper*.

Fire Stop: A material or method of construction used to restrict the spread of fire within or through *fire separations*, and having a *FRR* no less than that of the *fire separation*. *Fire stops* are mainly used to seal around penetrations but can also be used to seal narrow gaps between building elements. (Source: *C/AS2*) It must also meet *smoke stop* requirements.

Fire Systems Interface Matrix/Design Fire Matrix: Integrated building systems table showing the cause-and-effect functionality of various fire protection systems.

Flammability index: The index number for flammability, which is determined according to the standard test method for flammability of thin flexible materials. (Source: *C/AS2*) Refer Appendix C of *C/AS2* for a list of standard test methods.

FLED, Fire load energy density: Fire load per unit area (MJ/m^2).

FPANZ: Fire Protection Association of New Zealand

FoH, Front of House: In a *hospital* context, *FoH* relates to spaces which can be accessed by the public and patients (opposite of *BoH* spaces). Some *FoH* spaces may have security control to allow only patient access.

FSO, Fire safety objectives: High level objectives that shall be met by the design.

Group number: The classification number for a material used as a finish, surface, lining, or attachment to a wall or ceiling within an occupied space and determined according to the standard test methods for measuring the properties of lining materials. The method for determining a Group number is described in *C/VM2* Appendix A. (Source: *C/AS2*)

Group sleeping areas: A *firecell* containing sleeping accommodation for a specified number of people who may or may not be known to one another.

Hard standing: A hard-surfaced area that is sufficiently stable to carry a fire truck, and includes a road.

Hospital: Within this document, the term *hospital* refers to all public hospitals owned and managed by *Te Whatu Ora*.

Hospital buildings: Includes all buildings within a public *hospital* campus that are directly associated with patient healthcare. This includes *clinical* and *non-clinical* uses. It includes buildings providing services or direct support to the safe functioning of buildings associated with patient healthcare, such as energy centres, laboratories, imaging services. It does not include standalone administration and car parking buildings and implement and gardening sheds or other buildings on the public *hospital* campus falling within the scope of *C/AS2*.

Hospital street: A *non-clinical firecell,* typically with a primary function of providing circulation and wayfinding and which connects entrances to all clinical HPUs on a level and to stairway enclosures and lifts. It may also connect *final exits*, serve as a fire-fighting bridgehead and provide a safe evacuation route for occupants to parts of the building unaffected by fire. It is not expected to comply with the controls on surface finishes nor on activities within an *exitway* as prescribed in C/AS2. Note that this differs to the definition of a Hospital Street in the UK Department of Health document HTM 05-02. (Refer section 4.10)

HPU, Health Planning Units: Departments within *hospitals* described in *AusHFG*. It is recognised that terms and acronyms used for different HPUs can vary and will need to be clarified for particular projects.

HVAC, Heating, ventilation, and air conditioning systems: Forming part of the building services.

IQP, Independently Qualified Person: A person (or firm) approved by the territorial authority as qualified to inspect certain specified systems and ensure that necessary maintenance occurs (refer Building Act s 108).

Life Safety Systems: Consist of fire detection, warning and extinguishing systems, *smoke control systems*, evacuation and the safety of persons using lifts. The electricity supply to these systems shall not inadvertently be disconnected from electrical equipment required to operate during emergency conditions. *Life Safety Systems* are a subset of the *hospital* essential services.

Limited combustible: A material that does not comply with the requirements for a *non-combustible* material and is classified as A2 in accordance with BS EN 13501-1.

MBIE, Ministry of Business, Innovation and Employment

Non-combustible: Material either—

a) composed entirely of glass, concrete, steel, brick/block, ceramic tile, or aluminium; or

b) classified as non-combustible when tested to AS 1530.1; or

c) classified as A1 in accordance with BS EN 13501-1. (Source C/AS2)

NZBC, New Zealand Building Code

Occupant category P1, P2, P3, P4: Categories of occupant dependency for assistance with evacuation from fire based on mobility status and level of assistance needed, level of staff supervision for staff or security and/or the occupant’s ability to follow instruction. Occupants include patients, staff and visitors. Refer to Sections 3.1 in this Guide.

Open path: That part of an *escape route* (including *dead ends*) within a *firecell* where occupants may be exposed to *fire* or smoke while making their escape. (Source: *C/AS2*)

Place of safety: Either:

a) a *safe place*; or

b) a place that is inside a building and meet the following requirements:

i. the place is constructed with *fire separations* that have fire resistance sufficient to withstand burnout at the point of the fire source; and

ii. the place is in a *building* that is protected by an automatic fire sprinkler system that complies with NZS 4541 or NZS 4515 as appropriate to the *building's* use; and

iii. the place is designed to accommodate the intended number of persons; and

iv. the place is provided with sufficient means of escape to enable the intended number of persons to escape to a *safe place* that is outside a *building*. (Source: *NZBC*)

Protected shaft: A space, other than a *safe path*, enclosed by *fire separations* or external walls used to house building services, lifts, or conveyors which pass from one *firecell* to another. (Source: *C/AS2*)

RACEE: An acronym which describes the sequence of actions carried out when and by a person who discovers fire: Remove, Alert, Confine, Evacuate, Extinguish. The actions are part of established response procedures in *hospitals*. Refer Section 4.3 in this Guide for more information.

RSET, Required safe egress time: Time required for escape. This is the calculated time period required for an individual occupant to travel from their location at the time of ignition to a *place of safety*. (Source *C/VM2*)**Safe path:** That part of an *exitway* which is protected from the effects of fire by *fire separations*, *external walls*, or by distance when exposed to open air. (Source *C/AS2*)

Safe place: A place, outside of and in the vicinity of a single *building* unit, from which people may safely disperse after escaping the effects of a *fire*. It may be a place such as a street, *open space*, public space or an *adjacent building* unit. (Source *NZBC*)

Smokecell: A space within a *building* which is enclosed by an envelope of *smoke separations*, or external walls, roofs, and floors. (Source: *C/AS2*) Where surfaces of the *smokecell* have gaps or penetrations, *smoke stops* may be required to restrict the passage of smoke to other spaces.

Smoke Control Door: A doorset that complies with Appendix C, C6.1.2 of *Acceptable Solution C/AS2* (Source: (*C/AS2*), or is capable of resisting passage of smoke at 200ºC for 30 minutes, tested in accordance with AS 1530.7:2007. A *smoke control door* will be self-closing, self-latching and fitted with smoke seals. It is required to have marking and labels complying with *Acceptable Solution* F8/AS1.

Smoke Control System: A building ventilation system specifically installed for the purpose of controlling smoke in the event of a fire emergency, such as stairwell pressurisation systems and smoke extract systems. These systems are typically designed to certain parts of AS 1668.1 because there are many separate systems covered in the standard, and an engineer needs to select which parts are relevant.

Smoke Damper: A device that operates to restrict the passage of smoke through a duct or opening for the passage of air and operates automatically on receipt of a signal from a remote device. Smoke dampers shall be designed to AS 1682.1-2015 and AS 1530.7-2007 including leakage tests and shall automatically close to the fire position on the loss of control signal.

Smoke Management System: A system installed primarily to operate under normal building occupation for building ventilation or pressurisation, but also designed to provide a secondary function of managing smoke in the event of a fire emergency. Such systems could include operating theatre suite pressurisation systems, as well as general building fresh air and exhaust systems.

Smoke separation: Any building element able to prevent the passage of smoke between two spaces. Smoke separations shall:

Be a smoke barrier complying with BS EN 12101 Part 1, or comply with the following
a) Consist of rigid building elements capable of resisting without collapse:
i) a pressure of 0.1 kPa applied from either side, and
ii) self-weight plus the intended vertically applied live loads, and
b) Form an imperforate barrier to the spread of smoke, and
c) Be of *non-combustible* construction, or achieve a *FRR* of 10/10/-, except that non-fire resisting glazing may be used if it is toughened or laminated safety glass. (Source: *C/AS2*) Additionally, smoke separations should be capable of resisting temperatures up to 200°C.

Smoke Stop: A material or method of construction used to restrict the spread of smoke within or through *fire separations* or *smoke separations* (ie. practicably impervious to smoke). *Smoke stops* are mainly used to seal around penetrations but can also be used to seal narrow gaps between building elements. (Refer also to FPANZ Position Statement PS04 'Smoke Stopping'. www.fpanz.org/docs/position-statements).

Standards New Zealand: Organisation producing New Zealand Standards.

Surface Finishes: The combination of a surface coating and substrate material on surfaces of *building elements* exposed to view. It can be an applied decorative coating or the uncoated *building element* itself. For interior surfaces the requirements are evaluated in terms of a *Group Number*.

Swing bed space: A group of bedspaces or bedrooms usually located at the boundary between different *HPUs*, wards or *evacuation zones* and which, from time to time, may be allocated to one or other of the adjacent department/ward/*evacuation zone*. Swing beds may be allocated for use by patients associated with either *HPU*/ward/*evacuation zone* depending on the varying needs at the time of the respective department/ward.

TA, Territorial Authority

Health NZ– Health New Zealand: responsible for planning and commissioning hospital, primary and community health services from 1 July 2022, refer https://www.tewhatuora.govt.nz**.**

Verification method: Means a *verification method* issued under section 22(1) of the Building Act. **C/VM2** Framework for Fire Safety Design is, for this *DCN*, the relevant *Verification Method* for compliance with Building Code C clauses, Protection from Fire. C/VM1 Solid Fuel appliances is another Verification Method for compliance with Protection from Fire.

WIP, Warden intercommunication point

References

The following referenced documents, in whole or part, are normatively referenced in this document. The date of Standards referenced in the *DGN* has been specified. However, if an updated edition of the Standard has been incorporated by reference in revised New Zealand regulation, eg Electrical Safety Regulations or Building Code documents, then that later edition of the Standard will apply.

MBIE

C/AS2 Acceptable Solution for Buildings other than Risk Group SH, For New Zealand Building Code Clauses C1-C6 Protection from Fire

C/VM2 Verification Method: Framework for Fire Safety Design, For New Zealand Building Code Clauses C1-C6 Protection from Fire

D1/AS1 Acceptable Solution for New Zealand Building Code Clause D1 Access Routes

F6/AS1 Acceptable Solution for New Zealand Building Code Clause F6 Visibility in Escape Routes

F8/AS1 Acceptable Solution for New Zealand Building Code Clause F8 Signs

FENZ

F5-02 GD Designers' guide to firefighting operations Emergency vehicle assess

Standards New Zealand

AS/NZS 2293.1:2018 Emergency lighting and exit signs for buildings – Part 1: System design, installation and operation

AS/NZS 3000:2007 (including amendments 1 and 2) Electrical installations – Known as the Australian/New Zealand Wiring Rules (subject to modifications per Schedule 2 of the Electrical Safety Regulations (2010)

AS/NZS 3003:2011 Electrical installations – Patient areas

AS/NZS 3009:1998 Emergency power supplies in hospitals

AS/NZS 2327:2017 Composite structures – Composite steel-concrete construction in buildings

NZS 4303:1990 Ventilation for an acceptable indoor air quality

NZS 4332:1997 Non-domestic passenger and good lifts

NZS 4510:2022 Fire hydrant systems in buildings

NZS 4512:2021 Fire alarm systems in buildings

NZS 4515:2009 Fire sprinkler systems for life safety in sleeping occupancies (up to 2000 square metres)

NZS 4520:2010 Fire resistant doorsets

NZS 4522:2010 Underground fire hydrants

NZS 4541:2020 Automatic sprinkler systems

NZS/BS 476 Part 21:1987 Fire tests on buildings and structures – Methods for determination of the fire resistance of load bearing elements of construction

NZS/BS 476 Part 22:1987 Fire tests on buildings and structures – Methods for determination of the fire resistance of non-load bearing elements of construction

SNZ/PAS 4509:2008 New Zealand Fire Service firefighting water supplies code of practice

ISO

ISO 9239.1:2010 Reaction to fire tests for flooring – Part 1: Determination of the burning behaviour using a radiant heat source

ISO 23932 – 1:2018 Fire safety engineering — General principles – Part 1

Standards Australia

AS 1366: Parts 1-4 Rigid Cellular Plastics Sheets for Thermal Insulation

AS 1530.2: 1993 Methods for fire tests on building materials, components and structures. Part 2 Test for flammability of materials

AS 1530.4:2014 Methods for fire tests on building materials, components and structures. Part 4 Fire-resistance tests for elements of construction

AS 1530.7:2007 Methods for fire tests on building materials, components and structures Part 7: Smoke control assemblies− Ambient and medium temperature leakage test procedure

AS 1668.1:2015 The use of ventilation and air conditioning in buildings – Part 1: Fire and smoke control in buildings

AS 1668.2:2012 The use of ventilation and air conditioning in buildings – Part 2: Mechanical ventilation in buildings

AS 1670.4:2018 Fire detection, warning, control and intercom systems – Systems design, installation and commissioning Emergency warning and intercom systems

AS 1682.1:2015 Fire, smoke and air dampers Specification

AS 1682.2:2015 Fire, smoke and air dampers Installation

AS 1851:2012 Routine service of fire protection systems and equipment

AS 2220.1:1989 Emergency warning and intercommunication systems in buildings – Part 1: Equipment design and manufacture

AS 4072.1:2005 Components for the protection of openings in fire-resistant separating elements. Part 1: Service penetrations and control joints

AS 4428.16:2020 Fire detection, warning, control and intercom systems – Part 16: Control and indicating equipment Emergency warning control and indicating equipment

AS 4428.4:2016 Fire detection, warning, control and intercom systems – Part 4: Control and indicating equipment Emergency intercom control and indicating equipment

AS 5113:2016 (+A1:2018) Classification of external walls of buildings based on reaction-to-fire performance

British Standards

BS 6206:1981 Specification for impact performance requirements for flat safety glass and safety plastics for use in buildings

BS 8414.1:2015 +A1:2017 Fire performance of external cladding systems – Test method for non-loadbearing external cladding systems applied to the masonry face of a building

BS 8414.2: 2020 Fire performance of external cladding systems – Test method for non-loadbearing external cladding systems fixed to and supported by a structural steel frame

BS 9999:2017 Fire safety in the design, management and use of buildings – code of practice

BS EN 81-20:2020 Safety rules for the construction and installation of lifts. Lifts for the transport of persons and goods, Passenger and goods passenger lifts

BS EN 81-72:2020 Safety rules for the construction and installation of lifts. Particular applications for passenger and goods lifts Firefighter lifts

EN 81-76 :2022 Evacuation of persons with disabilities using lifts

BS EN 12600:2002 Glass in building. Pendulum test. Impact test method and classification for flat glass

Department of Health (UK)

Health Technical Memorandum 05-02: Firecode Guidance in support of functional provisions (Fire safety in the design of healthcare premises (HTM 05-02), 2015 edition

HTM 05-03 – Part E Escape Lifts

BD 2466 – Guidance on the emergency use of lifts or escalators for evacuation and fire and rescue service operations

BRE

BR 135 Fire performance of external thermal insulation for walls of multistorey buildings

FPANZ

COP-04 Code of Practice for the Integration of Building Fire Safety Systems with other Services

Passive Fire Position Statements

Engineering New Zealand

Practice Note 22: Guidelines for Documenting Fire Safety Designs (2011)

SFPE (NZ)

Construction Monitoring Guide – Fire Engineering (2021)

BRANZ

Guide to Passive Fire Protection in buildings (2022)

NFPA

NFPA 3 – Standard for Commissioning of Fire Protection and Life Safety Systems

NFPA 4 – Standard for Integrated Fire Protection and Life Safety System Testing

ASFP

ASFP TGD 19:2014 – Fire Resistance Test for Open State Cavity Barriers

ANSI/ASTM

ANSI/ASTM E2307 Standard Test Method for Determining Fire Resistance of Perimeter Fire Barriers Using Intermediate-Scale, Multi-story Test Apparatus, or

BS EN 1364-4:2014 Fire resistance tests for non-loadbearing elements.

SIS

Technical Specification SIS-TS 24833:2014/INSTA 950:2014 Fire Safety Engineering — Comparative method to verify fire safety design in buildings

Te Whatu Ora/Health New Zealand

New Zealand Health Facilities Design Guidance Note

Australasian Health Facilities Guidelines

Design Guidance and Assurance Framework

Part 1: Background and context

1 Introduction

1.1 Document purpose

1.1.1 The primary purpose of this document is to provide guidance to fire engineers engaged on projects to build new or make alterations to existing public *hospital buildings*. It provides the minimum standards of fire safety and design procedures that are expected by *Health New Zealand* and will also meet, as a minimum, Building Code requirements for public *hospital buildings* related to Protection from Fire (Clause C and Code clauses D and F as they relate to protection from fire).

1.1.2 It is also intended to assist other parties interacting with fire engineers (such as health planners, mechanical/electrical/structural/fire protection engineers and evacuation specialists) to understand fire engineering constraints.

1.1.3 This *design guidance note, DGN*, recognises the specialist nature of *hospital buildings*. The immediate and total evacuation of *hospital buildings* in the event of fire, particularly in *clinical* access areas, would be a major logistics exercise and, from a patient safety perspective, is not desirable. Therefore, most buildings within a public *hospital* campus require any evacuation to be a formally managed process following pre-determined procedures, rather than an all-out evacuation strategy.

1.1.4 *Hospital buildings* with managed evacuation schemes do not fall within the scope of *Acceptable Solution C/AS2* or *Verification Method C/VM2.* This document is intended to fill this current gap by applying statutory regulations sensibly and consistently to provide guidance and increased fire design clarity for fire engineers. The aim is to facilitate *BCA* building consent approval decisions and *FENZ evacuation scheme* approval, thereby minimising delays during design, consenting, commissioning and evacuation planning for *hospital buildings*.

1.2 Scope of application

1.2.1 This document shall be used in the design of:

- new public *hospital buildings* throughout Aotearoa New Zealand.

1.2.2 This document should also be applied as much as is practicable for the design of:

- extensions and alterations to existing public *hospital buildings*, whether leased or owned
- conversion of existing buildings into public *hospital* facilities, whether leased or owned.

For conversion, alteration or extension of existing buildings for a public *hospital* campus, the extent to which this document can reasonably be applied will vary depending on project-specific requirements and constraints.

1.2.3 This guide may be a relevant reference for other healthcare facilities in NZ.

1.3 Design Guidance Note requirements and reliance on other controls being in place

1.3.1 For new public hospital buildings, the following systems and controls shall be specified and developed during design and construction. For existing hospital buildings, the following systems and controls are expected to be in place, or added where reasonably practicable.

1.3.2 Automatic fire suppression systems shall be installed throughout all public *hospital buildings*.

1.3.3 Automatic detection and alarm systems shall be installed throughout all *hospital buildings*. Appropriate consideration should also be given to isolated and low risk buildings within the public hospital campus.

1.3.4 All *hospitals* shall keep a record of the Fire Engineering Report, details of the evacuation procedures, patient dependency and staffing levels, together with information on the operation and maintenance of any fire protection measures of the *hospital building*.

1.3.5 Documented emergency provisions should address how critical hospital services will continue in the event of a fire emergency.

1.3.6 Appropriate procurement processes for fire engineering services should be included in the scope:

- the collaboration of all relevant engineering, evacuation, architectural and health planning specialist disciplines during the concept design stage for new *hospitals buildings* or redeveloping existing *hospital buildings*
- documented co-ordination of fire safety provisions within other design disciplines as required
- early engagement with the appropriate *BCA* and *FENZ* Engineering Unit
- peer review of designs for significant projects
- providing for appropriate level of construction monitoring by the fire engineer, and
- providing for product specification, testing and approval of fire safety critical products being installed in the *hospital building* (fire doors, fire dampers, cladding, etc), refer Appendix E.

1.3.7 Appropriate recognised Standards shall be specified for the procurement of fitout materials, hard and soft furnishings, specialist *clinical* equipment, etc, and compliance is checked to avoid fire loads being in excess of those generally incorporated into fire engineering design.

This *DGN* has been written on the assumption that the *hospital* will implement a robust fire safety management system for functioning of the hospital. This will include having management obligations understood with appropriate fire safety processes and resources in place, and in the event of a fire, well-trained staff to implement pre-agreed emergency plans (eg for fire, security, healthcare emergency) to manage patient, staff and visitor safety. System elements include roles and responsibilities, audit, staff training, trial evacuations, emergency response and communication protocols, and evacuation scheme development. An outline of the key parts of an integrated fire safety system is provided in Figure 1.1.

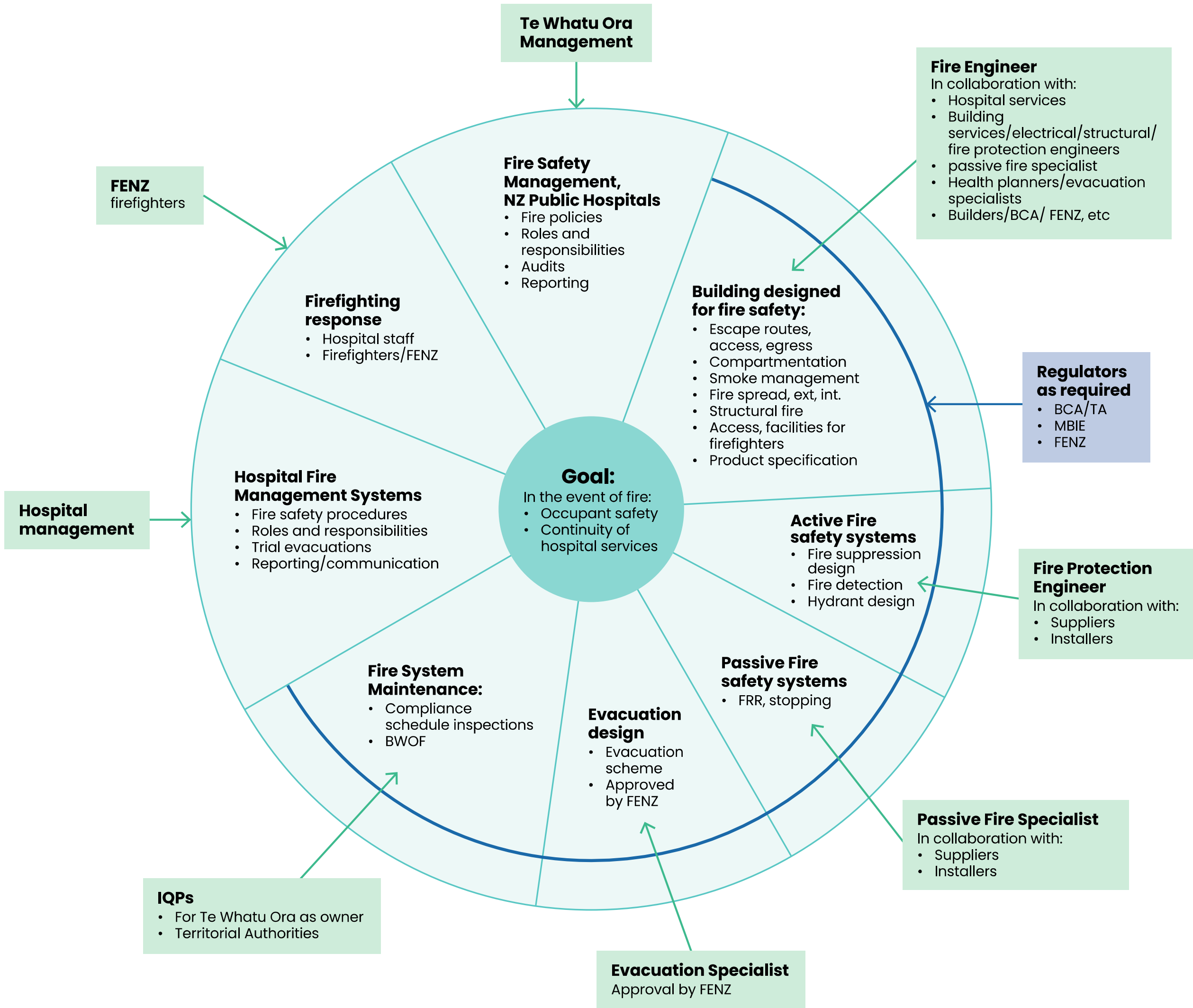


Figure 1.1: Integrated fire safety inputs for New Zealand public hospitals

1.3.8 In developing an appropriate fire safety strategy for *hospital* premises it is necessary to consider the way in which it will be operated and managed, as fire safety in *hospital buildings* relies on this. This is especially important where care is provided for high support *occupant categories P1 and P2* (refer Section 3.1).

Building management processes are generally not recognised in Building Code provisions.

1.3.9 It is essential that the design team has a full understanding of the type of care being provided and the dependency of the patients, and that the client team fully appreciate the constraints imposed by the design on the movement and evacuation of patients, visitors and staff. The design team and approving authorities should not assume that a design which complies with the requirements in this document will automatically be safe: the design needs to be supported by fully developed emergency procedures and an approved *Evacuation Scheme*. Emergency procedures need to be maintained and proactively reviewed for applicability for the entire duration that *hospital* services are provided in the *hospital building*.

A design that relies on an unrealistic or unsustainable management regime cannot be considered to have met fire safety objectives.

1.3.10 The preparation of emergency procedures and *Evacuation Schemes* shall commence early during the project design phase and be developed through the user consultation process. Refer to Appendix H for further detail on *evacuation schemes.* The fire safety strategy and fire evacuation procedures shall be developed and agreed through discussions with the *Fire Safety Stakeholder Team* (refer Definitions).

1.3.11 Each type of *clinical* service will present its own unique set of problems which may emerge during the design phase. It is therefore essential that architects and designers, through the *FEB* and client user group consultation process, fully understand and record in the *FEB* and during the design phase the fire safety issues associated with the *clinical* service being provided and the patients being treated.

1.3.12 The outcomes of these discussions shall be used to inform the design of the building as well as the fire evacuation procedures, including all assumptions relating to the availability of adequately trained staff to manage an evacuation (including night shift or other periods of minimum staffing numbers).

The fire *Evacuation Scheme* is required to be submitted to the *FENZ* local office for approval 30 days before the *hospital building* is occupied. However, FENZ can review and provide an approval in principal for public *hospital building Evacuation Schemes* earlier, generally from the time the design is complete and the Building Consent is being applied for. This is because hospital layouts generally remain fixed as opposed to many commercial buildings where last minute fitout changes can impact evacuation strategies. This early engagement makes the final approval of the *Evacuation Scheme* just prior to occupation a simpler process, checking that the construction is per the original design.

The application is typically submitted by the evacuation consultant, or by Te Whatu Ora directly for simple buildings and minor scheme amendments.

1.4 Outline of this document

1.4.1 The document is divided into three Parts: Part 1 includes Sections 1 to 3 providing background and context; Part 2, Sections 4 to 10, provides prescriptive fire engineering design requirements; Part 3, Sections 11 to 14, provides performance-based fire engineering design requirements. These Sections are followed by Bibliography and Appendices.

1.4.2 Part 1 Background and Context includes Sections 1 to 3:

- Section 1: Introduction, provides the overarching context and application of this document.
- Section 2: Principles of Fire Safety Design in Hospitals, outlines the Principles/Objectives/Philosophy for fire engineering design (what we are trying to achieve). It includes material relevant for the early *hospital building* concept design and business development case stages, such as the placement and co-location of important *hospital building* layout arrangements like plant rooms, cores for lifts and stairs, and the arrangement of health planning units (*HPUs)* likely to contain 'not immediately movable' patients.
- Section 3: Occupant Levels of Assistance and Staff Levels for Means of Escape from Fire, outlines categories of patient dependency and levels of assistance required for evacuation.

1.4.3 Part 2 Prescriptive Fire Engineering Design Requirements. It is intended to be standalone although it references many parts of C/AS2. Part 2 includes Sections 4 to 10:

- Section 4: Movement to a Place of Safety, provides *escape route* requirements, horizontal and vertical, to address the means of escape principles and fire evacuation strategy outlined in Section 2. It includes material that describes more specifically how/when lifts could be used (in a fire emergency) and expectations of staff involvement.
- Section 5: Firecells, provides *firecell* and *smokecell* requirements to address the means of escape principles and fire evacuation strategy outlined in Sections 2.
- Section 6: Fire Protection Systems and Building Services Systems, outlines requirements for automatic fire sprinkler systems, fire detection and alarm systems and emergency warning and intercommunication systems (*EWIS*) in the initial portion of the section dealing with fire protection systems. Ventilation systems, controls and *building management systems*, electrical systems, security systems,

and lifts as they relate to fire engineering design are addressed and coordination requirements and responsibilities are identified.

- Section 7: Interior Surface Finishes refers to the provisions of *Acceptable Solution C/AS2*. However, specific surface finishes for *hospital buildings* are also provided.
- Section 8: External Fire Spread, addresses controls against the fire spread between buildings located within a *hospital* site so that a fire within any *hospital building* does not interrupt the continued operation and occupation of a *hospital building* containing occupants receiving care and for those *hospital buildings* that provide support services (ie power generation, supply and water reticulation).
- Section 9: Access, Safety and Facilities for Firefighting, details the requirements so that the *fire brigade*, once alerted, will attend quickly and, once there, are provided with adequate facilities to ensure the protection of life and property. This includes: site access; vehicular access around the *hospital buildings* for fire appliances; access into the *hospital building* for the firefighting personnel; the provision of building hydrant systems within the *hospital building*; private fire hydrants; and venting for heat and smoke.
- Section 10: Fire Rating Resistance provides prescriptive fire rating requirements.

1.4.4 Part 3 includes Sections 11 to 14 describing performance-based fire engineering design requirements. It is recognised that there may be other ways of satisfying the healthcare or *NZBC* functional requirements by adopting a performance-based fire safety engineering approach, mainly as an alternative design approach to Part 2 (Sections 4 to 10). A fire safety engineering approach that considers the fire safety strategy in a holistic way can provide a different approach. If such an approach is used, the parties promoting it are responsible for demonstrating compliance with the functional requirements for the facility. It is intended that Part 3 be developed further in the future. Designers will need to take care if this approach is chosen and approval will be required from *Te Whatu Ora*.

- Section 11: Fire Engineering Performance-based Design provides high level guidance on fire engineering performance-based design of Aotearoa New Zealand public *hospital buildings*, ie design which is outside the prescriptive requirements provided in Part 2.
- Section 12: Performance-based design inputs for calculating *RSET*. Input data and sources provided in the Section will need to be verified as appropriate to use on the project as part of the *FEB* process.
- Section 13: Performance-based design inputs for calculating *ASET*. Input data and sources provided in the Section will need to be verified as appropriate to use on the project as part of the *FEB* process.
- Section 14: Structural Stability During Fire, discusses performance objectives for fire resistance, fire scenarios to consider, methods to determine fire resistance.

1.4.5 Appendices provide additional informative information:

- Appendix A. Legislative requirements

- Appendix B. Fire evacuation survey
- Appendix C. Evacuation using lifts
- Appendix D. Helipad design
- Appendix E. Product and system compliance
- Appendix F. Performance-based design process
- Appendix G. Background to occupant categories
- Appendix H. Evacuation scheme
- Appendix I. Passive fire design and installation
- Appendix J. Active fire system descriptions

1.5 Use of this document

1.5.1 This *DGN* has been prepared on the understanding that it will be used by competent persons having sufficient technical training and *hospital building* design experience, or technical knowledge and other qualities, both to fully understand the fire and healthcare risks involved, and to properly apply the statutory and guidance provisions referred to in this document. This competency is not likely to be discharged by a single individual and is more likely to rely on the collective experience and understanding of the fire safety strategy by the *Fire Safety Stakeholder Team*.

1.5.2 Where professional engineering judgement is needed, it is to be applied by *Health NZ* designers, fire engineers, *Building Consent Authority* staff and *FENZ* staff based on a full understanding of the problem, taking into account the patient *occupancy categories* and risk factors associated with evacuation appropriate to the facility and the implications of the dependency and medical conditions of the patients being treated.

1.5.3 Complying with the text in the numbered paragraphs of this *DGN* is a requirement (normative), whereas notes and background commentary (informative) are contained either within a text box with outside border or in an appendix. The normative requirements have been written following the ISO/IEC guidelines for preparing technical standards (distinct verbal forms are used intentionally) and the document should be interpreted with this in mind.

1.5.4 It is expected that following the prescriptive design requirements of Part 2 (Sections 4 to 10) will be followed wherever possible and sensible. There will be occasions when, while generally following a prescriptive design path, there are some specific aspects of Part 2 that may not be appropriate or possible to comply with. In these situations, performance-based consideration of those aspects may be possible provided that holistic fire engineering design is applied. This may include fire/evacuation modelling to demonstrate that the design meets Health NZ and Building Code operational and safety requirements to the satisfaction of all parties. A fully performance-based design solution following the principles set down in Part 3 is also possible, but will need early approval from Te Whatu Ora.

1.5.5 A design solution prepared in accordance with this *DGN*, whether following Part 2 using prescriptive methodologies, Part 3 using performance-based methodologies or a mixture of the two, are considered *Alternative Solutions* for Building Code compliance consenting decision making. They do not have the same regulatory status as a design following an *Acceptable Solution* or *Verification Method* published by *MBIE*.

1.6 Wider hospital design considerations

1.6.1 *Health NZ* requires project teams to use the *Australasian Health Facility Guidelines, AusHFG,* as the primary reference guide for briefing and designing health facility projects to encourage standardisation and provide consistency of design and project reporting across health projects without restricting innovation.

1.6.2 It is recognised that, while the *AusHFG* is primarily suitable for use in Aotearoa New Zealand, there are instances where there may be Aotearoa New Zealand-specific considerations that need to be determined.

1.6.3 The *AusHFG* focuses on clinical/healthcare guidance and does not provide fire engineering design details. This document is one of a suite of *Design Guidance Notes (DGN)* being developed by *Health NZ* to clarify specific requirements supplementary to *AusHFG* for all health facility development projects in Aotearoa New Zealand.

1.6.4 *Health NZ* has described the overarching principles of design for Health Facilities in the New Zealand Health Facility Design Guidance Note, refer: https://www.tewhatuora.govt.nz/for-the-health-sector/health-sector-guidance/health-facility-design-guidance-note/. A summary of the main elements is listed below:

- **Kaupapa Māori**
  Meaningful engagement with Māori is vital to improving health equity for Māori and ensuring that Treaty obligations are addressed.
- **Environmental sustainability**
  Sustainable healthcare infrastructure promotes better health outcomes, lowers emissions, reduces operating costs, promotes efficient use of resources, and assists with meeting responsibilities under the Carbon Neutral Government Programme (CNGP).
- **Universal design**
  Effective Universal Design practices ensure that all people can access, use, and understand the environment to the greatest extent possible without the need for adaptations or specialised solutions.
- **Co-design**
  Effective co-design practices ensure that specific stakeholder needs are appropriately reflected in the design outcome and that effective facility operation and service delivery are supported.

- **Futureproofing**
  Successful futureproofing ensures durability over time while providing initial flexibility of designed spaces, and adaptability.
- **Site master planning**
  Effective site master planning ensures that current and future health infrastructure supports current and future clinical service and asset management requirements and broader community objectives. Facility design should be aligned and integrated with a site masterplan.
- **Resilience and post-disaster planning**
  Effective disaster and emergency response planning ensures that healthcare facilities are designed to remain operational during and after natural disasters and pandemics.
- **Safe and secure environments**
  Effective design of safe and secure environments supports the safety of all building occupants (including building maintenance access).
- **Dignity, autonomy, and choice**
  Effective facility design provides a person with more choices for satisfying personal preferences and requirements.
- **Therapeutic environment**
  Effective facility design can contribute to good health outcomes.

1.6.5 It is intended that health facility project teams will refer to the *AusHFG* in combination with *Health NZ Design Guidance Notes*, such as this document, Fire Engineering Design for New Zealand Public Hospitals, and relevant New Zealand legislation, such as the Building Act, Building Code and Fire Safety, Evacuation Procedures and Evacuation Schemes Regulations.

1.6.6 *Hospital buildings* shall be designed to support efficient and effective healthcare processes. This is enabled through careful space planning which seeks to optimise the placement of *Health Planning Units, HPUs,* and their adjacency to each other. This space planning typically focuses on the flow of staff, patients, families and care partners, information, medications, supplies, equipment, and waste.

1.6.7 In addition to these usual *hospital* flows, a fire safe design also needs to incorporate the flows of building occupants, safe evacuation (where evacuation is required) and access for emergency personnel during an emergency.

1.6.8 Designing for a fire emergency shall be based around providing a number of ‘layers of protection’ (eg sprinklers, fire rated construction) and providing a suitable level of ‘design robustness and redundancy’. For this reason, the fire engineering design should seek to minimise single points of failure to an appropriate level, such as minimising / eliminating dead end *escape routes* wherever possible.

1.7 Design and construction process

1.7.1 *Health NZ* require the process outlined in 1.7.2 to 1.7.12 to be followed. Figure 1.2 provides a conceptual outline of the different stages and involvement occurring in hospital development and Figure 1.3 shows the steps for the fire design and construction of their healthcare projects.

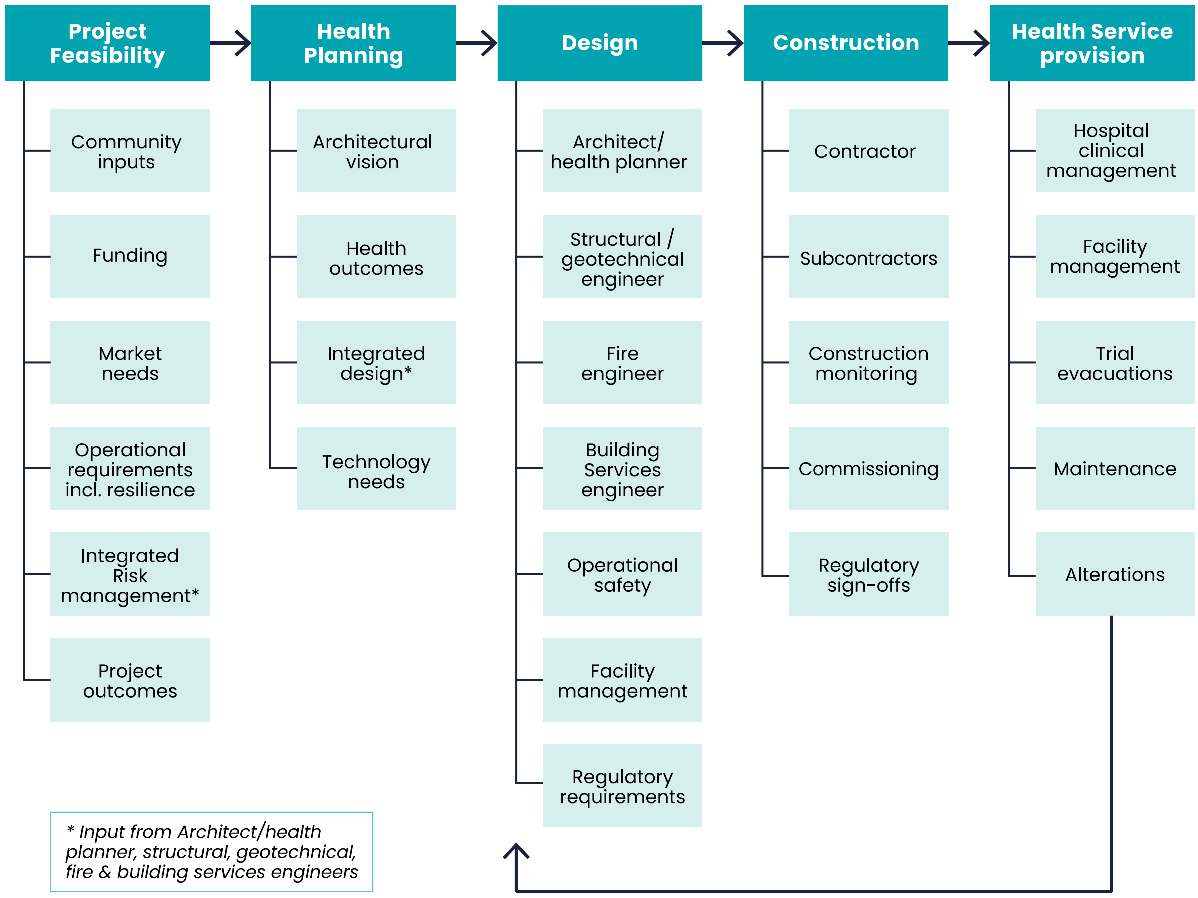


Figure 1.2: Hospital facility development stages and involvement

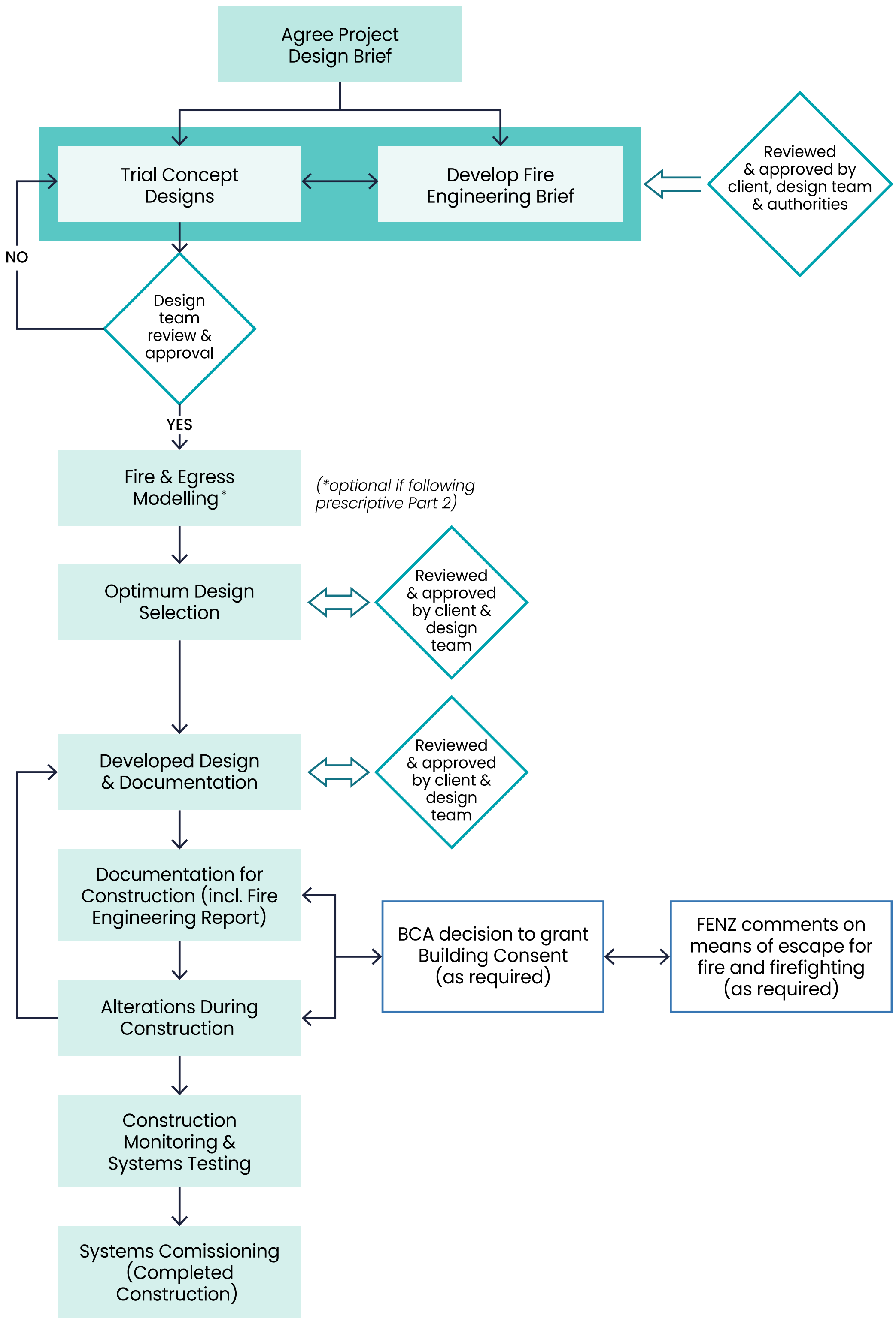


Figure 1.3: Fire engineering design process

1.7.2 From a client briefing on the requirements of the project, the fire engineer shall lead the *Fire Safety Stakeholder Team* and, in collaboration with them, prepare trial concept designs based on this *DGN* and a *Fire Engineering Brief, FEB,* document to record agreed key input parameters used in the design. These may include numbers of patients, patient types and minimum number of staff who will assist with evacuation.

1.7.3 The *FEB* document shall be reviewed and approved by *Health NZ* prior to its use to support consent application.

1.7.4 A desktop exercise shall be undertaken with relevant stakeholders to verify that the concept evacuation strategy is coordinated in detail with the *hospital building* design.

1.7.5 The fire engineer shall develop fire designs based on this *DGN* as part of the overall design team and develop the *Fire Engineering Report*. The report shall include the Fire Engineering Strategy and *Fire Evacuation Matrix* and clearly document assumptions/requirements with respect to the evacuation procedure.

1.7.6 Throughout the design process, beginning at the concept phase, the features of the fire engineering design shall be coordinated with the rest of the design team (eg client, design engineers, architect, evacuation consultant) so that it is integrated with the completed project documentation. This includes the provision of performance expectations for relevant active and passive systems (refer Appendix I and J) as well as pertinent emergency management expectations. Figure 1.2 lists involvement and input required from key parties during the various project stages.

Section 6 provides an outline to key fire systems design issues to facilitate discussions with the project fire protection engineer, building services engineer and others.

The *FPANZ* COP4 document, Code of Practice for the integration of Building Fire Safety Systems provides a useful reference, in particular Figure 1, Systems Integration Process flow chart. The roles and responsibilities of all parties for construction monitoring and commissioning should be discussed and agreed prior to completing the design work.

Practice Note 22 *Guidelines for Documenting Fire Safety Designs* provides further information to designers about the provision of adequate project documentation, the need for ongoing coordination, and how the fire engineering design is to be incorporated into the plans and specifications of other designers.

1.7.7 Any departures from this *DGN* shall be reviewed and approved by Te Whatu Ora.

1.7.8 For significant projects, decided in discussion with Te Whatu Ora, a fire design peer review shall be undertaken by an independent fire engineer. All performance based Alternative Solution fire designs, significant projects and buildings involving non-minor Section 112/115 *ANARP* assessments require a fire design peer review undertaken by an independent *CPEng* or equivalent fire engineer.

1.7.9 A building consent application shall be submitted to the *Building Consent Authority* for their review and decision to grant a building consent.

Under section 46 of the Building Act, applications for building consents using this *DGN* shall be provided to *FENZ*, to enable *FENZ* to comment on the provisions for the means of escape from fire, and the needs of persons authorised by law to enter buildings to undertake firefighting.

The *Building Consent Authority* decides what appropriate action is required as a result of any comments made by *FENZ* in relation to Building Code compliance. The fire engineer and peer reviewer may have to address any Code compliance means of escape matters or firefighting provisions raised.

1.7.10 The fire engineer shall appropriately review critical fire safety products and systems being specified, details and installed, such as *fire doors*, *fire dampers*, and cladding, refer Appendix E.

1.7.11 The fire engineer should undertake construction monitoring during the construction phase of the project to observe the installation of fire engineering design features. Guidance on this task is provided within the SFPE NZ Construction Monitoring Guide which helps to clarify the roles and responsibilities of those involved in building projects and creates a benchmark for decision-making between the relevant parties. The level of construction monitoring (CM) service shall be appropriate, influenced by the size, the importance and the complexity of the construction works, as well as the experience and demonstrated skill in quality management of the constructor. All parties undertaking construction monitoring shall always work within their own area of expertise (competency) and seek advice when encountering design or construction issues beyond their limits. A fire engineer is unlikely to be an expert in all fire safety systems. The need for additional third-party construction monitoring expertise should be discussed and agreed prior to completing the design work.

1.7.12 The fire engineer should be involved in the commissioning of systems relating to fire safety, Te Whatu Ora's representative. The FPANZ COP4 document, Code of Practice for the integration of Building Fire Safety Systems provides a useful reference, in particular Figure 1, Systems Integration Process flow chart. This chart notes that the fire engineer is to develop the initial *Design Fire Matrix* so that it meets the strategic details of the fire engineering design. This matrix would then be further developed by the system designers (eg fire protection designer, building services designers).

1.8 Document relationship to legislation

1.8.1 *Hospital buildings* shall meet legislative requirements, including compliance with the Building Code and Evacuation Regulations. This document aims to facilitate fire engineers achieving legislative compliance when designing *hospital buildings* as well as meeting *Health NZ* operational requirements.

1.8.2 Most *hospital buildings* require a managed evacuation strategy in which occupants move to a *place of safety* inside *hospital buildings*. The evacuation process is sequenced according to occupant priority and levels of assistance needed, rather than following a simultaneous all-out evacuation to a *safe place*. Buildings that use a managed evacuation process to a *place of safety* inside buildings are currently outside the scope of the current *C/VM2* or *C/AS2* for compliance with the Protection from Fire provisions of the Building Code. This means that there are currently no prescriptive design methods or solutions available to designers for these buildings. Designs developed following this *DGN* are considered *Alternative Solutions*.

1.8.3 This document has been developed to improve consistency and certainty for the fire design of *hospital buildings* with managed evacuation procedures.

1.8.4 Buildings on a *hospital* campus that have an *evacuation scheme* where patients, staff and visitors immediately evacuate to a *place of safety* outside the building, can be designed using New Zealand Building Code *C/AS2* (*Acceptable Solution* for Buildings other than Risk Group SH), or *C/VM2* (*Verification Method*: Framework for Fire Safety Design) provided they are otherwise within the scope of *C/VM2* or *C/AS2*.

1.8.5 Some provisions are included within this document that may be considered to be in excess of minimum requirements for Building Code compliance. The Building Act and the Building Code provide for the safety of occupants, protecting other property and provisions for firefighting. They do not provide for the ongoing functionality of *hospital* services following a fire. *Health NZ* aims to provide uninterrupted critical *hospital* functions to support the community following an emergency, therefore some increased fire protection measures are included. Other additional provisions support *Health NZ* objectives for standardisation, consistency and operational effectiveness.

1.9Alterations to existing hospital buildings

1.9.1 As noted above, alterations to an existing *hospital building* shall comply wherever possible to the requirements of this *DGN*. Existing buildings may not reasonably allow for full compliance. Departure from the *DGN* for specific projects will be approved be Te Whatu Ora.

1.9.2 All works classified as an “alteration to an existing building” or a “change of use” shall meet section 112 or 115 of the Building Act respectively. Where an alteration is made to an existing building or there is a ‘change of use’ (refer to Building (Specified Systems, Change the Use, and Earthquake-prone Building) Regulations 2005 for use categories of all or parts of buildings) the building shall comply with the requirements of the Building Code, *NZBC*, relating to means of escape for fire and accessibility ‘as nearly as is reasonably practicable’, *ANARP,* and continue to comply with the other provisions of the Building Code to the same extent as before the alteration.

1.9.3 The fire engineering design shall consider, to the extent required by the Building Act under s.112 and s.115, the Building Code clauses relating to ‘means of escape from fire’. This includes, where applicable to ‘means of escape from fire’, Clauses C3-C6, D1, F6, F7 and F8 of the Building Code. There may also be other considerations under Health and Safety at Work Act: 2015 (refer HSE, s 22 for meaning of reasonably practicable under HSE).

When altering or changing the use of an existing building, sections 112 and 115 of the Building Act, require the means of escape from fire to be brought up to *as nearly as is reasonably practicable, ANARP,* to the Building Code provisions. The fire engineer shall determine the extent to which the provisions associated with means of escape need to be applied. This will require an analysis of the 'life safety sacrifice / benefit' of the existing situation against current Building Code requirements for each compliance issue to present to the *BCA* or *TA* for their decision. Options include 1) the existing means of escape provisions in the *hospital building* can remain as-is, 2) some improvements need to be provided, or 3) a full upgrade to Code compliance is required.

This *DGN* accepts that alterations to existing hospital buildings may satisfy some but not all fire safety requirements. Finances will always be constrained and an evaluation process will inevitably require levels of compromise. The process will be most effective when it involves contributors with acknowledged experience and knowledge in their area of specialisation.

Many fire safety systems are interrelated and can be complex, such as: the coordination of fire detection, alerting to the appropriate staff, automatic operation of ventilation and smoke control systems, coordination of staff actions and evacuation procedures.

The complexity of these systems and their interrelationships depends on the size and scale of the hospital and the range and type of healthcare services that are provided. Integrating the fire-specific systems and their interfaces into the design of a new building is challenging enough. Adding new fire design requirements to an existing building is likely to be even more difficult, especially for existing buildings accommodating a healthcare service for which they were not originally designed.

The following stepped approach gives further guidance on balancing life safety sacrifice / benefit for public hospital projects, ie balancing the additional costs of incorporating some fire safety features with a resultant reduction in life safety risk in the event of fire against the impact of possibly not being able to provide certain hospital services:

1. **Discover** the fire safety documents of record for the existing building. This needs to be comprehensive if these documents have not been collated previously.
   Referring only to the most recent documents prepared for alterations to an existing building can be misleading if that fire design considered only part of a building or was prepared based on assumptions stated in earlier fire design work.
   If there are no fire assessment documents for the building then an in situ review or desktop evaluation may be required.

2. **List** the range of healthcare services which need to be accommodated in the existing building and the range of occupant categories associated with each (i.e. occupant vulnerability in a fire emergency and the level of occupant assistance needed).
   Use the Fire Engineering Brief process with input from the relevant stakeholders (principally the representatives from hospital management, healthcare planner, architect and fire engineer)

3. **List** the fire safety features and systems <u>*required*</u> for each of the occupant categories and those provided or <u>*not currently provided*</u> by the existing building.
   Compare the lists: in particular the gaps between the requirements (in this DGN, for a new building) and those <u>*not provided*</u> by the existing building.

4. **Rank** the fire safety requirements in this gap assessment in approximate order from highest importance to lowest. Ranking the importance of fire safety features might follow this order:

- evacuation procedures and hospital management plans for managing fire emergency
- horizontal means of escape (to an internal place of safety if required)
- automatic fire detection
- automatic fire suppression
- smoke containment
- firecell compartmentation
- fire resistance and structural stability
- fire brigade notification
- firefighter access
- vertical evacuation to a safe place
- control of external fire spread.

5. **Compare** the most important features from the fire safety gap assessment with a corresponding list of the healthcare services (ranked in order of importance) proposed for the existing building, using the occupant categories associated with those healthcare services as the common comparator. This comparison can form the basis of a cost-benefit assessment, prioritised by healthcare service, informed by occupant category and the importance and cost of providing the fire safety features to reduce the gaps where these are not provided in the existing building

An iterative approach is likely to assist when making judgements and decisions regarding which aspects of fire safety upgrade should assert priority or defer to allocating resources for public healthcare services and patient benefit.

1.9.4 The fire engineer should undertake site inspections and an assessment based on the comment box above to understand compliance for Building Code clauses C, D1, F6, F7 and F8 (as related to ‘means of escape from fire’), with engagement of design expertise as required, for example:

- Electrical Engineer – to design possible upgrades to F6 ‘emergency lighting’ and F8 ‘escape route signage’ compliance
- Architect – to design possible upgrades to *fire separation* wall construction or universal access.

2 Principles of fire safety design in hospitals

2.1Introduction

2.1.1 The fire engineering design of *hospital buildings* requires a specific design approach and collaborative input from a range of stakeholders. Section 2 outlines the design principles that *Health NZ* requires to be followed for the fire design of public *hospital buildings*. These design principles should also be considered when altering existing buildings. The subsequent Sections in this *DGN* describe in more detail how these principles are applied in design.

2.1.2 In *hospital buildings*, the immediate and total evacuation of the building in the event of fire may be a challenging exercise and not desirable from a patient and staff safety perspective.

> The full evacuation of an entire large *hospital building* in the event of fire would be an enormous exercise in which patients might be placed at risk due to trauma or their medical condition. Immediate full evacuation is generally not practicable. Factors which influence practicability include number of occupants in the total building occupant load who need assistance to escape from fire, floor area, number of levels and the vulnerability of the occupants. For small *hospital buildings*, full evacuation may be required at some point, although not immediately.

2.1.3 Hospital patients may be more susceptible to the effects of exposure to smoke and, as such, are more vulnerable.

> Occupants in *hospital buildings* include patients with restricted mobility, for example patients who use wheelchairs and patients confined to bed. They cannot negotiate *escape routes* unaided, particularly stairways. Patients under medication or any form of sedation may require staff assistance to evacuate away from the location of a fire. Patients who are dependent on electrical/mechanical equipment for their survival cannot always be disconnected and moved rapidly without serious consequences. Many medical procedures will require a delayed evacuation response either while the procedure is interrupted or completed and the patient prepared for evacuation, or because the nature of the procedures requires a strategy of staying in a protected place because moving patients may be life threatening.

2.1.4 *Hospital buildings* that accommodate occupants who cannot or should not be evacuated directly to a *safe place* shall be divided into a series of *firecells, smokecells* as well as *evacuation zones*.

2.1.5 The fire engineering design shall consider the different *occupant categories* who require various levels of assistance during a fire emergency, either for safe evacuation or management until the emergency has ended. The fire engineering design shall specify appropriate fire safety provisions as part of the *hospital building* design integrated with operational procedures which define sufficient staff resourcing levels to support safe evacuation of all occupants.

Section 3 in this Guide outlines the different *occupant categories* who require various levels of assistance during a fire emergency. This *DGN* assumes that there is a sufficient number of adequately trained staff on duty in the *hospital building* to implement the emergency evacuation plan. The sufficient number of staff is outlined in either the *Fire Engineering Brief* or the *Fire Engineering Report*. The training required is outlined in the *Evacuation Scheme*.

2.1.6 The evacuation strategy to be adopted shall be integrated with and coordinated with the proposed *hospital building* design and fire safety design. A systematic conceptual desktop review is required to verify that the proposed *hospital building* design and the evacuation strategy are coordinated. This exercise should be undertaken with the stakeholders to review the design to provide confidence that the strategy works for all design fire scenarios. This should include consideration and management of all potential fire locations, management availability and response, fire brigade intervention and any assistance assumed, together with expectations around performance of the *hospital building* and installed systems. Consideration of 'all potential fire scenarios' is likely to involve a scenario clustering approach, in which similar potential scenarios can be grouped for the purpose of analysis. This would include considering: the reliability and robustness of systems and features, the likelihood and consequence of their failure; a reduction in staff availability; the sensitivity of the proposed design to failures or reduced performance of any specific features. The process should be able to conclude that the proposed design together with management and staffing arrangements will be adequate to meet the design requirements given the size and locations of fire, smoke and *evacuation zones* and available egress provisions such as stairs, lifts and their dimensions.

2.1.7 Sprinklers shall generally be installed throughout *hospital buildings*.

Comment: This applies unless there is a valid reason not to, such as concern regarding sprinklers being inappropriate for the hazard. Where sprinklers are not installed other forms of fire protection and suppression shall be required, refer Section 6.

2.2 Means of escape

2.2.1 The design and construction of the *hospital building* shall provide *escape routes* such that all occupants, unless intimate with first materials burning, or in space with a single door and fire is between person and the door, can always move away from a fire to a *place of safety*. Where direct escape out of the *hospital building* to a *safe place* is not recommended or not possible, occupants should be moved to an adjacent *place of safety* inside the building on the same level. From this internal *place of safety*, at least one independent *escape route* shall be provided which does not pass through the firecell of fire origin and ultimately leads to a *safe place*.

2.2.2 Where the evacuation involves patients who are not readily movable, or patients with no or limited mobility, additional consideration shall be given to whether the patient can be moved at all, and, if so, the travel time and distance that might be necessary to reach a *place of safety* and also whether essential treatment or care needs to be recommenced in that *place of safety*.

Refer to Section 3 for more detailed information on classifying occupant levels of assistance needed for fire egress.

2.2.3 If evacuation becomes necessary for occupants with no or limited mobility, the strategy should involve progressive horizontal evacuation, with only those occupants directly at risk from the effects of fire being moved.

Refer to Section 3 for more detailed information on the fire conditions when evacuation is necessary or should be considered, and the sequence of evacuation. For Training and detail on *RACEE* procedure, refer Section 4.3.

2.2.4 The distance to adjacent *places of safety*, such as adjacent *smokecells*, *firecells* and *evacuation zones*, should be limited to ensure that occupants can be safely evacuated from the effects of a fire within a reasonable period of time.

Refer to Section 4 for more information on design of fire *escape routes*.

2.2.5 The widths of *escape routes* shall be adequate to accommodate the expected number of occupants and the necessary equipment such as beds, wheelchairs, patient trolleys, etc. and taking into account reasonably foreseeable obstructions and equipment likely to be present on the *escape routes*.

2.3 Vertical means of escape – stairways and lifts

2.3.1 Vertical evacuation of occupants who need assistance to evacuate is only carried out if a fire cannot be controlled within the *firecell* of fire origin and there is additional risk to the occupants who are outside of the *firecell* of fire origin. This approach seeks to minimise risks to staff and patients associated with carrying out vertical evacuation (especially when using stairs).

2.3.2 Stairs are expected to be the primary means of vertical evacuation, especially for ambulant members of staff and public. *Hospital buildings* containing occupants who need assistance to escape should be provided with at least two means of escape. Where occupants need a stairway to reach a *safe place*, a minimum of two fire-protected stairways shall be provided for means of escape. These stairways shall be located so that if the means of escape to one stairway is obstructed, occupants can use an alternative egress route to access another stairway. External stairways should be avoided where possible as means of escape for occupants requiring assistance.

2.3.3 In addition to stairs, lifts may be used to assist with vertical evacuation when evacuating occupants requiring a high level of assistance. Noting the multi-discipline design (and management) complexities of lift evacuation, the decision to include this feature should be made as early as possible during the project briefing or design stage. Design details to enable lift evacuation are expected to be influenced by key building and management features such as the:

- size of the floorplate
- number of *evacuation zones* provided in the floor plate
- number of lifts on the floor plate and their separation distance
- staffing arrangement during the time when lift evacuation is provided.

2.3.4 The lift evacuation design needs to consider the scenarios when each lift is and is not available for use (for example due to a fire in the lift shaft or lift lobby).

In the unlikely event that vertical evacuation becomes necessary because of fire, the use of lifts for the most dependent *occupants* (*Categories 1 & 2*) under the direct supervision of hospital staff should enable earlier and safer egress, provided they can do so safely and are not at risk of being trapped.

Other occupants should use the stairs to evacuate as is the norm at present. There is no reduction from current design requirements for the amount of stairways being provided.

Vertical evacuation using lifts can only occur when there is sufficient separation between the lift and the fire location. This generally means, vertical evacuation using lifts can only occur in buildings with multiple *evacuation zones* per level, ie the hospitals with larger floor plates, and with specified robust features (refer paragraph 4.12.7) incorporated into the lift design to improve lift availability in an emergency.

Hospital projects considering the vertical evacuation of high dependency occupants under supervision will need to:

- incorporate these emergency procedures, conditional on the lift not affected by the fire, into the hospital evacuation scheme, along with appropriate training
- have appropriate communication/signage if a lift is out of order (may be for routine maintenance, etc)
- provide signage at each lift advising that 'in the event of fire Do Not Use Lifts unless under direct orders from trained hospital staff' (or similar).

Prescriptive guidance on use of lifts for evacuation is provided in section 4.12. If an alternative evacuation strategy is proposed, Appendix C provides guidance on a performance-based approach.

2.3.5 In situations where the lift is remote from the fire location, is not affected by fire, and remains safe to use for normal hospital operations (ie for clinical reasons), lifts incorporating the robust features specified in 4.12.7 are expected to be used for vertical movement of patients.

2.4 Approach to firecell compartmentation in hospitals

2.4.1 *Hospital buildings* should be subdivided into *firecells* or *smokecells* for the following reasons:

- Different *clinical* and *non-clinical HPUs* should be separate *firecells* so emergency evacuation can be carried out from them with the minimum of disruption to other unaffected areas of the *hospital building*.
- This allow patients to be evacuated horizontally from the fire affected *HPU* into an adjacent *HPU* (separate firecell) which would be protected from the effects of fire.
- In buildings where evacuation from all spaces does not occur simultaneously, such as buildings with different *clinical* and *non-clinical HPUs* as mentioned above, the collections of *firecells* which are all evacuated simultaneously is designated as an *evacuation zone*. Each *evacuation zone* shall be a *firecell*, or a collection of *firecells*, which is *fire separated* from other *evacuation zones*.

An *evacuation zone* typically includes an entire *HPU*, not part of a *HPU*, but may contain more than one *HPU* depending on the *clinical* use, number of staff, *occupant categories,* the number of occupants within the *evacuation zone* and whether there are other specific reasons for *evacuation zone* cohorts such as pandemic isolation.

- *Clinical* areas should be further subdivided so that (where possible) patients can be evacuated in the event of a fire emergency from one part of the *HPU* to a separate *firecell* within that *HPU*.
- *Firecell* subdivisions may be required to limit the number of patients that need to be evacuated in a single stage of evacuation. This number of patients depends on the level of assistance required to evacuate (non-ambulant bed user, wheelchair, ambulant etc) and the typical ratios of staff to patient numbers that provide this evacuation assistance.
- Where the clinical activities and requirements of an *HPU* allow, patient rooms and ancillary spaces should have the ability to ‘contain’ a fire by simply closing the door on a room or area allowing safer evacuation of patients from other areas. This facilitates the ‘Contain’ action of the *RACEE* mnemonic.
- Various protected horizontal egress routes, such as *safe path* corridors, lobbies and *hospital streets,* are fire separated to protect them from fire in adjacent spaces.
- Vertical egress routes shall be constructed as *fire separated safe paths* if required to provide a protected means of escape vertically within the *hospital building*, or, if required, to provide a protected route for firefighter access and firefighting operations.
- In addition to the general requirement for progressive horizontal evacuation, *hospital building firecell* compartmentation can minimise the likelihood of fires from the non-patient areas affecting the patient-access areas. Patient-access areas should therefore be in different compartments from non-patient areas.

- Areas of higher fuel load or fire risk should be *fire separated* from patient sleeping areas where *clinical* activities allow this.

2.4.2 The principle of progressive horizontal evacuation is that of moving occupants from an area affected by fire through a *fire separation* barrier to an adjoining *place of safety* inside the *hospital building* on the same level. This internal *place of safety* is designed to protect the occupants from the immediate dangers of fire and smoke. The occupants may remain there until the fire is dealt with or await further assisted onward evacuation by staff to an adjacent internal *place of safety* or to the nearest stairway. This procedure can give sufficient time for non-ambulant and partially ambulant patients to be evacuated vertically to a *place of safety*, in the event it becomes necessary to evacuate an entire storey.

2.4.3 This strategy requires at least two and sometimes three or more types of constructed fire protection (as shown in figure 5.1):

- *smokecells*
- *firecells*
- *evacuation zones.*

2.5 Fire detection and alerting to staff

2.5.1 Early detection and warning of fire shall be provided in order to allow time to respond to the fire emergency and to evacuate occupants to a *place of safety*.

2.5.2 Where occupants are unable to move to a *place of safety* without assistance, consideration should be given to whether the alerting method should be audible and/or visual devices perceptible by all occupants or directed at staff only.

2.5.3 Staff outside the affected area or building may also need to be notified if they are expected to respond to assist with the evacuation.

2.6 Hospital street concept

2.6.1 A *hospital street* may be provided. A *hospital street*, as a design concept, is a *firecell,* usually on an egress route which, in addition to circulation and egress, may contain other forms of supporting use such as a café, reception, waiting areas, and retail. A *hospital street* provides a link between *hospital HPUs* and stairways and lifts, serving as a main circulation route for staff, patients and visitors.

Refer to Section 4 for more information on design of a *hospital street*. Although some large *hospital buildings* may be provided with a *hospital street*, this is not an essential requirement. In smaller *hospital*s such as community *hospital*s, or specialist healthcare facilities, *hospital streets* are generally not provided.

In this Guide the term *hospital street* is different from the term as used in United Kingdom hospital design guidance. The restriction on use and fire load in the *hospital street* is intended to be midway in the range between that which applies to an *open path* and that which applies to a *safe path*.

3 Occupant levels and staff assistance for escape from fire

3.1 Occupant categories

3.1.1 This *DGN* applies four categories of occupant dependency for assistance with evacuation from fire based on mobility status and level of assistance needed, level of staff supervision for support or security and/or the occupant's ability to follow instruction:

a) **Category P1: Not immediately movable, or need the highest level of staff supervision:** an occupant not capable of being moved immediately from their room.

b) **Category P2: Movable with assistance or supervision:** an occupant incapable of relocating themselves by their own efforts, but moving the occupant is not a last resort; an occupant who needs supervision or who has limited ability to follow instructions.

c) **Category P3: Responsive slow mobility:** an occupant who has no mobility impairment except that their average rate of travel is significantly slower; an occupant who needs instruction/direction and/or nominal level of supervision but has full ability to follow instructions, including an occupant who requires a mobility aid for unassisted evacuation.

d) **Category P4: Responsive no mobility impairment:** an occupant with no mobility impairment and is not constrained or restrained, and is not limited in response capabilities in any other way so that the type of arousal mechanism that would normally awaken an adult is not effective; an occupant who is able to follow instructions and does not need supervision.

Occupants of *hospital buildings* vary in risk factors and ability to evacuate. Occupants are described in different categories in this *DGN*. The risk factors can arise from physical or mental (cognitive and/or security) impairments. The different occupant categories require different design considerations and levels of assistance and staff resources. The occupants who need assistance to evacuate may include hospital staff.

Category P1 occupants:
Examples of occupants in this category are listed below.

- Patients attached to life-support systems or involved in medical or surgical procedures who cannot be moved immediately without extreme danger of death or serious harm. Moving these patients is a last resort.
- Occupants whose free movement beyond their immediate sleeping/living space is restricted.
- Occupants who are required to be evacuated to an internal place of safety and egress to places of safety inside the hospital building or their evacuation to the outside is impeded by locked exits.

- Occupants who need physical assistance to evacuate safely either because they may be uncooperative or because their free movement is highly restricted. This category includes occupants who must be kept separate from other occupants and constantly supervised, including while in their internal place of safety (either because they are vulnerable occupants or because of concern for safety of themselves or other occupants). This includes patients in forensic mental health services or in seclusion (several staff members are likely to be needed to evacuate a patient and/or a procedure of several minutes needs to be followed before the patient can be moved).

Category P2 occupants:
Examples of occupants in this category are listed below.

- Occupants who are totally bedridden, or who need assistance getting out of bed or moving or who are restrained/locked in their rooms, or who are otherwise unable to evacuate without assistance or staff supervision.

- Occupants who have free movement only within the sleeping and group activity spaces in their *evacuation zone* (this applies to some mental health services). Occupants who may be uncooperative and need physical assistance to evacuate safely or they may not be able to self-assess a fire threat and respond adaptively and need directional and/or physical assistance to evacuate a *place of safety* (eg uncooperative dementia care). Occupants for whom egress to one or more *places of safety* inside the *hospital building* is normally impeded by locked exits or egress to the outside is impeded by locked exits. Occupants in this category do not need to kept separate from other occupants nor continuously supervised while in their *place of safety*.

Category P3 occupants:
This includes occupants who have free movement to one or more *places of safety* inside the *hospital building*, from sleeping, living spaces and other internal spaces where their access is permitted, but egress to the outside may be normally impeded by locked exits (this applies to some mental health services). Egress to the outside might be considered in certain circumstances, but it relies on staff to unlock external doors.

Category P4 occupants:
This includes occupants who are capable of readily rising from bed and taking self-protecting actions at approximately the same rate as a healthy adult. To be classified as mobile an occupant must not need assistance in getting out of bed and must be able to open a closed or locked door. Other examples of mobile occupants include:

- those whose mobility is not impaired in any way and they are able to physically leave the premises without staff assistance, or they experience some mobility impairment and rely on another person to offer minimal assistance, and

- those who are sufficiently able to negotiate stairs unaided or with minimal assistance, and

- those who are able to comprehend the emergency wayfinding signage within the *hospital building,* and

- occupants who will respond cooperatively to staff instruction, their mobility is not impaired in any way and they have free movement without obstruction or restraint to evacuate without staff assistance via *escape routes* to the outside, from sleeping, living spaces and other spaces where their access is permitted (this applies to some mental health services).

For occupants that need to be segregated before or after evacuation to a place of safety, the specific staff procedures for patient safety and isolation management are handled by other protocols, in addition to fire safety evacuation procedures. Occupants in most inpatient *HPUs* are expected to be the P2 or P3 category. Most occupants in outpatient *HPUs*, imaging *HPUs* and ambulatory care *HPUs* are expected to be in this P4 category. It is important for fire engineers and the relevant stakeholders to discuss during the *FEB* process the likely *occupant categories* for design purposes and the extent of flexibility needed to accommodate future changes in the way spaces are used.

3.2 Classifying occupant dependency and levels of assistance needed for fire egress

3.2.1 The degree to which *hospital building* occupants need assistance in taking actions necessary for their safety in case of fire is an important factor in fire design. The level of capability in healthcare facilities varies from occupants who, if informed and directed, are able to take positive, self-protecting actions to those occupants who have no ability to move or even to take the simplest actions to safeguard themselves. In some cases, occupants are directly connected to a fixed life-support system and are so dependent on it that they cannot be moved without jeopardy of death or serious harm, or the evacuation process may increase the risk of harm occurring to themselves or others.

3.3 Applying occupant dependency classifications

3.3.1 *Health Planning Units* may contain occupants from a range of occupant categories. The *occupant category* that applies to a patient care area shall be based on the occupant requiring the greatest level of assistance that is expected in that area. The level of assistance should be based on the highest level of assistance needed (i.e. minimum level of mobility) that occurs over the course of an average 24-hour period, rather than assuming a lesser level of assistance can be used on average because the highest level of assistance is only needed for an hour or few. Where the range of occupant levels of dependency varies, the *HPU* may be subdivided into different *evacuation zones* to create more manageable evacuation procedures.

This guidance focusses on the people in a space (and the level of assistance they may require) rather than classifying the space itself. The rationale for this approach is that if an area can accommodate any patient with reduced mobility status, then permission is extended implicitly but in a deliberate and intentional way to accept other similar patients at any time. In *HPUs* where occupants needing a high level of assistance are accommodated highly infrequently, the balance of risks and flexibility of use and the design solutions to address these factors should be considered in specific detail.

3.3.2 The number of occupants needing assistance in an area shall be based on the number of beds/patient spaces in that area assuming that all patient spaces are occupied at the time of a fire emergency. This is based on foreseeable, predictable and reasonable use of that patient care area.

Overflow that occurs in situations when disaster management protocols apply is outside the scope of normal design scenarios. Although it might be foreseeable that an area may be subjected to overflow numbers of occupants in an extreme scenario, if this situation is highly infrequent then it is not a reasonable basis for assessing number of patients. The extent to which overflow numbers of occupants might be foreseeable and reasonable should be discussed with the *hospital clinical* advisors during the design stage.

3.3.3 Where there is doubt about the category of occupants, advice should be sought from clinicians as to what the best approach for fire evacuation should be. Although the occupants in an area may be identified as movable and mobile, consider the needs of occupants in other areas who need assistance and who may need to be evacuated through that area. In such circumstances the means of escape provisions shall reflect the measures necessary for evacuating the occupants who need the highest level of assistance.

Background information on the development of occupant categories and classifications of occupant dependency is included in Appendix G.

3.3.4 Any future change in the level of occupant dependency in an area or *HPU* is likely to result in a change to the fire safety features applicable. This is also relevant to premises designed for independent occupants.

3.3.5 In *HPUs* providing services for mental health or intellectual disabilities the design of fire precautions and evacuation strategies should not compromise safety and security.

In *HPUs* providing services for forensic mental health, the design needs to include the requirements needed to satisfy the relevant regulatory obligations.

3.4 Staffing levels and ratio of patients to staff assistants

3.4.1 The fire engineer and healthcare managers (and evacuation consultants where applicable) should meet early during the design stage to discuss, understand and agree on the specific nature of each *Health Planning Unit*, *HPU,* in terms of number of patients and level of dependency and staff resourcing needed to assist with fire evacuation. The purpose of this meeting is to provide the necessary inputs into developing the fire engineering design, fire evacuation procedures and the fire safety systems provided. This information enables the *hospital* management to align evacuation procedures with the appropriate staffing levels required to undertake the evacuation of the area in the event of a fire.

NOTE Obtaining this information may take the form of an initial 'Fire Evacuation Survey'. Refer to Appendix B for more information.

3.4.2 The fire engineering design shall be based on the proposed/briefed staff to patient ratios and accordingly the number of staff who receive effective fire safety training and who can respond quickly and effectively to assist with safe evacuation of patients.

The coordination of the fire engineering design with the proposed/briefed staff ratios is a fundamental expectation of the fire safety design process.

3.4.3 The fire evacuation procedures (which form an integral part of the Evacuation Scheme) shall list the minimum number of trained staff required to be available at the time of a fire emergency to implement those procedures in accordance with the fire engineering design.

3.4.4 *Hospital* management are responsible for providing adequate numbers of adequately trained staff who will always be available for effective implementation of the fire evacuation procedures.

3.4.5 The number of trained staff available at the time of a fire emergency to implement the evacuation procedures directly influences the effectiveness of staff to assist occupants immediately threatened by fire. This is strongly related to the staff to patient ratio. The staff ratio that is used for fire engineering design purposes shall correspond with the minimum number of immediately available attendant staff. In this context, 'available attendant staff' refers to staff who can be notified and will respond to the location where they are needed within a time frame that is useful for assistance.

3.4.6 The staff ratio is based on the minimum staffing level (usually occurring during the night shift). Where nurse stations or staff bases or similar positions are located near the junction of two *evacuation zones* and the location of the staff base is such that each *evacuation zone* is accessed immediately from and is in view of the staff base, the total staff assigned to that staff base can be credited to the *evacuation zones* that can be served by those staff. The exception is when members of staff are bound by duty assignments (intensive care, cardiac care, paediatric nursery care, operating suites, etc.) that prevent them from responding to patients other than those in their assigned zone. Staff who are counted in the staff/patient ratio need to be trained to suit their role and responsibility in assisting patients to evacuate.

NOTE Staff should receive training in the methods of occupant evacuation appropriate to the evacuation procedures at their place of work. The adequacy of staffing levels should take into account the sufficiency of training that staff have received relative to their roles in the evacuation process. *Hospital* management should be able to demonstrate that staffing levels are adequate at all times to enable the safe evacuation of patients. This is an integral part of the evacuation procedures which are part of the *Evacuation Scheme*.

The emergency actions that might be undertaken by staff include detection of a fire, raising the alarm/notifying other staff, confining a fire by closing the door to the room of fire origin, establishing barriers between patients and a fire by closing patient room doors, rescue/assistance to patients to evacuate, emergency medical aid, extinguishment of the fire where appropriate.

Part 2: Prescriptive fire engineering design requirements

4 Movement to a place of safety

4.1 Introduction

4.1.1 This Section provides requirements for horizontal and vertical *escape routes* to comply with the principles for means of escape and strategy for fire evacuation as outlined in Section 2.

4.2 Fire evacuation strategy

4.2.1 There are three levels of fire threat which determine when evacuation is necessary or should be considered. These levels apply differently to building occupants, depending on the patient dependency and level of assistance needed for fire egress:

- Immediate threat emergency – where there is an immediate threat to safety of occupants who are in the vicinity of the fire or who are immediately vulnerable to spread of smoke because of the location of the fire; or if sprinklers do not operate effectively
- Imminent threat – no immediate threat, but fire or smoke likely to spread from an adjoining area (assuming sprinklers operate effectively)
- Precautionary – no immediate threat to life or safety, but there is a fire on an adjoining floor or in an adjacent building (assuming sprinklers operate effectively).

4.2.2 The priority of evacuation in a fire emergency is:

- those in immediate danger
- ambulant patients, visitors, staff who are not assisting with patient evacuation or patient care
- the remaining patients who are not ambulant (starting with patients closest to the fire threat)
- occupants who are unable to follow advice or instructions to escape. That is, the highest acuity patients or patients who have the most complexity around moving them safety (eg intensive care, neo-natal or bariatric patients).

4.2.3 There are three main phases of evacuation for occupants who need assistance to escape:

- Phase 1 – (the default strategy) horizontal evacuation from the area where the fire originates to the next *evacuation zone*. This could take place in steps where movement takes place to another firecell in the same *evacuation zone* as an interim step.
- Phase 2 – Subsequent additional horizontal evacuation to the next adjacent *evacuation zone* may be undertaken (putting additional distance and fire resisting construction between the building occupants and the fire threat) prior to undertaking vertical evacuation; and
- Phase 3 – vertical evacuation to a lower floor in the *hospital building*, or to a *safe place* or adjacent building.

Whanau, parents and visitors who directly assist with patient evacuation or patient support normally follow the same evacuation procedures as the patient they are with (ie they move to an internal *place of safety* with the patient). This does not include visitors and whanau who are not providing direct assistance with patient evacuation or patient support.

Occupants who do not need assistance to escape, (which includes ambulant patients, whanau, visitors and staff who are not assisting with patient evacuation or patient care), are normally evacuated directly to a *safe place* when required to evacuate, rather than moving to an internal *place of safety* in the initial evacuation phase.

Back-of-House, BOH, spaces and *Front-of-House, FOH, non-clinical* public spaces would typically evacuate to a *safe place*.

During an evacuation, staff throughout the *hospital* provide assistance as necessary to direct people away from the area affected by the fire towards a *safe place*.

4.3 RACEE procedure

4.3.1 The normal fire evacuation management procedures for *clinical* areas of *hospital buildings* shall follow the established international practice known by the acronym *RACEE*. *RACEE* is defined below and schematically represented in Figure 4.1.

1. **R**emove anyone from the area of immediate danger.
   Early detection of the fire, identification of room of fire origin and alerting the staff in the area of fire origin are essential tools to assist with the safe removal of occupants from the fire area.
2. **A**lert emergency management, *fire brigade* and others as appropriate and necessary.
3. **C**onfine the fire and smoke to the immediate room of fire origin.
   This is generally achieved by passive building elements such as walls, ceilings, doors etc. *Fire/smoke separation* drawings and *evacuation zone* drawings show the *fire* and *smoke separations* that subdivide a *hospital building* into *evacuation zones, firecells and smokecells*.

4. <u>E</u>vacuate other occupants within the *firecell* if they are in danger from fire and smoke. Further *clinical* discussions during the design stage should confirm any specific patient separation requirements during evacuation (eg due to disease or infection risks).
5. <u>E</u>xtinguish the fire using hand operated fire-fighting equipment, if it is safe to do so.

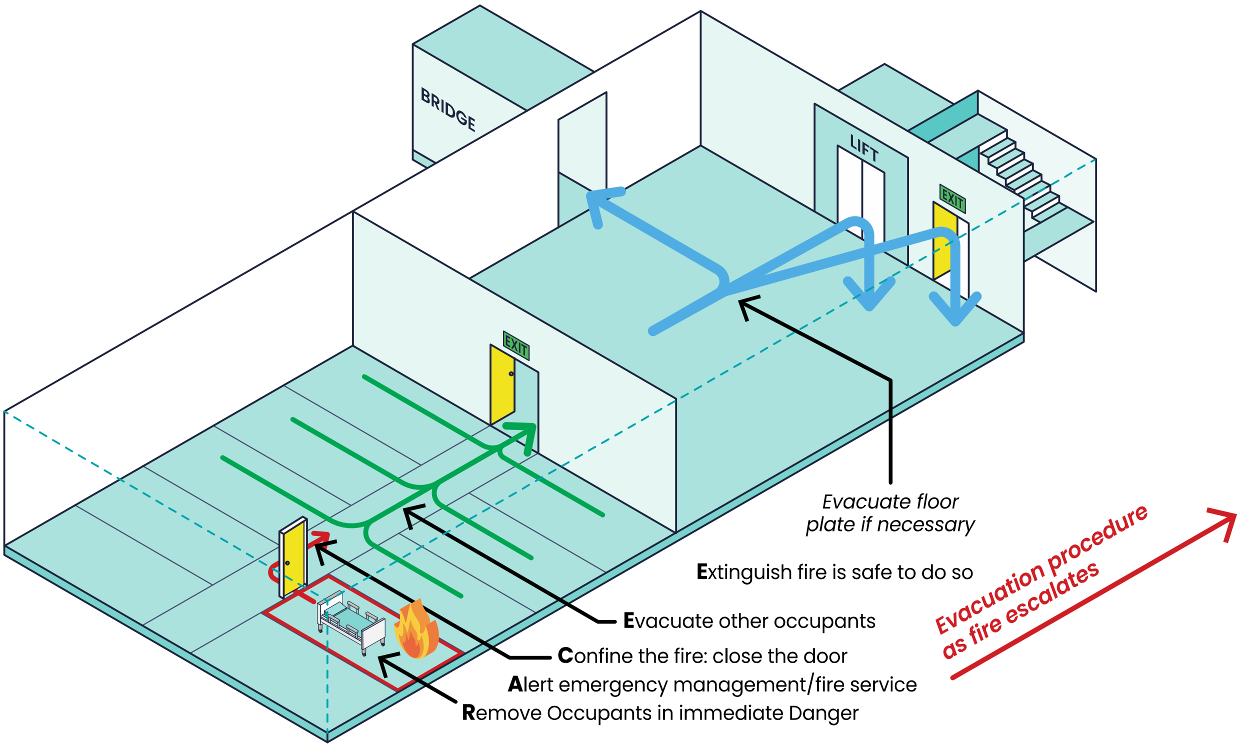


Figure 4.1: *RACEE* procedure

4.3.2 The evacuation process is carried out using the *RACEE* principle in accordance with the priorities in paragraphs 4.2.1 and 4.2.2 until the occupants reach a *place of safety*.

Smoke is likely to spread to the adjacent space as occupants evacuate. It is therefore likely that the adjacent spaces will need to be evacuated in a secondary round of evacuations. Depending on the size of the fire, and the amount of smoke spread as occupants evacuate, further patient movement may be required to avoid the irritant effect of the smoke. Vertical evacuation (using lifts or stairs) is unlikely to be required in evacuation Phase 1 or Phase 2.

Emergency response team

Hospital building evacuation requires proactive situation-specific decision-making by staff. During a fire incident, decisions may need to be taken by the *clinical* staff about which additional areas of the *hospital building* might be evacuated and in which order. Those occupants with greater dependency on staff, and particularly those with a critical dependency, would normally be given the highest priority.

To enable the evacuation of a patient area, and in additional to the assistance provided by staff local to the fire incident, an ‘emergency response team’ may be used. This team would be expected to immediate move to the fire incident area upon fire alarm activation, as notified by appropriate communication technology (eg text message or pager notification). This response team may include:

- the *hospital* Duty Manager (response team leader)
- the Shift Engineer
- *Hospital* Orderly
- Security Guards
- Clinical Nurse Advisor.

4.4 Phased horizontal evacuation

4.4.1 Horizontal evacuation requires the *hospital building* storey to be subdivided into two or more separate *firecells* (and *smokecells*) on the same level. Occupants are moved from an area affected by fire, through a fire-resisting barrier to an internal *place of safety* (adjacent *evacuation zone*) on the same level in the *hospital building*, designed to protect the occupants from the immediate dangers of fire and smoke. The occupants may remain there until the fire is dealt with or await further evacuation by staff to another internal *place of safety* or to a fire protected stairway if the internal *place of safety* is threatened.

This horizontal *evacuation procedure* is intended to avoid the need for immediate vertical evacuation and allows the non-fire affected areas of the *hospital building* to remain operational, including use of lifts for clinical purposes where it is safe to do so. Refer to Figure 4.2 and 4.3.

Active fire protection systems such as automatic fire alarm systems and fire suppression systems (sprinklers) increase the time available to carry out the phased horizontal evacuation procedures.

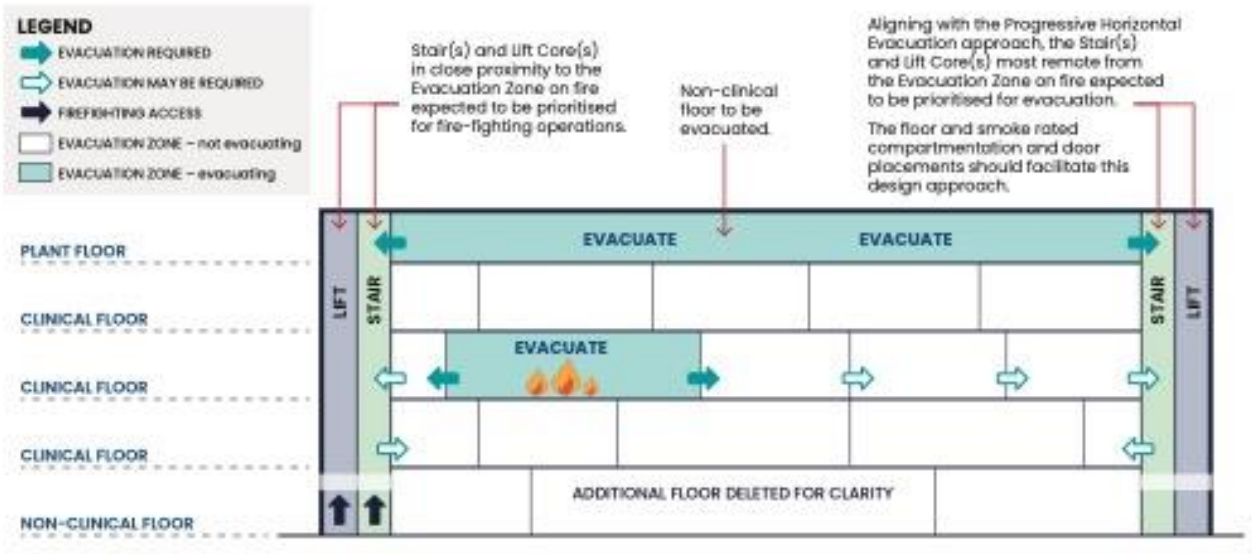


Figure 4.2: Building cross-section showing evacuation response for different *evacuation zones* and floor levels

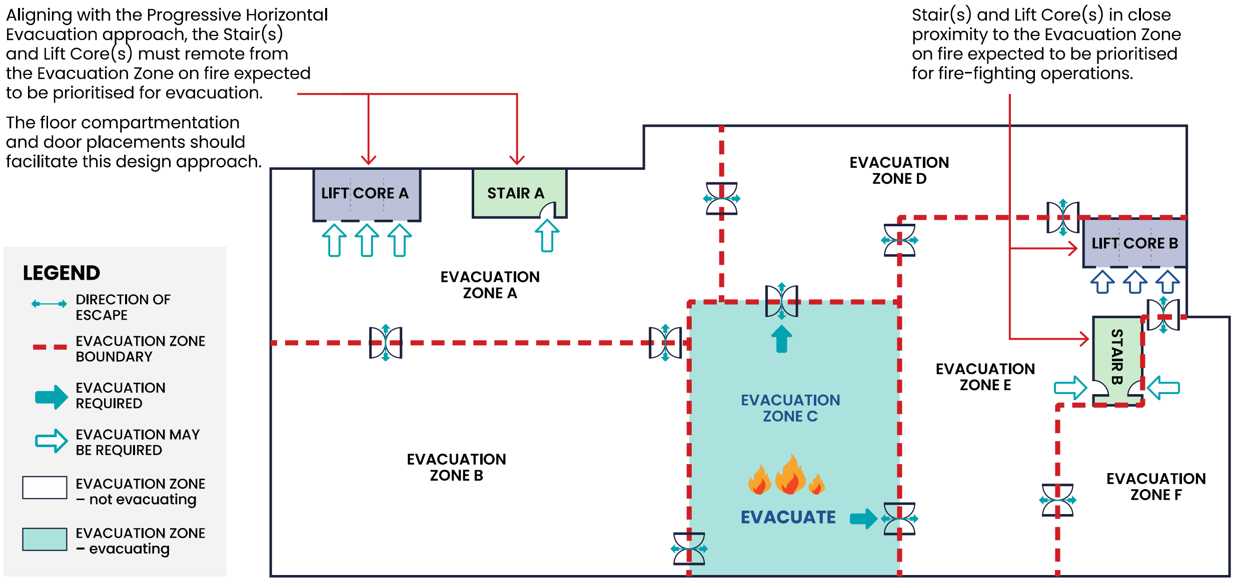


Figure 4.3: Building floor plan showing evacuation response for different *evacuation zones*

4.5 Escape routes for phased horizontal evacuation

4.5.1 Each *evacuation zone* is required to be provided with two independent means of escape to different *evacuation zones* which provide independent *escape routes* to a *safe place*. (See Figure 4.4)

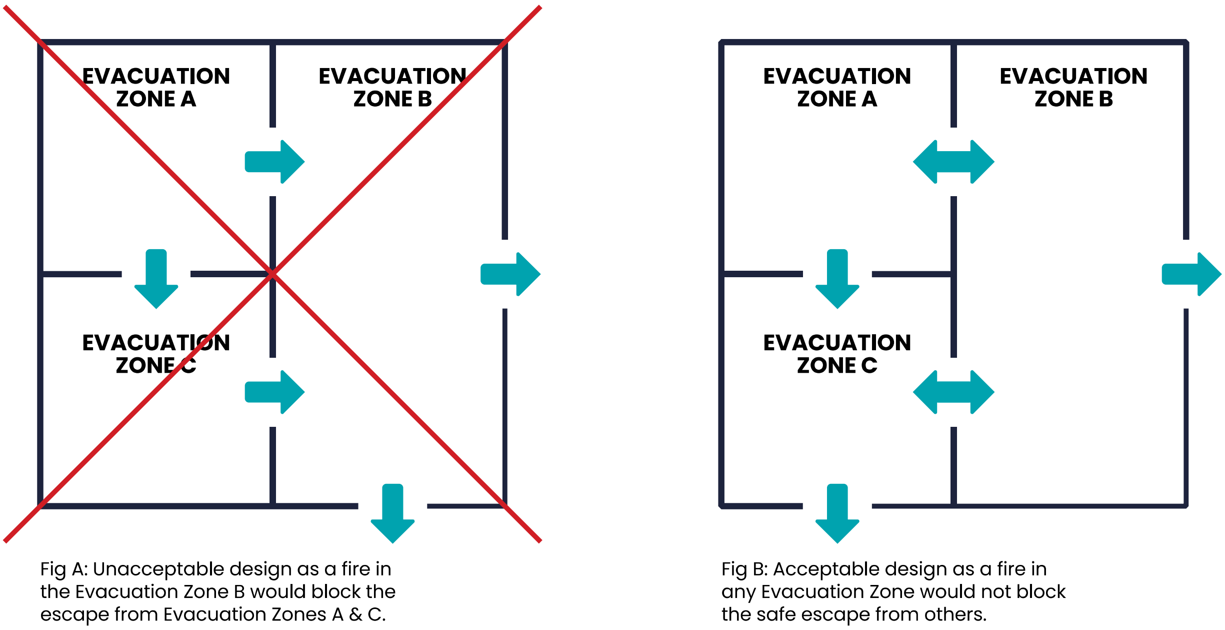


Figure 4.4: Exits from *evacuation zones* (adapted from HTM-05-02 Figure 4)

4.5.2 The allocation of *firecells* to enable phased horizontal evacuation shall take into account the staff management responsibilities, such as the extent of the area under their control and responsibility, management of patient wellbeing and evacuation, etc.

This will impact on the design, integrity, size and configuration of *firecells*. For these reasons it is strongly recommended that the design of a *firecell* should recognise and integrate the management and operational arrangements by making the boundaries of *firecells* consistent with *HPU* boundaries.

4.5.3 *Clinical* areas may be divided into smaller *firecells* (rather than fewer large *firecells*) to limit the number of occupants who may be directly affected by an outbreak of fire. Wherever possible, there should be a balance of the number of patients in co-located *firecells*.

Refer to Section 5.9 below (and subsequent Sections) for limits in *firecells* on the number of occupants who need assistance to evacuate.

4.5.4 In a fire emergency, each *firecell* shall be capable of accommodating, as well as its normal occupants, the designed occupancy of the adjoining *firecell/evacuation zone* with the highest occupant load. This shall include space to accommodate beds and medical equipment required to ensure continuity of care.

4.5.5 While it is permissible to locate *clinical* and some *non-clinical HPUs* adjacent to each other, the *escape routes* from *clinical HPUs* through the *non-clinical HPUs* shall be designed to safely accommodate the evacuation of all patients (that is, *escape routes* shall be of sufficient area and width to accommodate beds/trolleys as required).

It is not recommended to evacuate any *non-clinical* area through a *clinical* area.

4.5.6 Evacuation via ward bedrooms is only permitted from adjacent ward bedrooms.

4.5.7 Where it is necessary to evacuate groups of people at separate times, each group shall be housed in separate *firecells*, to allow for separate evacuation. Where *swing bed spaces* are provided at the boundary between adjacent *evacuation zones*, the design should allow to include the *swing bed spaces* in either *evacuation zone*.

4.5.8 Depending on the type of patients it may be necessary to maintain segregation during evacuation. Where this is the case, the design of *escape routes* shall be designed so that this segregation is maintained during the entire evacuation. This shall also extend to secure *places of safety* away from the effects of fire, outside the building.

4.6 Single direction of escape limitations

4.6.1 The design occupant load using any part of an *escape route* with a single direction of escape shall not exceed 50.

4.6.2 Refer also to the requirements of clinical occupants evacuation in sections 2.4 and 4.15 (eg staffing levels and *category P1 occupants*).

4.6.3 Adequate separation to provide independent *escape routes* shall be provided as described in *Acceptable Solution C/AS2*.

4.7 Escape route travel distance

4.7.1 Within an *evacuation zone* the maximum travel distance on an *escape route* with a single direction of escape (ie before reaching a point where there is a choice of independent *escape routes*) is:

- 20 metres for the escape routes used by *category P1, P2 or P3 occupants*
- 50 metres for the escape routes used by *category P4 occupants*
- 75 metres for the escape routes used by occupants in *back of house* spaces, staff-only areas, office spaces, administration areas.

4.7.2 The maximum total travel distance on an *escape route* to no fewer than two exits (exits leading to an *exitway* or *place of safety*) is:

- 50 metres for the escape routes used by *category P1, P2 or P3 occupants*
- 120 metres for the escape routes used by *category P4* occupants.

4.7.3 Travel distances shall be measured as described in *C/AS2*, including path length multipliers for intermediate floors, stairs and ladders.

Note**:** There may be exceptions to these distances in certain parts of *hospital buildings* (for example aseptic preparation units, operating departments, LINAC rooms). Where these distance limits are exceeded, the exceedance must be justified in the fire engineering design.

4.8 Escape route width

4.8.1 For fire *escape routes* where beds or patient trolleys will not be used to assist patients during fire egress, the minimum clear width of *escape routes* should be determined by the number of people who would normally be expected to use them in an emergency, in accordance with *C/AS2*.

4.8.2 For escape routes used by *category P1, P2 or P3 occupants* the design of *escape routes* shall allow for bed evacuation and should be designed either:

- to comply with the geometry required for bed evacuation as shown in Figure 4.5, or
- for the architect or designer providing evidence that their design provides adequate space for evacuation using beds, or
- as an alternative agreed method of evacuation that recognises the restricted mobility of the patients, the limitations of the proposed design and the availability of trained staff to safely manage the evacuation.

4.8.3 Smoke lobbies or *firecells* may be provided for additional protection adjacent to areas containing patients who are not immediately movable.

4.8.4 For those *category P1 occupants* who require equipment that is an integral part of the anaesthesiologist’s care (such as the ventilator and electrical back-up supply) an evacuation that requires moving this equipment with the patient must be pre-planned. Wider doors and corridors may be required to move ancillary equipment efficiently.

Ventilators and monitoring equipment is often large and unwieldy and may require additional width to that needed for moving the bed only. Receiving smoke lobbies or *firecells* need to be suitably sized to accommodate the space needed for the occupants who are being evacuated.

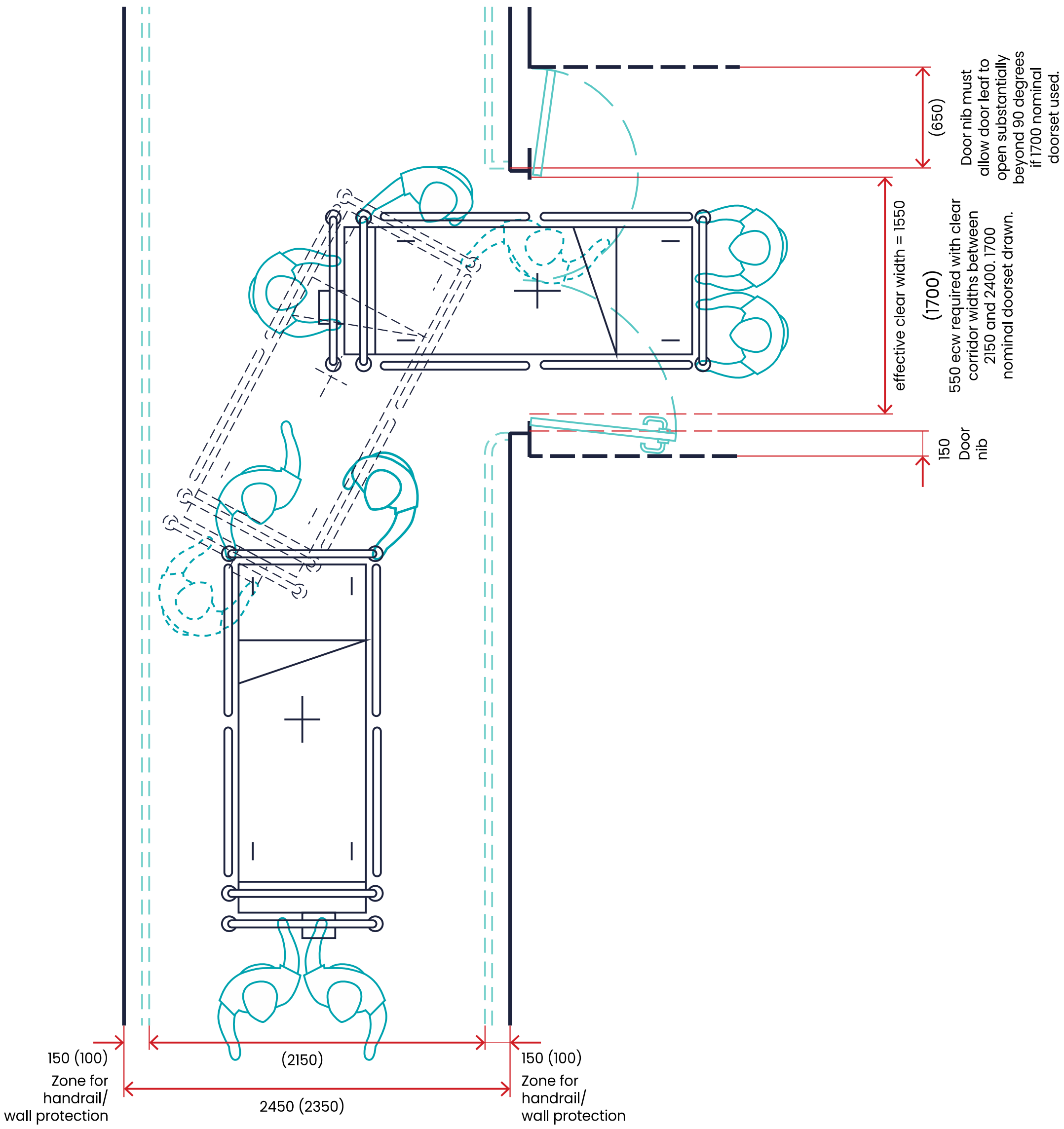


Figure 4.5: Width of doors and corridors to permit bed evacuation (from HTM-05-02 Figure 1)

The dimensions in Figure 4.5 should be regarded as indicative likely minimum values. Actual dimensions required should be verified as suitable based on the project, and the health planning unit.

4.8.5 Where staff and occupants need to move in opposite directions (eg where staff assisting patients need to move into an evacuation area against the normal direction of egress) the minimum width of horizontal *escape routes* shall be 1200 mm to allow for this opposing movement.

Where patients have restricted mobility, are elderly or otherwise require a high level of assistance for fire egress, moving the patients on their beds may be the most effective method of evacuation.

In *HPUs* where beds and patient trolleys are being moved, the width of the circulation routes required for these activities should generally be adequate for means of escape.

4.8.6 *Escape route* widths should allow for two-way traffic on all *escape routes* where staff provide assistance to patients (the *escape routes* need to wide enough to allow staff to enter an *evacuation zone* at the same time that patients are being evacuated).

4.8.7 *Escape route* widths for stairways are prescribed in Section 4.11.

4.8.8 Special consideration may be required for *escape route* (including door) widths for large bariatric beds (and patient connected medical equipment). Example overall beds dimensions are 1350mm width and 2230 mm length.

4.9 Escape route height and other requirements

4.9.1 Minimum height of *escape routes* shall be provided in accordance with *Acceptable Solution* D1/AS1, and any door opening within, or giving access to, any *escape route* shall be no less than 1955 mm for the required width of the opening.

NOTE: Some *escape routes* may need larger openings to accommodate patient care and other equipment.

4.9.2 The use of steps should be avoided on *escape routes* for small changes in level. Ramps should be provided.

4.10 Hospital streets

4.10.1 Where the escape design philosophy incorporates a *hospital street*, the *hospital street* shall be fire separated from all adjoining *evacuation zones* (the fire resistance of *fire separations* is the greater of that required to control fire spread from either the *hospital street* or from any *firecell* in the *evacuation zone*) and have a minimum clear width of 3 metres.

4.10.2 A *hospital street* may contain occupied spaces and furniture and fittings relating to its function as a main circulation route in a *hospital building*. The controls on internal surface finishes shall comply with controls on interior surface finishes in Section 7.

4.10.3 Entrances from the *hospital street* to adjoining *firecells* shall be located so that an alternative means of escape from each *firecell* is always possible (see figure 4.6).

A hospital street is an architectural feature which provides a main circulation route in the *hospital building* for staff, patients and visitors. When a *hospital street* also complies with specific fire safety requirements (see below), the *hospital street* can be used as an integral part of the fire evacuation strategy. Although many *hospital buildings* will be provided with *hospital streets*, they are not an essential requirement. In smaller *hospitals*, such as community *hospital*s, and other healthcare premises, *hospital streets* are generally not provided. Not all circulation routes qualify for designation as *hospital streets* for the purposes of fire evacuation.

When designated by the fire design as a specific fire safety feature, a *hospital street* acts to connect multiple *hospital HPUs* and provides *escape routes* to *places of safety*, stairways, lifts and *final exits*. It has two functions from a fire safety aspect:

a. if the spread of fire within an *HPU* cannot be brought under control, the occupants of the *HPU* affected may be evacuated via the *hospital street* to parts of the *hospital building* not affected by the fire; and

b. it can serve the *fire brigade* as a fire-fighting bridgehead if designed to serve for that purpose.

Note: a hospital street need not necessarily be a safe path (refer to the definitions).

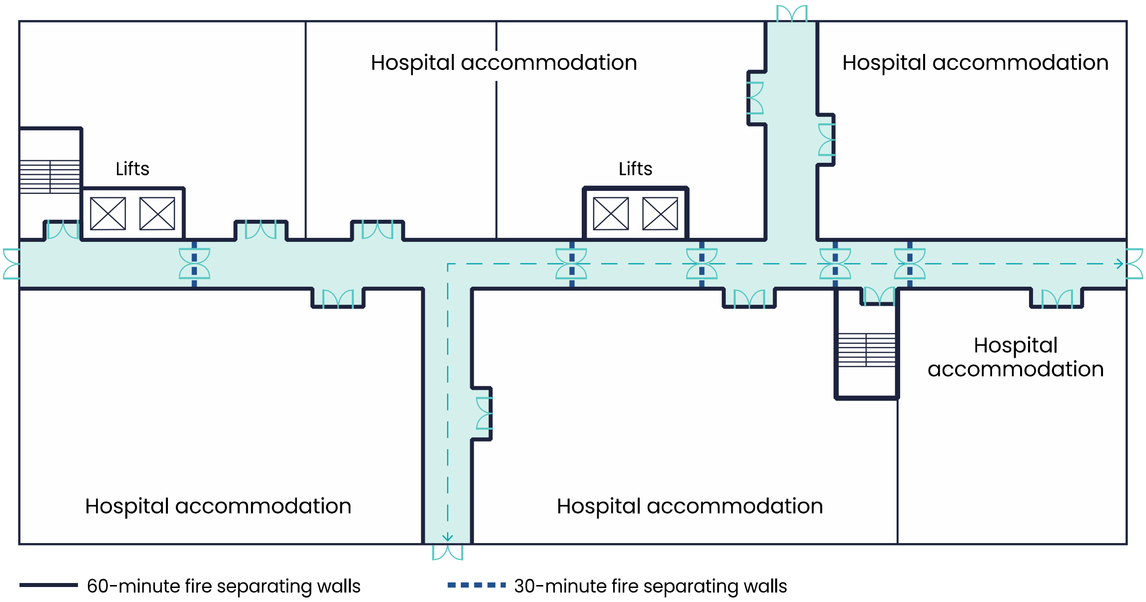


Figure 4.6: Example of *hospital street*
(adapted from HTM-05-02 Figure 7ii)

The definition of a *hospital street* notes that it differs from the term used in the UK Department of Health document HTM 05-02. It does not need to be entirely sterile of fuel load (like a *safe path*). It provides the option of containing support functions or other uses consistent with being a main entry or circulation space in a hospital. The definition intends to allow a *hospital street* to have waiting areas, seating, reception desk, help desk, cafe space or any other uses that require (for clinical or functional reasons) an open connection between an adjacent space and the hospital street.

A *hospital street* needs to be a separate *firecell*. There will be cases though where a *hospital street* will not need to be enclosed on all sides by *fire separations*, such as when one wall is an external wall.

As part of the fire design for the *hospital,* the design team would need to recognise that the more spaces that are part of the *hospital street firecell*, the increased likelihood that a fire might occur in the street, and therefore the less reliable and consequently less useful it will be as one of the escape routes serving adjacent *evacuation zones*. This becomes a design choice related to functionality and fire safety performance.

A *hospital street* will likely (almost certainly) end up needing to be a separate *evacuation zone*, either in its own right, or as part of a larger *firecell*. When it is part of a separate *evacuation zone*, it will need to be *fire separated* from other *evacuation zones* in order to qualify as a *place of safety* inside the building, or at the very least a place of interim safety while occupants transit to their place of safety (inside or outside the building). The need for *fire separations* arises from the requirements for *evacuation zones* (which must be *fire separated* from *adjacent evacuation zones*}.

Hydrant outlets in the *hospital street* provide *FENZ* with a bridgehead staging point to connect into the system, outside of the *clinical firecell* on fire, and also not within an adjacent *clinical firecell* where they might inadvertently compromise safety. If the *hospital street* is suitably subdivided (into separate *firecells*) then it is possible that provision of outlets in the *hospital street* would comply with Appendix A of NZS4510, as outlets can be in a 'safe location' for *FENZ* use.

4.11 Vertical means of escape – stairways

4.11.1 *Hospital buildings* containing patients needing assistance to evacuate should be provided with a minimum of two stairways. In *hospital buildings* requiring two or more stairways for fire egress, the stairways shall be located so that alternative stairways are always available from every *firecell* in which occupants evacuate to a *place of safety* inside the building.

4.11.2 All stairways shall provide egress to a *safe path* or *final exit*, but may also discharge to a *place of safety* inside the building.

4.11.3 All stairways, (other than service stairs), should be designed to permit vertical evacuation of occupants who need assistance.

In most *hospital buildings* the fire egress strategy should avoid designating certain stairways as escape stairways and others as access only stairways, since in an emergency any stairway would be used if necessary.

4.11.4 All stairways providing means of escape from areas that contain patients who need assistance to evacuate shall be sufficiently wide to permit the evacuation of patients on mattresses (mattress evacuation), evacuation chairs or other similar methods. The stair width is determined by the requirements of (mattress) manoeuvrability or other methods of assisted egress (See Table 4.1 and Figure 4.7). A stair width less than 1500mm shall be supported by a specific assessment for appropriateness.

Stair width is determined by the requirements of assisted patient evacuation not by the number of people expected to use the stairs in a fire emergency.

Table 4.1. Stair and landing widths for assisted occupant evacuation (adapted from HTM 05-02 Table 3)

Minimum clear stair width (mm) [1]	Minimum clear landing width (mm)	Minimum clear landing depth (mm)	
1500	3200	1550	Expected to allow assisted occupant evacuation and other ambulant occupants to pass with some width restriction or difficulty.
1600	3400	1600/1450 [2]	Expected to allow assisted occupant evacuation plus other ambulant occupants to pass without width restriction or significant difficulty.
1800	3800	1800/1350 [3]	

Notes for Table 4.1:

1. Stair width of less than 1500mm may be appropriate if the stair can only be used by category P4 occupants or staff who do not need assistance to evacuate.
2. 1600 mm is recommended depth to enable ambulant passing without difficulty or restriction. The minimum clear landing depth for assisted occupant evacuation is 1450 mm.
3. 1800 mm is recommended to equal the stair. The minimum clear landing depth for assisted occupant evacuation is 1350 mm

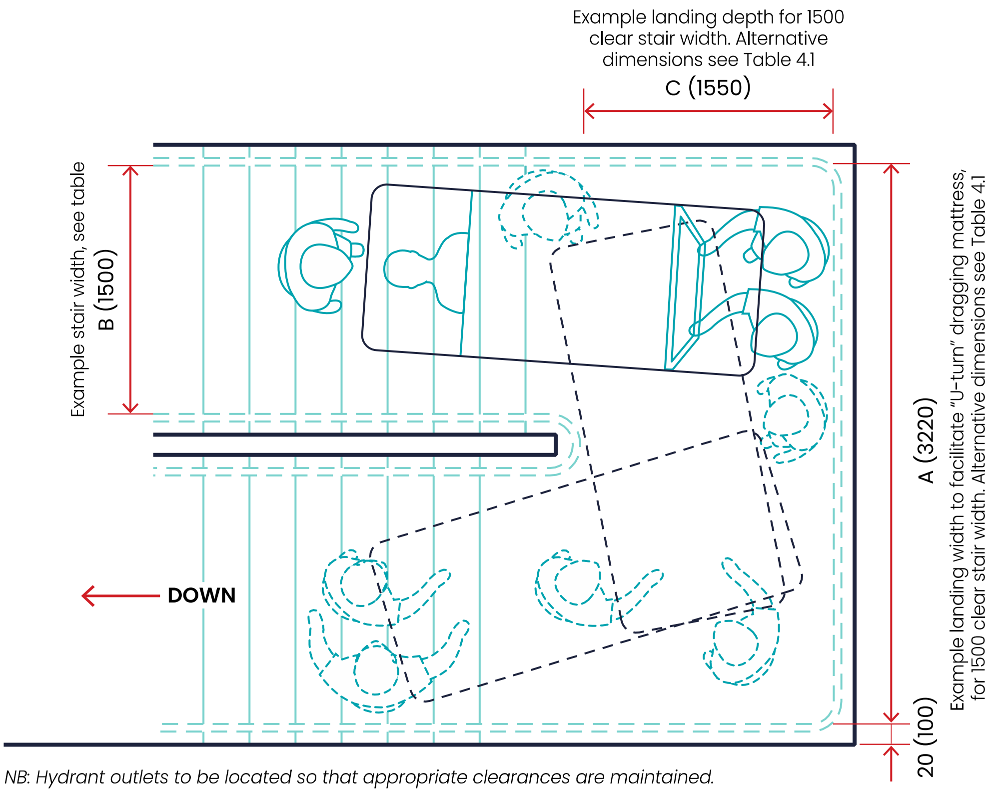


Figure 4.7: Assisted patient evacuation down a stair (from HTM-05-02 Figure 10)

> The dimensions in Figure 4.7 should be regarded as indicative likely minimum values. Actual dimensions required should be verified as suitable based on the project, and the *HPU*.

4.11.5 Where stairways provide escape from areas used only by occupants who do not need assistance to escape from fire, the width of the stairway may be determined in accordance with *Acceptable Solution C/AS2*.

4.12 Vertical means of escape – lifts

4.12.1 Lifts may be used to assist with evacuation if they are specifically designed for this use and their use is incorporated into *hospital* emergency management, fire evacuation procedures and staff training. Where they are used, the lift design needs to consider their availability and robustness during a fire incident.

4.12.2 Evacuation using lifts should be considered as an integral part of the overall fire engineering strategy in the early project briefing or design stages. It requires coordination between the fire design (in particular the fire compartmentation strategy for horizontal evacuation), and input from architect, evacuation consultant and electrical engineer, etc).

Providing alternative banks of lifts available for each floor in a *hospital building* provides alternative egress routes to a suitable lift. It is unlikely that incorporating lift usage at the final stages of design will provide an adequate and robust solution.

4.12.3 The total evacuation of occupants shall not be designed to be achieved solely by the use of lifts. The use of any lifts for evacuation does not diminish the requirements for other means of vertical escape.

4.12.4 Evacuation using lifts shall be led/controlled by trained hospital staff. Lifts should be used for evacuation only when it is necessary and appropriate to evacuate vertically and when more advantageous than the use of stairs (ie as part of Phase 3 evacuation, after Phase 2 horizontal evacuation – refer to paragraph 4.2.3). Lift evacuation is intended for *occupants categorised P1 or P2* only and who are in close proximity to the fire. It is therefore likely to be used for a relatively low number of occupants.

4.12.5 Lifts shall only be used for fire evacuation when it is safe to do so and there is minimal risk of occupants becoming trapped. This includes:

- physical separation from the fire by at least one other intermediary *evacuation zone* from the *evacuation zone* of fire origin. In other words, the lift entry doors are required to be located in an *evacuation zone* which is not directly receiving occupants transferred from the *evacuation zone* of fire origin). (Refer Figures 4.1 and 4.3). This means that lift use for fire evacuation is only likely in hospital buildings with larger floor plates with multiple *evacuation zones* per floor and more than one lift bank.
- local conditions near the lift not presenting a situation where lifts should not be used, eg significant smoke in lobby or significant water by lift doors because floor drains or raised threshold are not coping with the water from activated sprinklers or firefighter activity.
- the physical separation and local conditions constraints being specifically included in fire emergency procedures and staff being trained in their implementation.

Firecells containing occupants who are typically ambulant and do not need assistance to evacuate (eg plant rooms, office areas) are not expected to routinely use lifts for evacuation.

The availability of the lift and the suitability to use the lift requires proactive decision-making by hospital staff.

4.12.6 Robust design of lifts intended to be used during a fire emergency for fire evacuation use or routine use shall include appropriate protection to the lifts, features which provide for safe operation and a high degree of operational reliability.

4.12.7 The following features over and above the requirements of NZS 4332 are the minimum necessary for robust design of lifts used during a fire emergency:

- Lifts used for evacuation service shall be part of the building's normal vertical transportation system, so that they are in regular use (they provide a monitored circulation function).
- Electrical power supply to the lift is provided through an essential services switchboard (separate to the main electrical switchboard) as appropriate for *life safety systems*.
- Features are provided to minimise ingress of firefighting water into the lift shaft, such as floor drains or floor slope at the threshold of the lift landing doors. This is to protect the lift car, lift equipment and lift pit. Floor drains between *the evacuation zone* where the fire is situated (at least one intermediary *evacuation zone* away from lift lobby) and the lift threshold shall be designed to cope with a minimum of 750 litres of water per minute. Additional drain capacity may be required where higher sprinkler system hazard categories exist. Alternatively, a minimum 25mm raised threshold at the lift landing doors can be provided.
- Access hatches or local battery automatic self-recovery system, which upon total main and secondary power failure would move lift car to closest landing and open the lift door are provided to lift cars which are used during fire emergency to allow occupants to be rescued in the event that a lift car stops operating.
- A means to communicate with the hospital emergency response team and firefighters from the lift car shall be provided.

Floor drains at the threshold to lift landing doors are preferred instead of raised floor slopes in the floor surface because any firefighting water would be removed and the risk of large amounts of water redirected to other areas such as the stairwells would be largely mitigated. Additionally, excessive water around the lift entrance would interfere with movement of beds, trolleys and other equipment with wheels.

The means to communicate with emergency services from a lift car should be separate from the normal lift emergency communication device (to an offsite service provider). This could be by *WIP* phone or similar.

4.12.8 Safe use of lifts for fire evacuation requires *hospital building* floors to be subdivided into multiple *firecells*, *smokecells* and *evacuation zones*.

4.12.9 Lift shafts shall be enclosed in construction which provides a fire resistance rating. The fire resistance rating *for fire separations* protecting lift shaft and for *fire separations* creating *evacuation zones* located between a fire location and a bank of lift shafts shall meet the fire resistance rating as specified in section 5.3.

4.12.10 Lift shafts (serving one or more lift cars) shall be designed so that any failure of the lifts in one shaft, or compromised by fire conditions, does not impact on safe use of a lift shaft in another fire *evacuation zone*.

4.12.11 The dimensions of lifts and lift lobbies intended to be used during a fire emergency by occupants who need assistance for evacuation should comply with Figure 4.8 below.

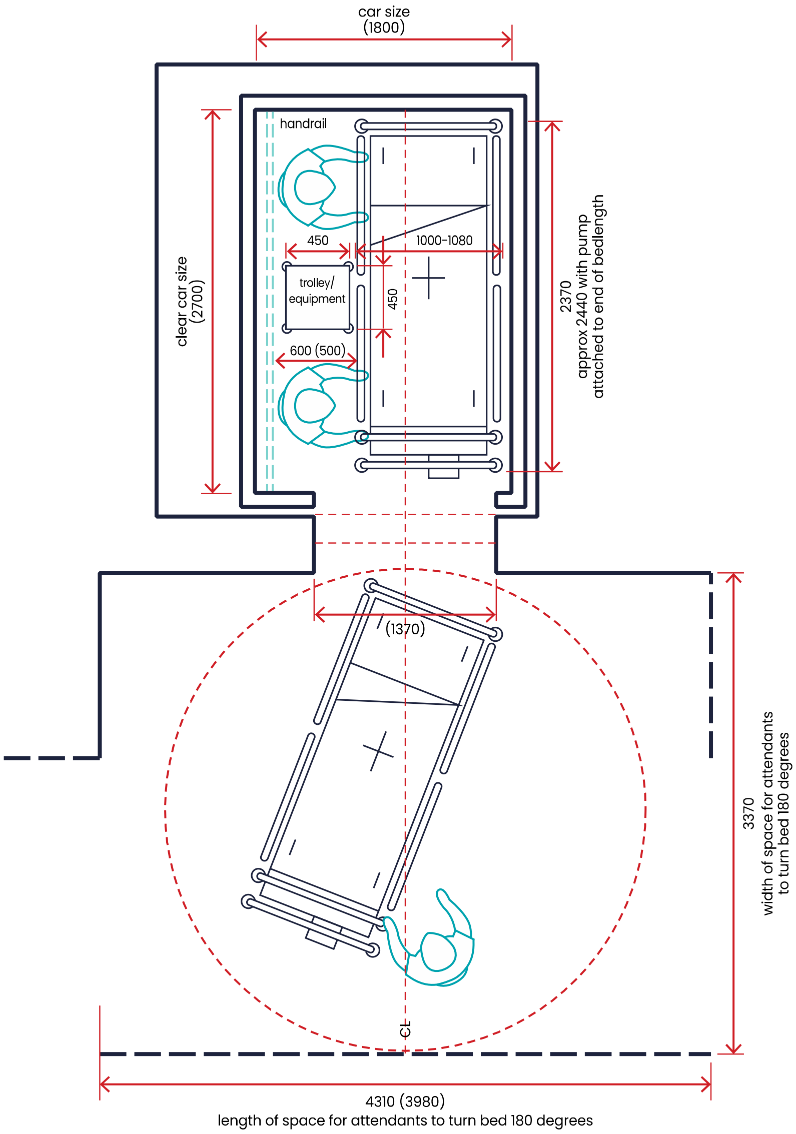


Figure 4.8 Dimensions of escape lifts and lobbies (from HTM 05-02 Figure 9)

> The dimensions in Figure 4.8 should be regarded as indicative likely minimum values. Actual dimensions required should be verified as suitable based on the project, and the health planning unit and type of occupants using the lift.

4.12.12 Refer to Appendix C for guidance on use of lifts for vertical evacuation if an alternative evacuation strategy is proposed, using a performance-based approach.

4.13 Doors and locking devices on escape routes

4.13.1 Doors (excluding bedroom doors) used for the passage of beds in *escape routes* shall open in the direction of escape or be motorised.

4.13.2 The minimum door leaf width in multi-leaf doorsets, where both leaves are required to be operated to enable egress of occupants, is 500 mm.

4.13.3 Doors on *escape routes* shall open onto a floor area which extends for a distance of no less than the arc of the door swing, and is at the same level on both sides of the door for the full width of the *escape route* (unless otherwise permitted by *Acceptable Solution* D1/AS1).

4.13.4 Doors on *escape routes* shall not cause the door swing when opened to obstruct the minimum required width of any *escape route*. The minimum door opening width shall not be less than 125 mm narrower than the required width of the *escape route* on which the door is located.

4.13.5 Smoke detector activated hold-open devices shall be fitted to *fire doors* or *smoke control doors* in locations where, due to the type or volume of occupant traffic using the doors, the doors may be kept open by unauthorised means. Determining appropriate locations should be coordinated during the design stage. Also refer to Section 6 for fire alarm interface requirements and design guidance, specifically Sections 6.16 and 6.21.

4.13.6 Doors on *escape routes* shall be constructed to ensure that the forces required to open these doors do not exceed those able to be applied: with a single hand to release the latch (where fitted); and using two hands to set the door in motion; and using a single hand to open the door to the minimum required width.

4.13.7 When the *hospital building* is occupied, controls on *escape route* door locking devices are as follows:

- Locking devices shall be clearly visible, located where such a device would be normally expected and, in the event of fire, designed to be easily operated without a key or other security device and allow the door to open in the normal manner. If the operation of a locking device is unusual, such as the pressing of a button close to the door, it shall have instructional signage complying with *Acceptable Solution* F8/AS1.
- Locking devices shall not obstruct, prevent or override the direct door hardware required to open the door.
- If locking devices are of an electromechanical type, then in the event of a power failure or door malfunction or locking device malfunction, either the locking device automatically switches to the unlocked fail-safe condition, or an alternative device complying with 4.13.3 and 4.13.4 above shall be provided to unlock the door.

Where locking devices are provided on stairway doors that control exit from the stairs (onto floors which are not on an *escape route*), it is recommended that consideration be given for all such locking devices to release and remain unlocked until reset whenever a building-wide fire alerting or evacuation signal is generated. A manual switch may also be provided in an appropriate central location (eg fire control room) to unlock all such doors. This unlocking operation is intended to allow occupants in the stairway to exit from any of the stairs at any level.

4.13.8 In areas where security for maintaining patient segregation or infection control is required, staff levels shall be sufficient to enable prompt operation of a key-operated or other staff-controlled security device to allow means of escape from fire. Any delay in the time required to unlock and open doors (compared with an automatic system) and suit up if there is infection control shall be considered when assessing the ability of the available number of trained staff to carry out a controlled evacuation.

4.13.9 Where it is necessary for security purposes for locking devices on doors at *final exits* not to release immediately on activation of an emergency door release or fire alarm, the release mechanism shall form part of the overall strategy for managing the evacuation. This gives control to the staff and increases the security of the facility. An overriding control system shall be part of the design, to allow for the use of doors on *escape routes* within a zone or the building when the acute need to evacuate overrides the need for security.

In certain situations, particularly for the coordination of means of escape and security in facilities with *P1 Occupant categories*, it may be essential to maintain a high level of supervision and segregation during an evacuation. In these situations, it may not be acceptable to automatically disengage the locks on any secure doors on the activation of the fire alarm system.

Free egress through doors may not be acceptable, since:

a) it would be very difficult for staff to maintain segregation of patients

b) patients would be able to disperse, not necessarily following the safest *evacuation route,* or abscond, possibly placing themselves or others at risk

c) it would be more difficult to establish that everyone had safely escaped from the evacuated area of the *hospital building*.

4.13.10 Where it is necessary to provide the potential for bedroom doors to be locked from the inside, such doors shall be easy to open from the inside without recourse to a key. In addition, any locking device used shall be easy to open from the outside of the room using a standard key issued to all staff with a fire safety responsibility.

For further information refer to the Department of Corrections Fire Design Guide for Prison Buildings.

4.13.11 *Fire doors* on *evacuation zone* boundaries should be provided with signs to identify to staff the location of the zone boundary. The sign shall include the text “Evacuation Zone Boundary” provided on both sides of the door leaf on *evacuation zone* boundaries.

Figure 4.9: Indicative F8 Signage to be provided on *evacuation zone* boundary *fire door* leaves (both sides)

Figure 4.9 details this sign in principle, which is an additional border provided to the signage defined in F8/AS1 Clause 5.2. This sign may be modified for smoke stop door or for door using hold open devices.

4.13.12 Vision panels shall be provided in:

- *fire doors* which separate fire protected stairs from floors
- doors which subdivide corridors on *escape routes*
- *fire doors* on *escape routes* and located on *evacuation zone* boundaries.

4.14 External escape routes

4.14.1 At doorways on *escape routes* used by patients who need assistance to evacuate that open to an external *escape route* the *escape route* surface should not be provided with a step. The *escape route* should open onto an area which is level, and not less than 1550mm x 3200mm to enable a bed to be manoeuvred onto a succeeding non-level area.

4.14.2 *Escape routes* over roofs shall comply with *Acceptable Solution C/AS2*.

4.14.3 The use of external stairs, and bridges, for evacuation of occupants who need assistance should be avoided where possible.

External escape routes may present additional hazards such as exposure to external temperature, wind and noise, the need to negotiate *escape routes* with wet surfaces and potential complications with security and re-entry to the *hospital building*. These hazards present additional challenges for assisted evacuation and are therefore not typically appropriate for *escape routes* used by occupants with limited or no mobility.

4.14.4 Adequate external assembly positions shall be provided for evacuees. If the occupants are not able to freely disperse, the assembly point must be designed as a *safe place* which allows them to remain safely in that location.

Suitable assembly positions can include suitably designed parts of the landscaping and can include roadways if traffic is managed appropriately and the roadways are not part of the vehicular accessway for fire appliances.

The following points should be considered when designing external *escape routes*:

- locate assembly positions to permit access for ambulances, while maintaining adequate circulation space for other emergency vehicles
- provide adequate artificial lighting
- provide electrical outlets for possible triage requirements
- provide adequate paved footpaths and dropped kerbs to the assembly points
- provide suitable gradients on external *escape routes*
- provide ramps with adequate width for the movement of wheelchairs, beds, trolleys
- provide appropriate separation of external *escape routes* from the external wall of the building
- maintain segregation of patients if required by the emergency evacuation strategy.

4.14.5 When designing external *escape routes* that are intended for use by assisted or fully supervised mental health patients, the considerations which apply to physical health patients needing assistance shall be also applied, with the additional caveat of any security measures required to ensure patient and staff safety.

For mental health *HPUs*, evacuation to an external assembly point would be a last resort only.

4.14.6 It may be necessary for some patients to maintain segregation during evacuation. Where this is the case, the design of *escape routes* shall be designed so that this segregation is maintained during the entire evacuation. This shall also extend to secure *places of safety* away from the effects of fire, outside the building.

4.15 HPUs containing category P1 occupants

4.15.1 Additional fire safety precautions shall be considered in these *HPUs* in order to address the consequences of:

1. fire and smoke in an adjacent *firecell* outside the patient care area
2. fire and smoke within the patient care area itself
3. fire or consequential damage or obstruction of an *escape route* in adjacent *firecells.*

In these *HPUs*, any movement or evacuation of patients may be life-threatening. Options for responding to and directly controlling an outbreak of fire in the space containing *category P1 occupants* may include use of fire blankets, cutting electricity supply to certain equipment, providing hand operated fire extinguishers with appropriate extinguishing agent, etc.

4.15.2 Spaces containing *category P1 occupants* require two independent *escape routes* into independent adjacent *firecells*.

Patients in these departments require the highest level of assistance in the event of needing to escape from fire and may require extended patient preparation prior to evacuation.

Consideration should be given to subdividing the *HPUs containing P1 occupants* by fire rating each operating theatre/care space or group of theatres/care spaces, so that in the case of fire within one space procedures can continue for a limited amount of time in the others.

The extent of the sub-division within the *HPUs* should take into account the size and number of specialist procedure rooms, and operational criticality of the procedure (for patient care) and of the *HPU* (that is, business continuity).

Although it is accepted that some occupants should not be moved because of their condition or treatment, provision must still be made for evacuation.

4.15.3 The compartmentation and *HVAC* in spaces containing *category P1 occupants* should be designed:

1. so an adequate period of time is provided to enable a fire to be detected and extinguished before it threatens the occupants
2. to minimise the likelihood that a fire in an adjacent *firecell* either on the same storey or on a storey above or below requires the evacuation of *category P1 occupants.*

4.15.4 In areas containing *category P1 occupants*, the *HVAC* systems should be designed so that they continue to operate in a fire emergency.

The *HVAC* systems provided to operating theatres and intensive care areas are designed so that the pressure within the patient care space is maintained at a level slightly above that of the adjacent spaces. In a fire emergency, the continuing operation of these systems will assist in preventing smoke and other products of combustion entering the patient care spaces.

4.16 Emergency and escape lighting

4.16.1 Emergency escape lighting shall be provided to all areas in accordance with *NZBC Clauses* F6, F8 and AS/NZS 2293.1.

4.17 Means of escape from plant areas

4.17.1 The means of escape from plantrooms should be designed to take account of the egress hazards presented by the equipment or contents of the room and any hindrance to the movement of the occupants (for example low headroom). All areas of plant rooms, including intermittently occupied spaces, shall be served by *open path escape routes* complying with C/AS2.

4.17.2 The means of escape from rooftop plant areas shall also comply with the egress length limitations contained in Section 4.7 and 4.8 and shall otherwise be served by *open path escape routes* complying with *C/AS2*. The maximum length of a dead-end path shall not exceed 50m, and the maximum length of an *open path* shall not exceed 120m.

5 Firecells

5.1 Introduction

5.1.1 This Section provides *firecell* and *smokecell* requirements to address the means of escape principles and fire evacuation strategy outlined in Sections 4.2 to 4.4, by reference to:

a) *firecell* size limitations

b) fire resistance ratings

c) *firecell* and *smokecell* compartmentation.

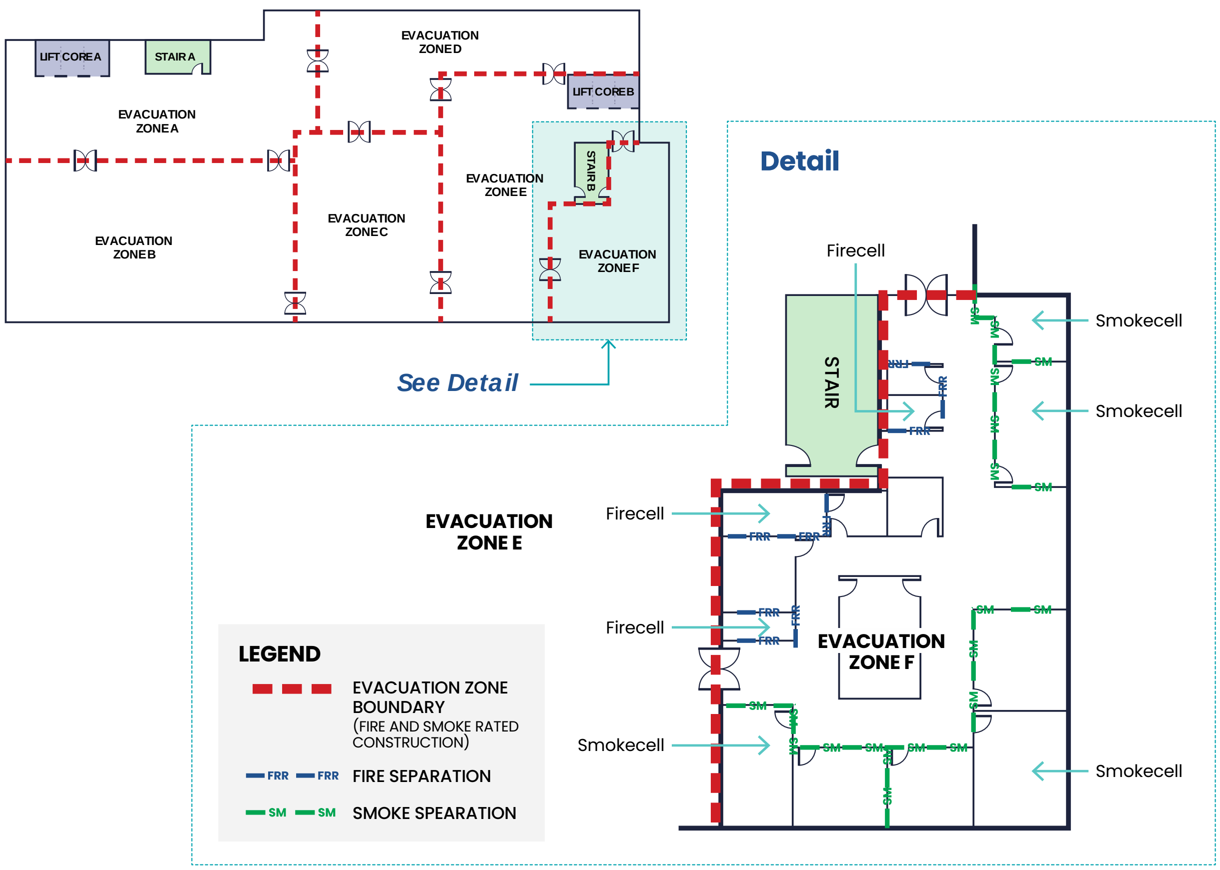


Figure 5.1: Typical *hospital building firecell* compartmentation showing fire and smoke rated construction

5.2 Firecell size limitations

The maximum size of a *firecell* permitted by this document is appropriate for fire containment. However, in determining the maximum size, fire engineers must be cognisant of a fire event where a large number of patients could be overcome by the spread of fire, smoke and toxic gases. Therefore, *firecells* containing patient-access areas could be further subdivided to limit the number of patients who may be affected by a fire. Wherever possible, there should be an approximately even number of patients in each of these subdivided firecells so the spread is more balanced, making horizontal evacuation more efficient.

5.2.1 A firecell should be compartmented further if:

1. it has a floor area greater than limits stated in this document (refer to Section 5.7); or
2. it contains *HPUs* to which more than the number of patients allowed by this document will have access at the same time (refer to Section 5.9 and 5.10); or
3. it contains sleeping accommodation for more than the number of patients allowed by this document (refer to Section 5.9 and 5.10).

5.3 Fire resistance rating values

5.3.1 Unless explicitly stated otherwise in this *DGN*, the *FRRs* that apply for each area in a *hospital building* shall be at least 60 minutes (-/60/-).

This prescriptive *FRR* does not prevent a fire engineer from selecting a fire resistance rating obtained from a calculation for burnout, or a higher fire resistance rating applied to specific elements for other reasons, such as property protection.

5.3.2 Structural elements in a single storey building need not be fire rated if *FRRs* are not required for any other reason.

5.4 General requirements for fire resistance ratings

5.4.1 *FRRs* shall apply to the sides of primary elements and secondary elements which are exposed to fire.

5.4.2 When different *FRRs* apply on each side of a *fire separation*, being a wall, the higher rating shall apply to both sides.

5.4.3 Floors shall have an *FRR* for exposure from the underside.

5.4.4 The *FRR* of a primary element integral with a *fire separation* shall be no less than that of the *fire separation*.

5.4.5 Except as stated in Section 8, areas of external wall not permitted to be protected areas shall be fire rated from the inside only.

Care to be taken with the protection of penetrations through the one-way linings, given there are limited fire stopping solutions available. It may be prudent to include trimmed and lined areas for the services to penetrate, where the linings extend in the wall cavity to the external cladding to protect against fire spread into the wall framing and to the detriment of the provided protection to the external wall.

5.4.6 Areas of external wall not permitted to be unprotected areas shall be rated for fire exposure from both sides equally where:

1. walls are within 1 m of a relevant boundary, or
2. the *hospital building* height is more than 10 m, or
3. the *final exit* is two or more floor levels below any risk group clinical occupancy.

5.5 Smoke stopping capability

5.5.1 A *fire separation* also needs to function and achieve the requirements as a *smoke separation.* This includes fire stopping of services penetrations, where there are to be no gaps (for infection control as well as control of smoke spread). For example, plastic pipe penetrations fitted with fire collars each side of the wall are to have fire mastic applied between the pipe and wall where the penetration occurs.

5.6 Applying insulation component in FRR

5.6.1 Except on e*vacuation zone* boundaries, since *hospital buildings* are required to be fitted with sprinkler systems throughout in accordance with NZS 4541 or, where applicable, NZS 4515, the insulation rating of a *FRR* is not required to apply to any fire resistive element in the *hospital building*.

5.7 Maximum area of firecells

Within patient-access areas, *firecells* are used to divide a level or area of the *hospital building* into places of temporary safety. In addition, they prevent rapid fire spread throughout the building and reduce the likelihood of large fires.

5.7.1 For *hospital buildings* more than one storey in height, all floors should be *fire separations* and therefore separate *firecells* – unless specific provisions for atria or mezzanines are provided, which would be the subject of specific fire engineering design.

5.7.2 In *hospital buildings*, the perimeter of each *HPU* should be a *fire separation*.

5.7.3 The maximum area of a *firecell* should not exceed:

1. 500m^2 for wards and areas of *HPUs* containing *P1, P2 or P3 occupants*

2. All other *hospital building* areas of other usage can have an unlimited *firecell* area as these *firecells* are sprinkler protected.

5.8 Subdividing clinical firecells

5.8.1 Patient care areas are to be fire separated from each other, and from adjacent non patient care areas with *fire separations* having an *FRR* in accordance with 5.3.1. They can be designed as *group sleeping areas* in accordance with the following Sections. Where *group sleeping areas* are not used, additional *firecells* may be required.

5.9 Maximum number of patients per firecell – category P2 and P3 patients

5.9.1 Where there are two or more *group sleeping areas* and these are adjacent to one another, each *group sleeping area* shall contain no more than the following number of beds and have sufficient space to accommodate, in an emergency, the beds from an adjacent *group sleeping area*:

1. for *group sleeping areas* with 6 staff (or more) in the *HPU* and able to immediately commence evacuation of patients – 20 beds
2. for group sleeping areas with 4-5 staff in the *HPU* and able to immediately commence evacuation of patients – 12 beds
3. for group sleeping areas with 2-3 staff in the *HPU* and able to immediately commence evacuation of patients – 8 beds.

5.9.2 If there are no adjacent *group sleeping areas* to evacuate into, the maximum number of patients/beds in a *group sleeping area firecell* with 6 staff (or more) is 12.

> Note
>
> At least 2 staff shall be available (and on duty) at all times in the HPU and able to immediately commence evacuation of patients.

> Note
>
> When referring above to staff *“able to immediately commence evacuation of patients”* this means they are either in the firecell concerned, or in the *HPU* concerned if that *HPU* in split into multiple firecells. Staff who need to come from an adjacent *HPU*, adjacent level of the building, or area on the same level but further afield than the same *HPU* would not be considered as *“able to immediately commence evacuation of patients”.*

5.10 Maximum number of patients per firecell – category P1 patients

5.10.1 If there are no adjacent *group sleeping areas* of any *occupant category* to evacuate into, the maximum number of patients/beds in a *group sleeping area firecell* is 6.

5.10.2 Where there are two or more *group sleeping areas* and these are adjacent to one another, each *group sleeping area* shall contain no more than the following number of beds and have sufficient space to accommodate, in an emergency, the beds from an adjacent *group sleeping area*:

a) for *group sleeping areas* with 10 staff (or more) in the *HPU* and able to immediately commence evacuation of patients – 18 beds

b) for *group sleeping areas* with 6-9 staff in the *HPU* and able to immediately commence evacuation of patients – 12 beds

c) for *group sleeping areas* with 2-5 staff in the *HPU* and able to immediately commence evacuation of patients – 6 beds.

5.10.3 Notwithstanding the limitations in Clause 5.10.1 and 5.10.2 above, if the firecell containing P1 patients is a group of operating theatres, procedure rooms, or MRI suites for example, then the further limitations of clause 5.17 shall apply.

Note:

Occupant category P1 patients are defined as requiring a period of preparation before movement, and so evacuation is delayed. They are also typically in *HPUs* with high staff-to-patient ratios as the level of care and observation is high. However, in some *HPUs* the maximum number of beds may be limited by the number of staff required to evacuate patients dependant on life-support equipment, such as intensive care and neo-natal intensive care.

The minimum number of staff that need to be in the *firecell* at all times and able to immediately commence evacuation of patients is two.

Protecting occupants by enclosing *HPUs* with fire- resisting construction and the strategic planning of adjacent *firecells* helps to mitigate the risk. The time required to evacuate patients who are not immediately movable is longer, as it is often necessary to move the patient with their ventilators and monitoring equipment as one unit. This may require several staff dedicated to each patient being evacuated. The design should specify appropriate level of *fire separation* to protect the occupants while allowing for extended pre-movement times.

Note

When referring above to staff *"able to immediately commence evacuation of patients"* this means they are either in the firecell concerned, or in the *HPU* concerned if that *HPU* in split into multiple firecells. Staff who need to come from an adjacent *HPU*, adjacent level of the building, or area on the same level but further afield than the same *HPU,* would not be considered as *"able to immediately commence evacuation of patients".*

5.10.4 Where the number of *occupant category P1* patients in a *group sleeping area* exceeds 6, then the space is required to be subdivided into not more than three *smokecells* each containing no more than 6 patients. Each of these *smokecells* is required to have two means of escape, either into an adjacent *smokecell*, or into an adjacent *group sleeping area firecell*.

5.10.5 If one of the means of escape is into an adjacent *smokecell*, then the means of escape from that subsequent *smokecell* is required to discharge into a different *firecell* than the initial space. That is, each *smokecell* in an *occupant category P1 group sleeping area* is to have a means of escape into a separate *firecell*, independent of the other.

5.11 Direct support functions

5.11.1 Direct support functions may be included in a *group sleeping area* without *fire or smoke separations*. Direct support functions may include sanitary facilities and tea making activities for use by the occupants, but may not include cooking facilities.

Direct Support Functions are activities that provide support to the primary use of a space that are open areas of low risk and low fire load which may include but are not limited to reception desks, nurses stations, sanitary facilities, kiosks, tea bays, small lounge rooms such as small whanau rooms and 'cohort lounges' of $20m^2$ or less which are not expected to be used communally and therefore offer little in the way of additional fuel load to what might be expected in a sleeping room or ward firecell. Sanitary facilities may be enclosed to provide appropriate privacy.

5.12 Communal service functions for group sleeping areas

5.12.1 Communal service functions shall be separated from *group sleeping areas* or suites with *fire separations* having an *FRR* of 60 minutes.

Note:

Communal Service Functions are spaces that provide day to day service function to support the sleeping areas and are higher fire risk than direct support functions. These are generally enclosed spaces which include but are not limited to offices, waiting rooms, larger communal lounges, stores, dining rooms, laundries and kitchens.

5.13 Subdividing the space

5.13.1 A *group sleeping area* may be subdivided with full height *smoke separations*, extending to floor slab or roof above, including *smoke control doors* which need not be fitted with self-closers.

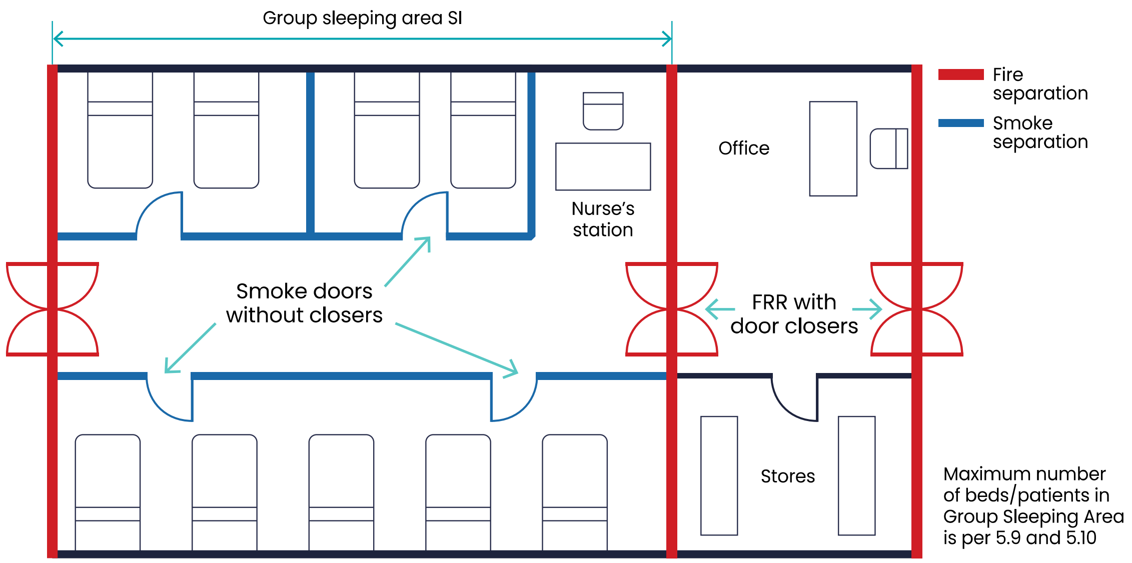


Figure 5.2: *Group sleeping area* (adapted from C/AS2 Figure 4.5 (b))

5.13.2 A *group sleeping area* may be subdivided with non-fire rated partitions if it contains no more than 6 beds.

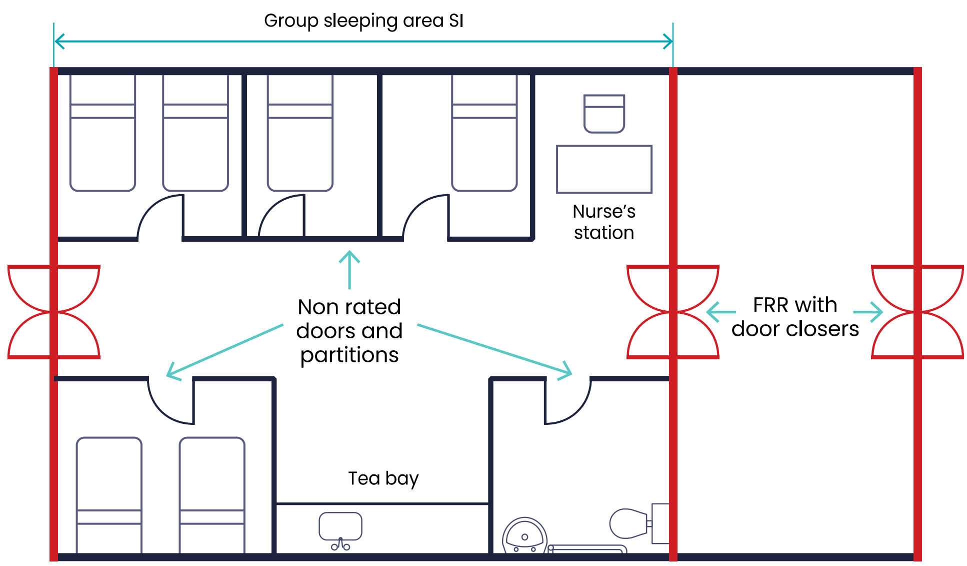


Figure 5.3: *Group sleeping area* – maximum 6 beds (adapted from C/AS2 Figure 4.5 (c))

5.14 Plant rooms and spaces

5.14.1 Any space within a *hospital building* containing an incinerator plant, boiler or machinery which uses solid fuel, gas or petroleum products as the energy source (but excluding space and local water heating appliances) shall be a separate *firecell*. The *firecell* shall be *fire separated* with an *FRR* of no less than 60 minutes.

5.14.2 Plant, boiler and incinerator rooms shall have:

- at least one external wall, and
- either an external access that may be at any floor level including the roof or alternative internal access that shall be via a smoke lobby that is protected with a heat detector connected to the fire alarm system, and
- floor levels no lower than the ground level outside the external wall if gas is the energy source.

5.14.3 Only the third bullet point of 5.14.2 shall apply if the *hospital* services plant is in a building that is solely to contain the plant, and the building:

a) is sprinkler protected and separated by 3.0m or more from any adjacent building, or

b) is not sprinkler protected and is separated in accordance with NZS 4541.

5.14.4 If smoke detection is removed from these spaces due to the propensity for false alarms, and allowed by the relevant sprinkler and fire alarm standards, then addressable heat detection shall be installed (as well as sprinklers) to provide suitable addressability and information on the location of alarm activation.

5.15 Energy generating and storage systems

5.15.1 Where solar energy generating and storage systems are located on the roof of a *hospital building* (such as photo voltaic cell arrays) the roof area below this plant and equipment, as well as the roof forming the means of access to it, shall be constructed so the exposed components are of *non-combustible* materials.

5.16 Solid waste stores

5.16.1 Solid waste storage areas shall be enclosed when located adjacent to all occupied spaces.

5.16.2 Enclosed solid waste storage areas within any *firecell* shall themselves be a separate *firecell* separated from adjacent *firecells* by *fire separations* having an *FRR* of no less than 60 minutes.

5.17 Operating theatres/suites

5.17.1 Operating *HPUs*, by their very nature, are considered to include very high dependency occupants. Evacuation of patients from these *HPUs* may be life-threatening; therefore, additional measures should be provided to allow sufficient time to prepare patients for evacuation.

5.17.2 *Hospital* operating theatres, procedure rooms, and high dependency areas such as MRI rooms containing *category P1 occupants* shall be either:

1. contained in separate *firecells* having *fire separations* with an *FRR* of no less than 60 minutes, or
2. grouped together within a *firecell* which is separated from other activities by fire separations with an *FRR* of no less than 60 minutes. Within that *firecell,* the maximum number of patients under care (or number of theatres, procedures rooms etc) shall be no more than four, and each space shall be separated from adjacent spaces by *smoke separations*.

5.17.3 *Firecell* subdivision should be configured so that each theatre (or procedure room, MRI etc) has two means of escape into two separate *firecells*. One of these routes of egress may be through adjacent theatres or procedure rooms, etc.

Note

Because of the potentially extended time period before patients in these spaces are able to be evacuated, there is potential for adjacent *firecells* affected by fire to be unsuitable for evacuation of patients. These spaces should therefore be provided with two separate means of escape into two separate *firecells* so when ready to move, they can be evacuated through *firecells* unaffected by fire.

The extent of the sub-division within the operating *HPUs* should be risk-assessed, taking into account its size and the number of operating rooms, and operational criticality of the *HPU* (ie for business continuity).

5.17.4 The design of the *firecells* and *smokecells*, the location of smoke-retarding construction and the operation of *fire* and *smoke dampers* should not impede the clean air-flow paths and room-air dilution rates, as this may lead to an increased risk of healthcare-associated infections. It is therefore essential that experts in theatre ventilation systems are fully involved in the design of all fire safety measures in operating theatres.

5.18 Care suites

5.18.1 Where sleeping areas in *hospital buildings* are subdivided to create suites, each suite shall contain no more than 6 beds. Each suite shall be a separate *firecell* with *fire separations* having an *FRR* of 60 minutes. Suites may be subdivided with non-fire rated construction to provide separate spaces for sleeping, sanitary facilities and other activities.

5.18.2 Care suites are limited to category *P2, P3* and *P4 occupants* only.

5.18.3 To facilitate evacuation of patients and occupants of a care suite, at least 2 staff must be present in the *HPU* at all times.

> Note
>
> A care suite is a *firecell* containing residential style accommodation for the exclusive use of one person or several people known to each other. It comprises one or more rooms for sleeping and may include spaces used for associated domestic activities such as hygiene and cooking (kitchens), as well as lounge and dining – similar to a hotel room.
>
> Examples include aged care facility, or mental health facility patient rooms which contain a small residential lounge and kitchenette associated with the bedroom(s).

5.19 Carparking

5.19.1 Carparking provided inside a *hospital building* shall be in a separate *firecell* and fire separated from adjacent areas with an *FRR* of not less than 60 minutes.

5.19.2 Within the car parking *firecell*, other spaces (such as ticket office, a gate booth, or a storeroom not greater than 10 m^2) are permitted where they are necessary for the operation of the car parking *firecell*.

5.20 Fire and smoke stopping

5.20.1 The continuity and effectiveness of *fire separations* shall be maintained around penetrations, and in gaps between or within *hospital building* elements, by the use of *fire stops*.

5.20.2 *Fire stopping* shall have an *FRR* of no less than that required for the *fire separation* within which they are installed, and shall be tested in accordance with AS 1530.4 or NZS/BS 476 Parts 21 and 22, and in accordance with AS 4072.1.

5.20.3 *Fire stopping* and methods of installation shall be identical to those of the prototype used in tests to establish their *FRR*.

5.20.4 The material selected for use as *fire stops* shall have been tested for the type and size of the gap or penetration, and for the type of material and construction used in the *fire separation*.

5.20.5 Care should be taken when *fire stopping* penetrations involving some specialised services (such as pneumatic tube systems, med gas, fume hood extraction etc) as the operation of these systems may adversely affect the performance of some *fire stopping* products. Products and systems should still be installed strictly in accordance with manufacturer instructions, and match the prototype tests used to establish their *FRR*. This may require additional features or interfaces so the service penetration does not deviate from what was tested (eg shutting down pneumatic tube air supply on fire alarm activation).

5.20.6 A *fire stop* for a penetration is not required to have an insulation rating provided that the *fire separation* is not an *evacuation zone* boundary (see Clause 5.6.1), and the building is sprinkler protected throughout in accordance with NZS 4541 or if means are provided to keep combustible materials at a distance of at least 300mm away from the penetration and the *fire stop* to prevent ignition.

5.20.7 The assessment of smoke production and smoke spread is outside the scope of AS 1530.4 and AS 4072.1. Significant smoke spread or smoke production can occur even though an element of construction may have achieved high *FRR*. The fire design may need to consider other methods when evaluating the potential for smoke spread and *smoke stopping*.

Note:

The *FPANZ* ‘Passive Fire Position Statements’ and BRANZ ‘Guide to Passive Fire Protection in buildings’ are useful references on the provision of comprehensive fire and *smoke stopping* design and construction details and documents to support the project and the ongoing management of passive fire details. Refer also to Appendix I for further details.

5.21 Glazing in fire and smoke separations

5.21.1 Any glazing provided in a fire rated wall should have the same period of *fire resistance* (integrity and insulation) as the wall and this shall be a certified system tested to AS 1530.4. Glazing should have a permanent, legible mark giving the manufacturer, product name, *fire resistance rating* and any requirement for impact safety performance according to BS 6206 or BS EN 12600.

5.21.2 There is no restriction on the area of glazing in *smoke separations* (including smoke lobbies). Non-fire resisting glazing may be used if it is toughened or laminated safety glass. Glazing shall have at least the same *smoke stopping* ability as the *smoke separation*.

5.22 Fire doors and smoke control doors

5.22.1 Glazing in *fire doors* shall be fire resisting glazing having the same integrity value as the door. If the door requires an insulation value, an uninsulated vision panel may be used without downgrading the insulation value of the door. Vision panels shall comply with NZS 4520.

5.22.2 Glazing in *smoke control doors* shall meet the requirements for *smoke separations*.

5.23 Junctions of fire separations

5.23.1 Where *fire separations* meet other *fire separations* or external walls, they shall either be bonded together or have the junction *fire stopped* over its full length.

5.23.2 Any wall/floor junction shall be constructed with the *FRR* required for the higher rated element.

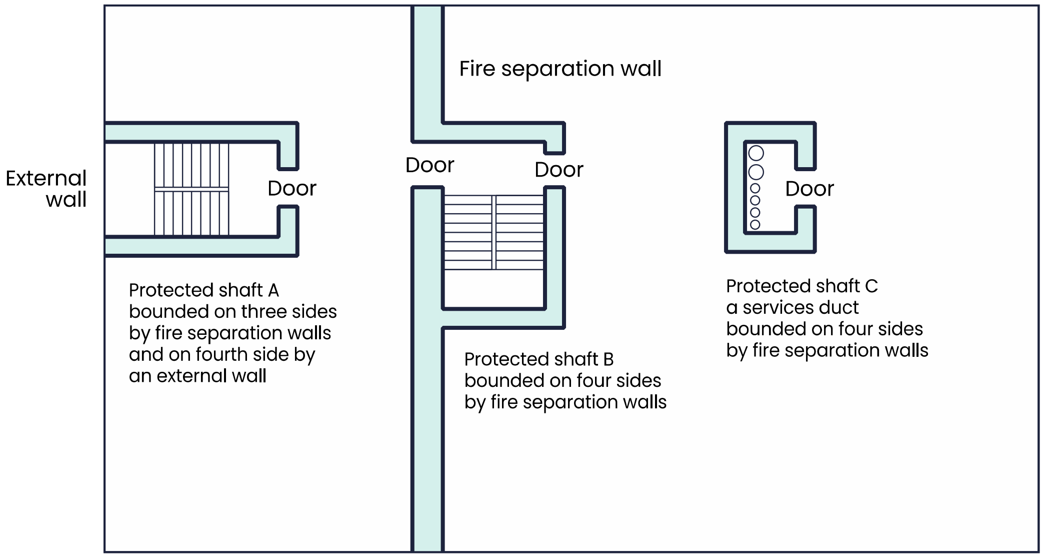
5.24 Junctions with roof

5.24.1 Vertical *fire separations* and external walls shall either:

1. terminate as close as possible to the external roof cladding and primary elements providing roof support, with any gaps fully *fire stopped,* or
2. extend not less than 450 mm above the roof to form a parapet.

5.25 Protected shafts

5.25.1 Openings in floors for stairways, lifts, escalators, and pipes and ducts not complying with paragraph 5.20 should be enclosed in a *protected shaft* that has the same period of *fire resistance* (integrity, insulation and, where applicable, load-bearing capacity) as the *firecell* floor.



Note: *The protected shaft should meet the relevant provisions for fire separation walls*

Figure 5.4: ***Protected shafts***
(from HTM-05-02 Figure 13)

5.25.2 The *protected shaft* should form a complete barrier to fire between different *firecells* to which the shaft connects and should be constructed from materials of limited combustibility. Where services (pipes, cables, ducts etc) are required to pass through the enclosing structure they should be adequately *fire-stopped* to maintain the *fire resistance* of the *protected shaft*.

5.25.3 The use of *protected shafts* should be limited to:

a) stairways

b) lifts

c) escalators

d) chutes

e) ducts

f) pipes, collections of pipes, or services risers.

5.25.4 Occupied spaces (normally occupied or intermittently occupied) should not be included within *protected shafts*.

5.26 Fire protection of external egress routes

5.26.1 Where an *escape route* enters a space exposed to open air (eg an open stairway, a balcony, across a roof, or ground level path) it shall meet the requirements of a *safe path* between that point and the *final exit*. *Safe path* separation requirements shall be achieved by providing either distance or fire rated construction between the *escape route* and adjacent *firecells*, as specified in this Section.

5.26.2 Separation by distance shall be achieved as follows:

- if there is only one direction of escape, roofs and external walls shall not have unprotected areas closer than 1m to the external *escape route*, or
- the *escape route* shall be located so it diverges from external walls (see Section 5.26.3), or
- where alternative directions of escape are provided from the point where the *escape route* passes through an external wall and becomes an external *escape route* (see Section 5.26.3), unprotected areas are permitted.

5.26.3 For an *escape route* which passes through an opening in an external wall, parts of the external wall need not be *fire rated* if:

- the direction of escape to a single *final exit* diverges from the external wall at an angle of no less than 45 degrees in plan, or
- the directions of escape to alternative *final exits* diverge from each other at an angle of no less than 90 degrees in plan and the escape routes subsequently do not both pass the same firecell (other than the *firecell* from which they originated).

5.26.4 Except where the separation distance requirements of paragraph 5.26.2 and 5.26.3 are achieved:

- external walls and roofs adjacent to external *escape routes* shall have an *FRR* of not less than 60 minutes and have no unprotected areas, and
- if the *escape route* is a balcony with a single direction of escape, and the vertical distance between the underside of the balcony and the closest unprotected area in the external wall below is less than 5.0m, balcony barriers shall have no openings, and be protected with a material having a *Group Number* of 1.
- If the vertical separation between the underside of an external *escape route* and unprotected areas in the external wall below is less than 5.0m the floor of the external *escape route* shall have an *FRR* of not less than 60 minutes, and treads and risers of stairs on external *escape routes* shall either be constructed of a material which has a critical radiant flux of not less than 2.2kW/m2 or shall be protected on the underside with a material having a *Group Number* of no greater than 2.

5.27 Ventilation systems

5.27.1 Mechanical ventilation is used extensively in healthcare premises, including specialist systems for primary patient treatment in operating *HPUs*, critical care areas and isolation rooms.

5.27.2 In the event of a fire, the mechanical ventilation system is typically controlled so that it limits the spread of smoke and toxic gases between *smokecells*, *firecells* and *evacuation zones*. It is critical that there is early design coordination between the fire engineer, architect and building services engineers to coordinate the location of these cells and the mechanical ventilation systems.

5.27.3 Refer to Section 6 for details on the coordination requirements between the fire design and building services design.

5.28 Location and operation of fire and smoke dampers and fire dampers

5.28.1 Ventilation ducts should maintain the period of *fire resistance* of the construction through which they pass; this includes but is not limited to fire hazard rooms, *firecells, smokecells*, cavity barriers and *protected shafts*. This is achieved through the use of *fire and smoke dampers* and the use of *fire rated* duct material.

5.28.2 Refer to Section 6 for details on the coordination requirements between the fire design and building services design.

5.29 Operation of ventilation plant

5.29.1 It may not be desirable to shut down the ventilation plant automatically on the activation of the fire alarm system. For example, in areas where the automatic shutdown of ventilation plant will impede the clean air-flow paths and room-air dilution rates, this may lead to an increased risk of healthcare-associated infections. Where, due to operational reasons, the ventilation plant continues to run, override facilities will be required and the shutdown of the system should be controlled from panels located either at department entrances or adjacent to the main fire alarm indicator panels.

5.29.2 Refer to Section 6 for details on the coordination requirements between the fire design and building services design.

5.30 Cavity barriers

5.30.1 Concealed spaces or cavities in the construction of a building may permit the rapid spread of fire and smoke. It is possible for fire and smoke to be transferred to areas remote from the seat of the fire by way of uninterrupted or non-fire rated concealed spaces. For this reason, it is essential that fire-resisting barriers are provided to restrict the size of these concealed spaces.

5.30.2 In *hospital buildings*, the subdivision provided through the requirements for hazard protection and compartmentation is such that generally the additional subdivision of ceiling voids for cavity barriers is not required. Irrespective of the above, there is a requirement to prevent the interconnection of horizontal and vertical cavities.

5.30.3 Fire-resisting cavity barriers having the same fire resistance as the surrounding construction or fire separations should also be provided:

a) to prevent the interconnection of vertical and horizontal cavities
b) at the intersection of fire-resisting construction and elements containing a concealed space
c) within the void behind the external face of rain-screen cladding, at every floor level and on the line of compartment walls abutting the external wall. This also allows open-state cavity barriers in accordance with AS1530.4 modified by ASFP TGD 19.

5.30.4 Openings in barriers should be limited to those for:

1. doors which have a fire resistance of at least the *FRR* of the separation in which they are located
2. pipes with appropriate *fire stopping*
3. cables or conduits with appropriate *fire stopping*
4. openings fitted with a suitably mounted automatic *fire and smoke damper* (see Table 6.1)
5. ducts which, unless they are fire-resisting, are fitted with a suitably mounted automatic *fire damper* where they pass through the cavity barrier.

5.31 Cavity barriers above operating HPUs

5.31.1 The complexities of ventilation ductwork systems above operating *HPUs* mean that the provision of cavity barriers may seriously compromise service access and means of escape for maintenance staff. Therefore cavity barriers should not be provided over operating *HPUs*. Walls shall extend full height to the underside of the *fire separation* above, or roof, as applicable.

5.32 Identification of fire and smoke rated construction

5.32.1 It is recommended that on walls within plant rooms, service risers and above ceilings concealed from general view, the fire or smoke rating is stencilled in a permanent way on both sides of the:

- *fire* and *smoke separations* (text to read "xx/xx/xx Sm Fire and Smoke Rated Wall" where xx is the rating of the separation)
- *fire separations* (text to read "xx/xx/xx Fire Rated Wall" where xx is the rating of the separation)
- *smoke separations* (text to read "-/-/-Sm Smoke Rated Wall").

5.32.2 The design of the stencils should be reviewed and agreed by the architect, fire engineer and client. The stencil would generally be located at every 3 metres or at every change in direction. The colour used for the stencil would be contrasting to that of the wall it is placed on. The size of the stencilling is to be suitable so all words can be viewed from floor level.

6 Fire protection systems and building services systems

6.1Introduction

6.1.1 *Hospital buildings* contain many complicated and varied building systems. Many of these systems need to be considered as part of the fire engineering design. Some building systems are installed specifically to form part of the fire safety and evacuation procedures of the *hospital* as specified by the fire engineer. These systems typically include (but are not limited to):

- automatic fire sprinkler systems
- fire detection and alarm systems
- building hydrant systems
- hand operated firefighting equipment
- Emergency Warning and Intercommunication Systems (EWIS).

6.1.2 They typically form part of a holistic fire safety solution that includes other building infrastructure such as water supplies, power networks and controls networks.

6.1.3 Building systems installed primarily for day-to-day functions that are also designed to provide critical functions in the event of a fire emergency include:

- ventilation systems
- controls and building management systems
- electrical systems
- security systems
- hydraulic systems
- lifts.

6.1.4 This Section covers the typical building systems used as part of the fire safety solution within *hospital buildings*, key factors and design principles that need to be taken into consideration during the design process, and guidance on the installation, testing and maintenance of these systems to ensure continued reliability and performance.

6.1.5 The aim is to ensure that the building systems perform in a way that contains and controls the effects of a fire so occupants can safely evacuate, firefighting personnel can attend to the fire without undue risk exposure, and unaffected areas of the *hospital building* remain operational.

6.1.6 Fire engineers need to communicate to other designers at an early stage of design the key life safety expectations around active fire systems, passive fire safety features and evacuation strategy. Careful co-ordination, collaboration and system integration is required in the following stages of design to ensure the fire safety objectives are maintained without compromising the primary purpose and performance of the building services systems.

6.1.7 The fire engineer should lead the development of a *Fire Systems Interface Matrix* describing the cause and effect between active fire protection systems and building services systems. This matrix should be initiated early in the design process to facilitate coordination of building services.

The *FPANZ* COP4 document, Code of Practice for the integration of Building Fire Safety Systems provides a useful reference, in particular Figure 1, Systems Integration Process flow chart.

Practice Note 22 *Guidelines for Documenting Fire Safety Designs* provides further information to designers about the provision of adequate project documentation, the need for ongoing coordination, and how the fire engineering design is to be incorporated into the plans and specifications of other designers.

6.2 Evacuation management

6.2.1 *Hospital buildings* have an evacuation strategy to mitigate the risk to patients and staff. Additional safeguards against the effects of a fire may be incorporated, such as pressurising specific areas either to maintain a sterile environment or control possible smoke ingress.

6.2.2 The automatic fire alarm system in a *hospital building* shall be configured to communicate the status of an alarm and interface with support systems according to an evacuation matrix. This includes notification to *FENZ*, key *hospital* staff and alarm zone areas designated to either evacuate or prepare to evacuate. Secondary interfaces may include visual and audible alerting devices, door release mechanisms, way-finding systems, shut-down or change-of-state of *HVAC* systems, and/or lift systems changing operating mode to assist *FENZ* operations or evacuating personnel. An *emergency warning system* is usually provided to enable *FENZ* and key *hospital* personnel to communicate across a public address network to better inform occupants to the status of an emergency and evolving instructions (refer Section 6.18).

6.3 Alterations to existing hospital buildings – fire protection and building services

6.3.1 Section 1.9 addresses the regulatory requirements relating to altering *existing hospital buildings*. Once alterations to existing buildings are complete the means of escape from fire shall comply ‘as near as is reasonably practicable’, *ANARP,* to provisions of the Building Code. This includes fire protection and associated building services systems.

6.3.2 Existing *hospital building* spaces undergoing alterations or redevelopment and systems are expected to meet this guideline except where that is not feasible within the constraints of the project requirements and limitations. It is recognised that where upgrading and working on an existing facility achieving compliance with the requirements of this *DGN* may not be physically possible due to building constraints, such as space availability. The case for any departures with this *DGN* shall be documented to demonstrate that it is not reasonably practicable to do the work, for discussion and approval by Health NZ and, and that alternative options or improvements have been reasonably considered to address the risks arising from the non-compliance. The documented case for *ANARP* will then form part of the building consent application for *BCA* decision on granting the building consent.

6.4 Integrated building systems

6.4.1 *Hospital building* services systems and fire systems are often large and complex. The *hospital* designers and fire engineers shall carefully coordinate these systems throughout the design process from concept phase through detailed design to the completion of specific maintenance plans for the *hospital* facility.

6.4.2 The *Fire Systems Interface Matrix* is an essential tool for achieving system integration.

6.4.3 Some international standards specify requirements for systems integration. The following may be useful references:

- AS 1851 – Routine service of fire protection systems and equipment
- NFPA 3 – Standard for Commissioning of Fire Protection and Life Safety Systems
- NFPA 4 – Standard for Integrated Fire Protection and Life Safety System Testing
- CIBSE Commissioning Code M – Commissioning management.

6.5 Ventilation systems

6.5.1 Mechanical ventilation is used extensively in healthcare premises, including specialist systems for primary patient treatment in operating *HPUs*, critical care areas and isolation rooms. It is also installed to ensure compliance with quality standards for manufactured items in pharmacy and sterile services *HPUs* and to protect staff from harmful organisms and toxic substances (for example in laboratories). *Clinical* requirements may also require certain parts of a *hospital building* to be positively pressurised (eg for protection of vulnerable occupants) or negatively pressurised (eg to control spread of infectious organisms). Consideration should be given at an early stage to design air handling systems to suit *evacuation zones*.

6.5.2 The *HVAC* systems provided to intensive care areas, operating theatres and isolation rooms are designed so that the pressure within the *HPU* is maintained at a level slightly different to that of the adjacent areas (above or below, depending on the *clinical* requirement). In *HPUs* providing intensive care such as operating theatres, the *HVAC* systems should be designed so that they are stand-alone to the *firecell* and continue to operate safely in a fire emergency to allow clinical procedures to be completed before evacuation. The control and override of these systems is normally located on the control panel within the operating theatre or a remote panel at the entrance to the *HDU*. There should also be clear override controls for all *HVAC* systems which have a fire function on the *Building Management system*.

6.5.3 The design of *smokecells* and *firecells*, including the operation of *fire and smoke dampers* should not impede the clean air-flow paths and room-air dilution rates in intensive care and isolation rooms, as this may lead to an increased risk of healthcare-associated infections. It is therefore essential that the Building Services engineers designing the *HVAC* systems are fully involved in the design of all fire safety measures in operating theatres and other pressurised spaces.

6.5.4 If practical, plantrooms should be subdivided into separate *smokecells* or *firecells* to separate essential services (for example power and ventilation) serving very high dependency areas from other plant equipment and machinery (for example lift motors, maintenance areas etc). The degree of protection should be determined in consultation with *Te Whatu Ora*, *FENZ* and other key stakeholders.

6.6 Ventilation Standards

6.6.1 In Aotearoa New Zealand the design of ventilation is covered by *Acceptable Solution* G4/AS1 which includes ventilation requirements for normal building use. However, there are no NZ standards which define ventilation requirements for the specific health requirements of hospitals.

6.6.2 Accordingly, the designers of *hospital building* services refer to various documents from other sources including:

- Health Technical Memorandum (HTM) from the UK Department of Health
- The Chartered Institution of Building Services Engineers (CIBSE) Guidelines
- Australian Health Facility Guidelines
- The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Guidelines.

6.6.3 As a result of this range of information sources, the strategy and design of building services in *hospitals* can vary throughout NZ. The lack of a consistent approach can complicate the ability of fire engineers and building services engineers to coordinate essential fire and emergency functions from one project to the next.

6.6.4 This document aims to provide a consistent basis for the design of building services in *hospital buildings* where fire safety and evacuation systems are required to interface.

6.7 Smoke control systems

6.7.1 This Design Guide classifies *smoke control systems* in the following ways:

- *Smoke Control System* (paragraph 6.7.2): a smoke control system specifically required by the fire engineering design, designed in accordance with AS 1668.1 and installed for the purpose of controlling smoke spread in accordance with defined performance criteria.
- *Smoke Management System* (Section 6.8): a building ventilation system which provides a secondary level of smoke control performance, usually utilising air handling systems installed for normal operation. These systems may be controlled by the BMS during a fire emergency. A *Smoke Management System* may be designed to comply with relevant parts of AS 1668.1 at the discretion of the fire engineering designer.

  The parts of a *hospital building* served by air handling systems that are designed for Smoke Control or Smoke Management are normally described in the *Fire Engineering Brief*, together with the intended (qualitative/quantitative) smoke control system performance requirements, if predicted at that stage of design. Both types of system need to be included in the *Fire Systems Interface Matrix*, Compliance Schedules and in testing and maintenance schedules.

6.7.2 *Smoke control systems* and some building ventilation systems are specifically installed for the purpose of controlling smoke in the event of a fire emergency, such as zone pressurisation systems and atria smoke extract systems. These systems should be designed to AS 1668.1, specifically:

1. power supply from the site generator supply
2. fire rated cabling (including cable support systems) or “fail to fire” mode on power loss (such as spring open/closed dampers)
3. low level and high level interface controls as described in AS 1668.1 (as opposed to *Building Management System* control)
4. controls segregated from normal controls
5. additional maintenance systems and processes to AS 1851 including integrated testing with the fire alarm system.

6.8 Smoke management systems

6.8.1 This *DGN* defines *smoke management systems* as building ventilation systems installed primarily to operate under normal building occupation, but also designed to provide a secondary function of smoke management in the event of a fire emergency. Such systems could include operating theatre suite pressurisation systems, and general building fresh air and exhaust systems which can be used for smoke management between *evacuation zones*.

6.8.2 The fire design shall aim to reduce the risk of fire spread to areas containing *category P1 occupants*.

The *HVAC* systems provided to operating theatres and intensive care areas are usually designed so that the pressure within the department is maintained slightly above that of the adjacent areas. In a fire emergency, the continued operation of these systems can assist in reducing the amount of smoke that would enter spaces containing *category P1 occupants*.

6.8.3 *Acceptable Solution C/AS2* Appendix A allows a Smoke Control in Air Handling System (Type 9 system) shutdown without reference to AS 1668.1 which could include *BMS* or standalone wiring (depending on system complexity), and this is seen as a *smoke management system*. Fire engineering design may show that a design fire may result in smoke visibility issues before a patient area can be fully evacuated. Adapting the ventilation system to extract the low temperature smoke (based on sprinkler activation or a smouldering fire only) to outside, at a rate that raises the smoke layer height to an acceptable level could be agreed to be acceptable by the approving authorities (ie peer reviewer, *BCA* and *FENZ*). This would need to show through modelling that the ventilation system extraction mode removes the smoke close to ceiling level and has adequate make up air close to floor level.

6.8.4 The air handling system for the zone of origin should changeover to a smoke management mode through interface to the *Fire Alarm Panel, FAP,* via the *BMS*. This should continue to function in this mode until the *FAP* is reset. Continued 'extract mode' function for post-incident purging could be controlled manually through the *BMS*.

6.8.5 For *smoke management systems* the fire engineer shall consider what aspects of AS 1668.1 need to apply. Operating Theatre air pressurisation systems, as an example, are expected to remain under the control of the clinicians in the space treating the patient rather than have remote control possible from the *FFCP* as this may impact *clinical* outcomes.

Care is needed regarding the impact of fire/smoke damper activation on system operation in fire mode(s). Zone based closure of all dampers at zone boundaries may produce undesirable clinical results. An example where this may be an issue is zone smoke damper closure on an operating theatre air handling system. Such a closure may compromise the system's ability to maintain pressurisation/sterile conditions in the space.

6.8.6 Designers shall consider, in conjunction with fire engineering, whether additional in-duct smoke detection is required on such systems to ensure the system continues to operate when a fire is signalled in the relevant zone. The system therefore continues to operate to protect occupants and only shuts down (along with damper closure) when the ventilation system starts to spread smoke. Normally any such additional smoke detection should be located in the fresh air supply duct rather than the mixed return air duct to minimise the risk of nuisance tripping.

6.8.7 For *smoke management systems* the following key issues shall be considered as part of the design:

- power supply robustness and “fail-safe” controls for reliability in the event of a fire emergency
- fire rating of ductwork and equipment if required through the fire engineering design. In most circumstances rigid sheet metal ductwork could be adequate
- suitable operation and rating of motorised dampers to maintain correct operation of the emergency functionality as determined by the fire modelling
- inclusion *of fire/smoke dampers* where ductwork passes firecell boundaries according to the fire design
- control or indication to be provided at the *FAP* and *BMS*
- *BMS* monitoring and control of emergency functionality shall be provided specifically for fire safety through dedicated “emergency mode” graphics screens.

6.8.8 Designers should consider utilising the fire alarm network for transmission of signals and whether relay output modules from the fire alarm network above mechanical boards results in better system maintenance outcomes when compared with parallel mechanical cables systems. Note also the allowable low level and high level interfaces as described in AS 1668.1.

6.8.9 All fire/smoke sensing hardware shall be installed and maintained by the fire protection contractor and not by the *HVAC* maintenance contractor.

6.9 Location and operation of fire and smoke dampers and fire dampers

6.9.1 Ventilation ducts shall maintain the *fire resistance rating* of the construction through which they pass. This is achieved through the use of *fire and smoke dampers* and the use of fire rated duct material.

6.9.2 All dampers shall be installed in accordance with the manufacturer’s tested details so that they maintain their integrity against the passage of fire for the required period of fire resistance. They shall be adequately fixed within the construction they are protecting. A *fire damper* that is supported only by the ductwork in which it is located, or by timber battens, frames or other methods that do not provide the fire resistance required, is not acceptable.

Where, due to the specialist nature of the ventilation system, the inclusion of dampers is not recommended, fire rated ductwork or a fire rated chimney will be required. This would typically occur with the provision of fume cupboards, isolation rooms and kitchen extract systems, for example. The fire rated ductwork should meet the same performance requirements of the elements through which it passes and should be installed in accordance with the manufacturer’s tested detail. Refer AS 1668.1 for specific related detail.

The fire resistance may be achieved by the ductwork material itself, or through the application of a protective material.

6.9.3 Where ductwork crosses a *smoke separation* and integrates a separate *smoke damper* (upstream or downstream of a *smoke or fire separation*) and is constructed from *non-combustible* rigid ductwork with no other openings, smoke sealing in lieu of an additional *smoke damper* may be used with approval of the Fire Engineer.

6.9.4 *Fire dampers* and *smoke dampers* shall:

- comply with AS 1682.1 and AS 1682.2, and
- [*fire dampers* only] Have a fire integrity and insulation rating no less than that of the *fire separation*, except that the damper blade is not required to have an insulation rating if the building is sprinkler protected or means are provided to prevent combustible materials being placed closer than 300mm to the fire damper and air duct, and
- be readily accessible for servicing.

AS 1530.4 (section 11.6) gives guidance on allowable leakages rates. This leakage rate consideration relates to the potential for fire spread under the criterion for fire integrity only.

6.9.5 AS 1668.1 requires motorized '*fire and smoke' dampers* to be designed so that they close to their required position within a time period not exceeding 60 seconds from receipt of a fire alarm signal.

6.9.6 Refer to Table 6.1 below for *fire damper* locations and types.

Table 6.1: *Fire* and *smoke damper* locations and types

	Mechanical *fire* and mechanical *smoke damper* electrically activated by fire alarm[(1)]	Mechanical *smoke damper* electrically activated by fire alarm	Mechanical *fire damper* thermal activation	Intumescent *fire damper* thermal activation
Fire & Smoke Rated Floor	✔	✘	✘	✘
Fire & Smoke Rated Floor where *HVAC* system performs a smoke management function	✘	✘	✔	✘
Fire & Smoke Rated Wall	✔	✘	✘	✘
Smoke Rated Wall	✔	✔	✘	✘
Fire & Smoke Rated Wall where *HVAC* system performs a smoke management function	✘	✘	✔	✘
Fire doors in *evacuation zone* boundaries	✔	✘	✘	✘
Fire doors where *HVAC* system performs a smoke management function [(2)]	✔	✔	✔	✔
Fire doors generally	✔	✘	✔	✘

1. Includes combined *fire & smoke dampers*.
2. Intumescent dampers in *fire doors* shall form part of the certified *fire door* design.
3. *Smoke control system* ductwork is controlled by AS 1668.1 which has requirements that supersede this table.
4. If a fire rated wall or floor does not also require a smoke rating then a thermally activated mechanical fire damper may be used.
5. In a *smoke management system*, the designer should consider the possibility and consequence (even though unlikely) of an incorrect activation of a thermal damper

6.10 Building systems controls interface

6.10.1 *Hospital* facilities contain multiple building services systems that need to interface with the fire alarm system, to shut down or to change modes of operation on detection of a fire emergency. This interface will typically consist of integration with the *Building Management System (BMS)*, and some separate direct hardwired controls.

6.10.2 Controls for essential and *life safety systems*
The fire engineer will determine the essential and *life safety systems*. The control of these systems will typically be designed to AS 1668.1 and will be independent of the *BMS*.

6.10.3 *Building Management Systems, BMS*
In most *hospital* facilities the majority of the building services will be controlled by a *Building Management System (BMS)*. The *BMS* controls the day to day functions of the building services in the *hospital*. Some fire and emergency functions are interfaced with the *BMS*. Because it is normally impracticable to fire rate the complete *BMS* installation, the fire and emergency functionality should be provided with fail safe modes and appropriate backup (eg use spring-loaded dampers which will fail to the fire position on loss of control signal and VSD control of fans used for smoke control will default to fire mode on loss of control signal). Critical functions, such as smoke control systems, shall be provided with separate hard wired and fire rated control systems that are connected to the *Fire Fan Control Panel*.

6.10.4 *Fire Fan Control Panel, FFCP*
Where provided fire fan control panels shall be constructed to AS 1668.1. Designers shall consider which systems need to be directly controlled from the *FFCP*. In addition to fans, the *FFCP* may control motorised dampers as part of passive make up air supply for smoke exhaust systems. *FENZ* may require over-ride switches and system display panels with LED indication of operation.

> Designers should consider whether proprietary fan controllers and control panels provided as part of the fire alarm system result in a better maintained system than a bespoke constructed *FFCP*.

6.10.5 Designers need to integrate any specific smoke control needs in managing phased horizontal evacuations. The *Fire Alarm Panel, FAP,* needs to have an effective interface to the *EWIS* system (if installed) and the *FFCP* so that only evacuation and smoke management of the zone in alarm occurs, with appropriate support system interface in the adjacent zones.

6.10.6 The following systems shall be controlled by the *FFCP*:

- *smoke control systems* designed to comply with AS 1668.1
- active (fan) or passive (motorised damper) make up air systems required for smoke extract systems.

6.10.7 The following systems might not be controlled by the *FFCP*:

- *smoke management systems* that are part of the *air handling unit*, *AHU,* function of the *hospital building* during normal operation within *clinical* areas, including systems critical for patient care. Smoke management mode is activated during a fire emergency
- general fresh air and extract ventilation systems that are not specifically designed as part of the emergency functionality but may be controlled from the *BMS* to assist with functions such as purging the *hospital building* after a smoke event.

6.10.8 Systems used in fire and emergency mode that are controlled directly by the *BMS* with no override at the *FFCP* should have the following features:

- indicator lights at the *FFCP* to show the system operation status
- fail safe mode programmed into the *BMS* to ensure correct emergency mode operation on the event of a controls or communication failure
- clear override control available at the *BMS* via dedicated graphics screens designed specifically for the purpose of fire emergency control.

6.10.9 *Fire Systems Interface Matrix/ design fire matrix*.
The fire engineer leads the development of the *fire systems interface matrix* with input from the services engineers. This matrix should facilitate coordination of building services and the functionality of the control systems.

6.10.10 Building services designers and fire engineers shall document the AS 1851 system baseline data, cause and effect statements, the *fire systems interface matrix* and any other relevant information necessary to enable constructing contractors to complete the implementation procedure required by AS 1851 at commissioning. A system interface diagram is expected to exceed that from AS 1668.1 Figure 4.2 (modified and reproduced below as Figure 6.1) and should show all communication paths, ie in-duct smoke sensors signal pathways directed through the fire alarm network and/or utilised via local switching contacts for items in the immediate plantroom.

6.10.11 Building Services designers and Fire Engineers shall coordinate their respective design requirements so that a single overarching *fire systems interface matrix* (cause and effect) is produced that reflects both fire engineering requirements and the consequential *HVAC* system outcomes. An integrated matrix needs to include (where applicable) double knock smoke detection system consequences, *HVAC* boost modes, smoke management, *HVAC* shutdown behaviours. It also simplifies future testing and improves the likelihood that future changes don’t unintentionally alter system performance.

6.10.12 Building services designers should consider extending the matrix to a level identifying specifically which systems stop or start, open or close, etc, in each system state. The main contractor should complete a construction version of the matrix including all details required for commissioning and testing for approval through the contract. This matrix together with the system baseline data will be used for ongoing maintenance and testing of the systems.

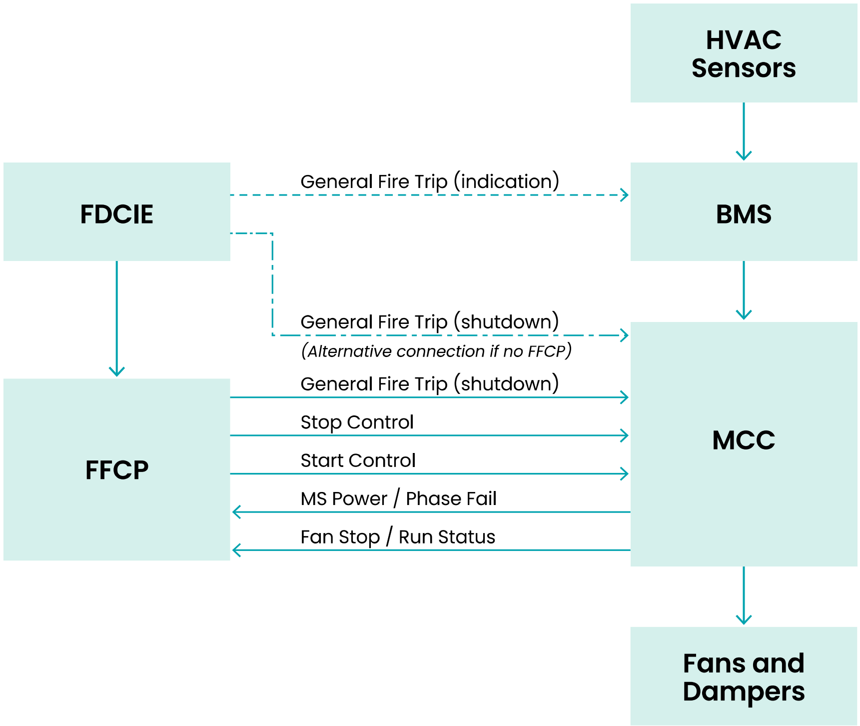


Figure 6.1: Indicative interface diagram (adapted from AS 1668.1 Figure 4.2)

6.10.13 An example *Fire Systems Interface Matrix/ Design Fire Matrix* is shown below. This is a fundamental part of the building services control system design, and requires early coordination between the fire engineer and the building services engineers.

Refer – COP 04 | FPANZ Code of Practice for Integration of Building Fire Safety Systems

DESIGN FIRE MATRIX

	EFFECT																			
	Fire Alarm									Mechanical			Electrical				Misc.			
CAUSE	FENZ notification	Fire contractor notification	Alarm - Building wide	Alarm - Local alert in fire cell of origin only	Alarm - Zone of origin notification	Alarm - Adjacent zone notification	Escalation timer[3]	Remote Display Unit	Fire alarm LED indicators Flow and level/zone	HVAC - Building fans/ dampers	HVAC - Zone of origin fans/dampers	HVAC - adjacent zone fans/dampers[4]	Electrical lighting	Doors / gates[5]	Security monitoring company	Integrated Passive systems (fire doors) in zone of origin	Utilities (Gas) in zone of origin	Equipment (fryers, oven) in zone of origin	Nurse call	Owner
Sprinkler operation[1]	Fire	Fire	Fire	-	-	-	-	Fire	on	off	-	-	on	release	Fire	-	off	off	Fire	Fire
Sprinkler supervised valve operation	Fire	valve op	Fire	-	-	-	-	-	on	off	-	-	on		valve op	-	off	off	valve op	valve op
Sprinkler defect	Defect	Defect	-	-	-	-	-	-	on	-	-	-	-		Defect	-	-	-	Defect	Defect
Sprinkler isolate	Isolate	Isolate	-	-	-	-	-	-	on	-	-	-	-		Isolate	-	-	-	-	Isolate
Zone MCP operation	Fire X	Fire X	-	-	Fire X	Alert	-	Fire X	on	-	off	-	on	release	Fire X	-	off	off	Fire X	Fire X
All out evacuation switch at SVR (White manual call point) operation	Fire	Fire	Fire	-	-	-	-	Fire	on	off	-	-	on	release	Fire	-	off	off	Fire	Fire
Zone heat/smoke detector operation	-	Alert X	-	-	Alert	-	Start	Alert X	on	-	off	on	on	release	Alert X	-	off	off	Alert X	Alert X
Detectors adjacent fire door operation	-	Alert X	-	-	Alert	-	Start	Alert X	on	-	off	on	on	release	Alert X	close	off	off	Alert X	Alert X
Escalation time reached	Fire X	Fire	-	-	Fire X	Alert	-	Fire X	on	-	off	on	on	release	Fire X	-	off	off	Fire X	Fire X
Local Remote Display Unit reset[2]	-	Reset[6]	-	-	Reset[6]	-	Stop	Reset[6]	Reset[6]	-	Reset[6]	Reset[6]	Reset[6]	Reset[6]	Reset[6]	Reset[6]	Reset[6]	Reset[6]	Reset[6]	Reset[6]
Fire alarm defect	Defect	Defect	-	-	-	-	-	-	on	-	-	-	-		Defect	-	-	-	-	Defect
Fire alarm isolate	Isolate	Isolate	-	-	-	-	-	-	on	-	-	-	-		Isolate	-	-	-	-	Isolate

Figure 6.2: Example *Fire Systems Interface Matrix* (extract from FPANZ COP 04)

6.11 Ventilation services coordination summary

6.11.1 The following aspects of the ventilation design require coordination and design integration between the fire engineer and the building services engineer: (also refer to Section 6.24 and Table 6.2 for a summary of design co-ordination indicating who leads the co-ordination process for each item and secondary responsibilities):

1. Which system are considered to be *smoke control systems* (requiring compliance with AS 1668.1) and which systems are considered to be *smoke management systems.*
2. Coordination of building zones including evacuation zones, fire zones, smoke control zones and critical spaces (eg pressurised zones for operating suites). These zones need to be coordinated with the building services layout and operation. (Refer also to Section 2.4 Approach to Firecell Compartmentation in Hospitals).
3. Design layouts, air flowrates, and pressure performance requirements for both *smoke control systems* and *smoke management systems.*
4. Determining whether fire or smoke rating of ductwork is required.
5. Locations and control of *fire and/or smoke dampers* to achieve *clinical* and evacuation management outcomes.
6. Correct operation of *fire and smoke dampers* to best serve both patient health care and fire safety requirements. For example, do not automatically shut off pressurisation airflow to an operating theatre on a signal from the automatic fire detection system. A more suitable solution may be to install separate smoke detection in the supply air duct of these systems.
7. Performance requirements for specific smoke extract systems such as used in atria, including location of all smoke extract/smoke management discharge points and fresh air intake points.
8. Location of *FFCP* coordinated with *FENZ* attendance points and Fire Control Room location.
9. AS 1851 design and installation survey requirements and interactions between Mechanical, Electrical and Fire Alarm Trades.
10. Routine services and maintenance requirements integrated with fire alarm test procedures (ensure that only full end to end tests trigger all behaviours – managing disruption to operations during routine testing).
11. In-duct smoke sensors provided by the fire alarm trade with auxiliary relay outputs used for local or networked fire alarm outputs.

6.12 Active fire control systems – general

6.12.1 Public *hospital buildings* typically have a wet pipe sprinkler system throughout the main buildings as a minimum requirement. Small *non-clinical* detached buildings such as garages or stores may not necessarily be sprinkler protected but would need to be designed to not create a spread of fire risk to adjacent sprinkled buildings on the *hospital* site. Refer to Appendix J for further information on active fire system descriptions.

6.12.2 *Hospital* sites should be served by a fire-fighting water supply network including in-ground hydrants to suit the risk as described in SNZ PAS 4509. Most buildings on *hospital* sites also require an internal building hydrant system in accordance with NZS 4510 to ensure firefighting facilities for *FENZ* result in manageable fire hose run distances.

6.12.3 *Hospital buildings* housing inpatient and outpatient *clinical* services also typically have automatic smoke detection installed throughout as per NZS 4512, connected to the fire alarm network that also interfaces manual call points and alerting devices. Automatic heat detectors are sometimes also present according to the false alarm risk, zone compatibility with the evacuation requirements, and for protection in smaller detached buildings.

6.12.4 The above form the main active fire control systems that are further described in this Section. The design of these systems is largely prescriptive through the related Standards. There are ancillary systems that occasionally are included such as different forms of automatic suppression or fire detection. There are also variations in the type of auxiliary control interfaces to other building systems, to support the fire safety strategy for the building(s). This could range from closing critical *fire* or *smoke doors*, releasing security doors, initiating *smoke management systems* or controlling evacuation lift systems.

6.13 Automatic fire sprinkler systems

6.13.1 *Hospital buildings* are expected to be sprinkler protected throughout in full compliance with NZS 4541 “Automatic Fire Sprinkler Systems”. There may be special protection areas such as a transformer room where sprinkler protection is not permitted as part of the Power Supplier Agreement, or where an alternate form of suppression such as gas flood is preferred for the specific risk such as within a data centre. *Fire separation* requirements between sprinklered and non-sprinklered areas would usually need to apply in accordance with NZS 4541.

6.13.2 Placement of fire sprinklers within patient accessible areas of mental health units or similar where wilful damage or self-harm may occur is expected to include partial concealment or guard protection to minimise the risk of malicious damage or unintended use while retaining compliance with NZS 4541. Final approval of intended placement and protection is expected to be provided by the *hospital* authorities.

6.13.3 Full compliance with the sprinkler standard is required for *FENZ* approval of an *evacuation scheme* for evacuation to a *place of safety* inside the building, in accordance with the Evacuation Scheme Regulations[2]. For *hospital buildings* this normally includes provision of a dual water supply meeting the requirements of Class A1, A2, B2 water supply class within NZS 4541 based on scale of buildings so as to give resilience in the event of any emergency. The *hospital* is expected to be seen as an essential facility and requires the sprinkler system to remain operational if a major emergency such as an earthquake has occurred in the surrounding community.

6.13.4 Options exist within the sprinkler design to suit the *hospital* environment. This includes differing response time sprinkler heads, differing spray pattern heads, semi and fully concealed heads, dry pipe sprinkler branches and tail-end freeze protection branches.

6.13.5 Sprinkler activation is able to be monitored to the zone of origin through a flow switch. A zone assembly (incorporating an isolate valve, flow switch, test / drain facilities) are usually provided for each floor. Taking into account the number of *evacuation zone*, additional sprinkler zones could be considered. Isolation valves will also minimise an area of isolation if a head discharges or building alterations are occurring to that area, retaining protection to the remainder of the building.

6.13.6 A high level of reliability is attributed to sprinkler systems within Aotearoa New Zealand. Within *hospital buildings* this can be enhanced with design features such as a dual water supply, an enhanced safety valve set(s), careful placement of monitored isolating valves and a regular maintenance and audit process.

Tampering with sprinklers, manual call points and smoke detectors is common within hospital buildings. Additional protection features such as concealed heads, alarmed cabinets, CCTV, alarm status monitoring should be considered for areas more susceptible to malicious misuse.

6.14 Firefighting equipment

6.14.1 Hand Operated Firefighting Equipment.
Fire Extinguishers should be provided throughout the *hospital building*. Where fire extinguishers are required they shall be provided in compliance with NZS 4503. Generally, these will be ABE dry powder units of at least 2.7kg capacity. Special extinguishers shall be provided for special risks such as CO2 for large switchboards and wet chemical extinguishers for deep fat fryers. Fire blankets should also be provided in kitchens and any aligned risk areas.

6.14.2 Where fire extinguishers are likely to be subject to malicious damage such as in open public spaces they should be housed in tamper proof cabinets recessed into the wall. Where possible fire extinguishers should be located adjacent to fire alarm manual call points.

[2] Fire and Emergency New Zealand (Fire Safety, Evacuation Procedures, and Evacuation Schemes) Regulations 2018

6.14.3 Appropriate training is to be provided to staff in the use of hand operated firefighting equipment including appropriate decision making in the event of a fire and evacuation expectations for personnel.

6.14.4 Fire Hose Reels are not expected to be provided.

6.15 Building hydrant riser systems

6.15.1 Public *hospital buildings* will normally be fitted with an internal fire hydrant network in accordance with NZS 4510 because the large building footprints result in *FENZ* being unable to achieve the 75m maximum fire hose run distance from the Fire Appliance attendance point.

6.15.2 Building hydrant systems consist of a fixed piping system and hose valve connections. They are charged at the building hydrant inlet point by FENZ to deliver water to the hose connections, and outlets will be located in stairwells or protected lobbies. This enables fire fighters to connect fire hose at a point within the *hospital building* where they can mount an effective internal firefighting attack as required.

6.15.3 The hydrant system is usually a wet-pipe system, charged and pressured with water to ensure the integrity of the system. It needs to be maintained in this condition, and a flow test outlet is recommended as part of the sprinkler valve house *FENZ* attendance configuration.

6.16 Fire detection and alarm systems

6.16.1 *Hospital buildings* shall be equipped with automatic fire detection and alarm systems throughout in accordance with NZS 4512. Refer to Appendix J for further information related to declared functional requirements of NZS 4512. The automatic fire alarm system communicates the status of an alarm and interfaces with related systems according to a *fire evacuation matrix*. This includes notification to *FENZ* (via approved alarm monitoring provider), key hospital staff (via nurse call system and fire alarm system visual and/or audible alerting devices) with alarm zone areas designated to either evacuate or prepare to evacuate. Secondary interfaces may include door release mechanisms, way-finding systems, shut-down or change-of-state of *HVAC* systems, and/or lift systems changing operating mode to assist *FENZ* operations or evacuating personnel. In large buildings an *EWIS* is usually provided to enable *FENZ* and key hospital personnel to communicate across an emergency warning network to better inform occupants to the status of an emergency and evolving instructions.

6.16.2 Fire detection systems typically involve analogue addressable point type smoke detectors to provide an early fire warning while providing an accurate location for the source of the alarm. Other forms of smoke detection may be preferred such as aspirating or beam smoke detection systems either for better sensitivity and control stages, or to overcome height and access constraints.

6.16.3 Where smoke detection may be prone to false alarms such as wet areas and kitchens, heat detection should be used for substitute coverage within the occupied spaces to maintain the advantages of addressable technology. Within concealed and non-occupied spaces sprinklers are typically maintained as the means of detection, as well as part of the comprehensive suppression sprinkler coverage throughout the entire *hospital building*.

6.16.4 Visual and audible alerting devices are to be distributed throughout the *hospital building* in accordance with NZS 4512. This includes provision for "other suitable means" (refer NZS 4512 4.6.5) if the alerting devices may cause occupant distress, including alerting only staff where this is appropriate. For care facilities low level audible or visual (or combined audible and visual) devices are to be provided to alert all on-duty staff "wherever they may be located". Consideration to be given to integrating standardised voice messages for Health NZ hospital facilities.

6.16.5 The fire alarm system is typically interfaced with a number of Building Services Systems. These could include door release mechanisms, way-finding systems, shut-down or change-of-state of *HVAC* systems, and/or lift systems changing operating mode to assist *FENZ* operations or evacuating personnel.

6.17 Fire detection and alarm systems in facilities providing mental health services

6.17.1 In facilities providing services for mental health or intellectual disabilities, placement of fire alarm equipment within the patient accessible areas of mental health units is expected to include partial concealment or guard protection to address ligature risk zoning as well as minimising the risk of malicious damage or unintended use while retaining compliance with the Fire Alarms Standard NZS 4512. Final approval of intended placement and protection is expected to be provided by *Te Whatu Ora*.

> Patients may exhibit behavioural problems that impact on the fire and security measures installed. Patients with an acute mental illness or learning disability have a history of generating unwanted fire signals. Tampering may impede the effective operation of fire safety systems, create false alarms (and impact on staff complacency) as well as potential security issues.

6.17.2 Integration of the fire alarm system with staff alerting systems shall be considered where it usefully improves response times to alarm situations. The fire alarm system may be programmed so that initially only staff receive the fire alert. This can reduce patient anxiety and adverse reactions. The system may also be programmed to only activate the alerting devices in the *evacuation zone* or *firecell* of fire origin.

6.17.3 Because of the risk of deliberate fires, bedrooms and communal bathrooms should not be discounted as common locations for fire ignition.

Communal bathrooms allow unsupervised access and are distinct from patient bathrooms, which are normally kept locked, with patients only having access when supervised by staff. The former are generally provided in older premises where patient bedrooms are not provided with full ensuite facilities; the latter are generally provided in premises where patient bedrooms have full ensuite facilities (WC, washbasin and shower).

6.18 Emergency Warning and Intercommunication System (EWIS)

6.18.1 An *EWIS* system in compliance with AS 1670.4 as described and moderated by NZS 4512 is normally expected in a large public *hospital building* given the scale of the facility and number of *evacuation zones*. The *EWIS* shall include the main evacuation control panel with a possible intercommunication system within a designated control room. This may include a microphone in the fire control room.

Inclusion of Warden Intercommunication Point, *WIPs*, that can also interface into a voice over PA amplifier and speaker system is referenced in AS 1670.4 but is not generally considered useful in most hospital environments.

6.18.2 The design, installation and commissioning requirements for *emergency warning and intercommunication systems*, *EWIS*, are prescribed in AS 1670.4 “Fire detection, warning, control and intercom systems – System design, installation and commissioning, Part 4 Emergency warning and intercom systems”, as described and moderated by NZS 4512.

6.18.3 As also described in NZS 4512, AS 1670.4 specifies the use of emergency warning control and indicating equipment, with this equipment needing to conform with AS 4428.16. Other reference standards include:

- AS 2220.1 “Emergency warning and intercommunication systems in buildings – Part 1: Equipment design and manufacture”
- AS 4428.4 “Emergency intercom control and indicating equipment”.

6.19 Security systems

6.19.1 The security systems require an interface with the fire system typically through a monitored clean contact relay provided by the fire protection engineer. This interface allows the security system to respond to a fire emergency mode to lock or release doors and gates, etc, as required for the fire response.

6.19.2 The functionality of the security system in fire mode should be considered in the design concept phase and should be documented in the construction version of the *Fire Systems Interface Matrix*.

6.19.3 The design of the security system should consider the following:

- the functionality of the security system needs to be assessed for different categories of occupants as defined in Section 3. For some occupant categories, the design solutions are likely to require a high degree of staff management
- the security system design needs to be cognizant of the emergency requirements for fire, but also for events such as earthquake, flood, terrorism, bomb threats and other such scenarios

> Because the security system in a hospital is typically monitored, this can provide another useful form of alert when interfaced with the fire system.

6.20 Nurse call systems

6.20.1 Nurse call systems in *hospitals* facilitate communication between the staff of the healthcare provider and the people they serve. Connecting the fire system to the nurse call system can be a useful means of providing additional communication and early warning capability. The extent of system integration should be discussed during the concept design phase as part of the *Fire Engineering Brief* process.

6.20.2 The design of nurse call systems shall consider the following:

- coordination of nurse call display units with other mandatory signage such as exit signs
- consistency of naming and numbering (*HPUs*, floor levels, corridors and rooms) between fire systems and nurse call systems
- interface and coordination with other *hospital* communication systems such as the Integrated Messaging Systems, MIE.

6.20.3 Any interface between fire systems and nurse call systems should be via a low level or high-level API interface from the fire alarm panel as described in NZS 4512.

6.20.4 The Nurse Call system designer shall be consulted during the fire safety design to co-ordinate the integration of the fire alarm and nurse call systems.

6.21 Electrical systems

6.21.1 This Section describes the design principles and standards that should be implemented in the electrical design to facilitate the correct functioning of the fire and evacuation systems in the *hospital building*.

6.21.2 The design and operation of fire and evacuation systems in *hospital buildings* is intrinsically linked with the electrical services that power these systems. This includes requirements such as reliable power supplies to essential emergency equipment and suitable lighting and indication for way finding in emergency conditions.

6.21.3 The electrical design must be undertaken with an understanding of the fire safety systems and *hospital* operational requirements.
The *hospital* emergency operation plan will advise how the *hospital* will operate in the event of emergencies. There may be hold in place requirements rather than full evacuation and this will impact on the electrical systems servicing those areas. There may need to be increased essential lighting and power services in the hold in place areas.

6.21.4 Fire zoning, *escape routes*, *safe paths*, *exitways* and *safe places* will collectively affect the electrical system design, placement of switchboards, fire ratings of the electrical services and extent of emergency lighting and signage.

6.21.5 Electrical supply system for *Life Safety Systems*

Life safety systems will require fire rated electrical supplies as per AS/NZS 3000. The requirements of clause 7.2 of this Standard apply to the electrical installation of building services that are essential for the safe operating of *Life Safety Systems* consisting of fire detection, warning and extinguishing systems, *smoke control systems*, evacuation and the safety of persons using lifts. These requirements are to prevent electricity supply from being inadvertently disconnected from electrical equipment that is required to operate during emergency conditions. These systems will have isolation control separate from the general supply. The power system shall provide full discrimination for the protection on the general supply so a general supply system fault will not cause loss of supply to the *Life Safety Systems*.

The list of building systems which are designated as *Life Safety systems* for the purposes of fire safety should be discussed during the concept design phase as part of the *Fire Engineering Brief* process.

Where *life safety systems* are installed within a *hospital building* then the electrical supply system will need 120 minute fire rating from where the supply enters the building up to the final outlet/service connection. This will entail fire rated mains cables, main switch rooms, life safety service submains, distribution boards and final circuits.

The power supply reticulation design needs to coordinate with the fire engineering design of *firecells* to minimise the risk of a fire in one cell compromising the power supply to another area of the *hospital building*.

6.21.6 Electrical system resilience

Interruption of normal electrical service in *hospitals* may be caused by catastrophes such as storms, floods, fires, earthquakes or by failures of the systems supplying electrical power. Outages may be corrected in seconds or may require hours. For all such situations, electrical systems need to be planned so as to limit disruption and to provide continuity of emergency and vital services at all times.

In *hospitals*, electrical distribution is generally provided by essential and non- essential electrical circuits. To enable services to be maintained, the essential circuits are provided with standby generators that operate when there is a failure of mains electricity serving the site or building. These are designed to provide an emergency electrical back-up supply within 15 seconds of a mains failure.

Life Safety Systems circuits need to be fire rated and off a separate switch not controlled by the general mains switch. Generator backed essential circuits that are not designated as essential for *life safety system* functions do not need to be fire rated but should be considered as a recommended option.

In terms of supporting resilience, additional precautions are necessary; for example, the distribution boards for the essential and non-essential circuits may be in the same location but should be in separate metal cabinets. Likewise, essential and non-essential circuits are normally segregated. However, where this is not possible, essential services should be wired in fire-resistant cable.

In addition to the above, within each *hospital HPU* separate circuits are generally provided for circulation spaces. Therefore, failure of a lighting circuit supplying a circulation space should not affect the lighting circuits in the adjacent rooms, and vice-versa. While these features provide a degree of resilience, they do not fully address potential failure modes such as final circuit, distribution board or phase failure.

AS/NZS 3009 sets out the requirements for the design, installation, operation and maintenance of emergency power and lighting for *hospital buildings*. The standard applies to those portions of the *hospital* electrical system in which the failure of the supply from their normal authority would jeopardise the effective and safe care of its patients.

6.21.7 Emergency lighting and egress signs

Emergency lighting is covered under NZBC F6 and F8 clauses of the *NZBC*. AS 2293.1 is the current design standard referenced for emergency lighting and illuminated exit signage. Note: *Acceptable Solution* F6/AS1 has amendments to this standard. The fire report shall be consulted to determine many parameters required for the emergency lighting design. The evacuation routes including *safe paths*, *exitways* and *safe places* shall all be covered by the emergency lighting.

AS 2293 requires emergency lighting to illuminate within 0.5 seconds of general electricity supply failure which precludes generator backed emergency lighting from being used. Health NZ should be consulted about the type of emergency lighting system to be installed for such things as the requirement for a monitored system, central battery or single point type lights.

Acceptable Solution F6 /AS1, 1.2 prescribes any *escape route* designed for more than 250 people to have emergency lighting. F6 /AS1, 1.6.1 (b) (iii) prescribes buildings with over 1000 occupants to have a minimum emergency lighting duration of 90 minutes. The occupancy loads must be obtained from the Fire report.

6.21.8 Operational essential lighting

Areas where it is proposed to hold in place during an emergency and where enhanced emergency lighting is required, need to be accommodated within the electrical services and lighting design. This is above and beyond that prescribed in *NZBC* F6 for emergency lighting in *escape routes*. Typically 50% of general lighting would be on essential generator backed supply in *clinical* areas.

6.21.9 *Smoke control systems*

These may be smoke extract or pressurisation systems as described in Section 6.7. These require fire rated electrical supplies with control separate from the general supplies.

6.21.10 Sprinkler pumps

Electric sprinkler pumps require reliable power supplies as described in NZS 4541 to the equipment and a separate mains switch.

Diesel powered pumps require electrical auxiliary supplies that are taken from a separate main switch or in front of a distribution board isolator.

6.21.11 Fire panels

These require electrical auxiliary supplies that are taken from a separate main switch or in front of a distribution board isolator.

6.21.12 Door hold open devices

Door hold open devices may be part of the fire/*smoke control system*. Door hold open devices need to operate as per the fire/smoke control plan.

6.21.13 Door locking

Electronic locking needs to be controlled to meet the needs of the fire evacuation plan and security requirements.

6.21.14 Lifts and firefighter lift control

Lifts provided with firefighter control require fire rated supplies and a separate main switch.

General lifts are treated as life safety services which require their own power supply unless they have battery backup to run to a floor and open doors on mains fail. In a *hospital building*, lifts would typically be treated as a *life safety system*.

6.21.15 Generator backed supply

Where a permanent automatic start generator is available then this changes the supply arrangement for *life safety systems*. *Life safety systems* are to be connected to the Generator supplied essential busbar on the main switchboard. Switching arrangement should still allow for isolation of general services separately from life safety services.

AS/NZS 3009 Appendix C has some indicative schematics for switchboard arrangements.

Other essential services for the *hospital building* which require generator backup are to have separate isolation from life safety services.

Note that a generator backed essential supply provides security of supply from mains failure but does not protect from any internal system failure. Therefore, for *clinical* areas it is recommended to have a mix of general and essential circuits for power and lighting.

Generator capacity and fuel storage should be coordinated with client requirements and consider factors such as the fuel delivery after an emergency event (e.g flood or earthquakes), and the functional requirements of the *hospital* after a fire or emergency event.

6.21.16 Fire zones treated as separate buildings

Portions of a structure segregated by 120 minute fire ratings can be treated as a separate building as per AS/NZS 3000:2007 7.2.3.3. Life safety services in the separate building can be serviced from a switchboard within the separate building as if it was a main switchboard.

6.21.17 Cable supports

All cabling supplying life safety services must be fire rated and be installed on fire rated cable supports such as fire rated cable tray. Cable support installation shall be both seismic and fire rated. Note that anchors into concrete must be both seismic and fire rated.

6.21.18 *Clinical* UPS

A *clinical* UPS system is not a defined *life safety system* but for operational reasons will require a fire rated UPS room and fire rated electrical supply from the generator backed essential busbar. Submains from the UPS to UPS Distribution boards would typically be fire rated.

6.21.19 Applicable Standards

- AS/NZS 3000: Electrical Installations
  Note the electricity regulations cite AS/NZS 3000 which means this version of the standard must currently be used. Refer particularly to Section 7.2 Safety Services.
- AS/NZS 3003: Electrical installations - Patient areas
  This standard covers electrical installations for patient areas.
- AS/NZS 3009: Emergency power supplies in hospitals
  This standard provides for a variety of forms of emergency power plant such as batteries, static inverters and engine driven generating sets.

Standard AS/NZS 3009 does not specifically apply to *life safety services* (fire and smoke control equipment, emergency evacuation equipment and lifts) which are covered by AS/NZS 3000 Electricity Regulations. This standard does specify areas for emergency lighting and emergency power supplies as required for patient care, which should also be considered as part of the fire safety strategy and fire evacuation procedures.

- AS2293.1 Emergency and escape lighting
- NZBC F6 and F8 covers emergency lighting and egress signage. Acceptable Solution F6/AS1 cites AS 2293.1 for emergency lighting design.

6.22 Lifts used for evacuation

6.22.1 Refer to Section 2.3, 4.12 and Appendix C for guidance when the vertical evacuation strategy incorporates the use of lifts.

6.23 Commissioning, testing and maintenance

6.23.1 The building specification should include information on the design, installation, commissioning, certification, documentation, testing and maintenance of the integrated building systems that are required to operate in a fire emergency.

6.23.2 Refer also to FPANZ Code of Practice COP-04 for the Integration of Building Fire Safety Systems with other Services.

6.23.3 Designers shall consider the maintenance implications of *smoke control systems* to achieve the AS 1851 requirements. Designers shall consider the implications of regular periodic system testing on the normal operation of *hospital* systems (ie whole system test, system component or subunit tests) on normal day-to-day utilisation of the *clinical* facilities (ie how to carry out tests with minimal impact on *hospital* operations).

6.23.4 Designers are encouraged to consider whether systems testing can be automated through the use of external systems to minimise down time, ie using a *Building Management System* to monitor only *smoke damper* positions, allowing reports to be automated. With corresponding requirements for the testing plan to monitor failure in the automated system, eg a sample of dampers being visually checked at each test activation (in much the same way that 20% of curtain type *fire dampers* have to be checked annually).

6.23.5 Full end-to-end integrated testing is required at commissioning and for ongoing maintenance tests. The fire alarm is to be tested annually and this shall include all other systems that are integrated with it. Tests should ensure that the fire alarm system and integrated systems operate as intended at the time of commissioning and through the full life cycle of the *hospital building*.

6.23.6 The fire alarm, when activated may automatically cause *fire doors* to be released, stairwell pressurisation systems to operate and goods handling equipment such as conveyors to stop operating, etc. The testing shall be a complete end-to-end test from detection, signal transportation through relays to the controller for the integrated system and finally the operation of the integrated system.

6.23.7 The integrated testing should adhere to the *Fire Systems Interface Matrix* for the building – refer Figure 6.2 for an example of a *Fire Systems Interface Matrix* as taken from FPANZ COP 04.

6.23.8 The Health NZ representative (the integrated testing agent) should coordinate testing of the interfaced fire alarm system as well as any other integrated systems, with involvement from the fire engineer. The systems to be tested should be clearly identified using the *Fire Systems Interface Matrix*.

6.23.9 Integrated testing requires the coordinated attendance of technicians responsible for the various integrated systems including but not limited to the fire alarm system, automatic sprinklers systems, heating, ventilation and air-conditioning systems, the electrical system and *building management systems*.

6.23.10 Supporting documentation to demonstrate that integrated testing has taken place is the responsibility of the building owner. The Testing agent(s) is to confirm the correct functioning of Integrated Building systems with Integrated testing.

6.23.11 The use of an Integrated Testing Agent to coordinate all Building Services testing agents is recommended.

6.24 Coordination requirements and responsibilities

6.24.1 Table 6.2 identifies the key areas requiring design coordination between the fire engineer and the building services engineers. General co-ordination between the required fire safety systems and other building design features such as structural elements, architecturally designed features, and façades is expected to follow the Engineering New Zealand Practice Note 22 “Guideline for Documenting Fire Safety Designs” or equivalent to ensure that the buildings fire engineering design solution is holistically captured in the combined design documentation.

Table 6.2: Coordination responsibilities of the fire engineer and the building services engineers

Coordination Requirement	Fire Engineer Responsibilities	Fire Protection Engineer Responsibilities	Mechanical Services Engineer Responsibilities	Electrical Services Engineer Responsibilities	Notes
Overall life safety strategy	To be determined by the fire engineer and relevant support services explained to the services engineers.	Familiarise and coordinate as required including advice on fire protection options.	Services engineer must coordinate with the fire engineer to understand and comply with the fire safety strategy.	Familiarise and coordinate as required including advice on wayfinding options.	*Hospital buildings* usually include a staged evacuation strategy. This requires specific coordination and design of the building services.
Smoke Control Systems	Define the Smoke Control requirements including ventilation rates required.	Provide support design for fire control system interface to smoke control systems, including assistance with commissioning and testing.	Detailed design, installation, commissioning, and testing. Provide producer statement.	Design specific electrical supplies as required.	*Smoke Control Systems* are specifically installed for the purpose of controlling smoke in the event of a fire emergency and shall be designed to comply with all relevant requirements of AS 1668.1.
Smoke Management Systems	Define the smoke management requirements. Coordinate a suitable	Provide support design for fire control system interface to smoke management	Detailed design, installation, commissioning, and testing.	Design specific electrical supplies as required.	*Smoke Management Systems* are ventilation systems

Coordination Requirement	**Fire Engineer Responsibilities**	**Fire Protection Engineer Responsibilities**	**Mechanical Services Engineer Responsibilities**	**Electrical Services Engineer Responsibilities**	**Notes**
	design solution with the services engineer.	systems, including assistance with commissioning and testing.			with a secondary function of managing smoke flow behaviour. This could include pressurisation of a space. Consider robustness requirements such as fail-safe modes, fire rated controls or power cabling if located in a different fire zone to the area served, temperature rating of fans and ductwork in co-ordination with the fire engineers design parameters.
Fire and Smoke dampers	Define fire and smoke zones and coordinate the control philosophy for the dampers with the services engineer.	Familiarise and coordinate any secondary detection systems as required.	System design, component selection and assessment of robustness requirements. Overseeing commissioning and testing.	Familiarise and coordinate as required.	Ventilation ducts should maintain the fire resistance rating of the construction through which they pass. Refer

Coordination Requirement	Fire Engineer Responsibilities	Fire Protection Engineer Responsibilities	Mechanical Services Engineer Responsibilities	Electrical Services Engineer Responsibilities	Notes
					separate table for *fire and smoke damper* type and operation.
Fire Fan Control Panel (*FFCP*)	Coordinate with the services engineer and *FENZ* to agree which systems shall have control and/or indication at the *FFCP*. Confirm the location of the *FFCP* in consultation with *FENZ*.	Ensure provision for interface circuit relays at the fire alarm panel for the mechanical trade to connect to the *FFCP*. Assist in commissioning and testing.	System design and specification of *FFCP* and interface matrix for input and output controls connections. Define which services are controlled from the *FFCP.*	Provide power supply as required by AS 1668.1 to *FFCP.* Familiarize and coordinate as required.	Fire fan control panels shall be constructed to AS 1668.1.
Smoke detection in ventilation systems	Familiarise and coordinate as required.	Detailed design, installation, commissioning, and testing according to the instructions from the mechanical services engineer.	Identify the ventilation systems requiring localised smoke detection for specific shut-down. Coordinate with the fire protection engineer and design the emergency shut-down system to suit.	Familiarise and coordinate as required.	Smoke detection is critical in systems such as operating theatre air supplies which continue to operate and provide pressurisation in fire mode. Such systems also provide medical life safety and therefore may not

Coordination Requirement	Fire Engineer Responsibilities	Fire Protection Engineer Responsibilities	Mechanical Services Engineer Responsibilities	Electrical Services Engineer Responsibilities	Notes
					be controlled at the *FFCP*. Smoke detection is essential to shut down these systems in the event of smoke ingress.
Exitways and *safe paths*, *safe places*, *evacuation zones,* and smoke control or smoke management zones	Provide drawings defining *safe paths*, *safe places*, *evacuation zones* and smoke control or smoke management zones.	Familiarise and coordinate as required.	Design and coordinate plant layout, services compartments and services zoning with smoke control and smoke management zoning as determined by the fire engineering design.	Design emergency lighting to F6 and exit signage to F8. Coordinate plant layout and services compartments with smoke control or management zoning.	These spaces and zones, including the life safety support services, are critical in an effective managed evacuation scheme. Early coordination and input from all designers is very beneficial at the design concept phase. Coordination of plant zoning with smoke control or management zoning will provide

Coordination Requirement	Fire Engineer Responsibilities	Fire Protection Engineer Responsibilities	Mechanical Services Engineer Responsibilities	Electrical Services Engineer Responsibilities	Notes
					a more robust design. Coordination shall also include critical spaces such as operating suites and isolation rooms which have specific air pressurisation requirements that will impact the zoning for fire, smoke and evacuation.
Lifts with firefighter lift control	Identify lifts that need firefighter lift control as described in NZS 4332.	Familiarise and coordinate as required.	Familiarise and coordinate as required.	As for a lift with firefighter lift controls as per NZS 4332 unless the lift is specifically designed for vertical evacuation, per 2.3 and 4.12. In this case design the lift supplies as life safety services to meet AS/NZS 3000.	The rules for when lifts are to incorporate firefighter lift controls are covered in NZS 4332. These lifts are not considered as a supplementary part of the vertical evacuation design

Coordination Requirement	Fire Engineer Responsibilities	Fire Protection Engineer Responsibilities	Mechanical Services Engineer Responsibilities	Electrical Services Engineer Responsibilities	Notes
					strategy unless the lift is specifically designed for vertical evacuation of vulnerable patients per 2.3 and 4.12 (refer Section 6.22).
Fire separations- floors, walls, ceilings	Provide drawings indicating position of *fire and smoke rated separations*. Provide fire treatment details for services penetrations as required.	Familiarise and coordinate as required.	Design for services penetrations to maintain fire and smoke ratings through rated elements. Advise fire engineer of the service penetration details.	Design for services penetrations to maintain fire and smoke ratings through rated elements. Advise fire engineer of the service penetration details.	Early consideration and coordination of *fire* and *smoke separations* can simplify the building services design.
Support systems for fire protection systems	Provide support system requirements for systems such as fire pumps, fire panels, diesel pumps, VESDA systems, gas flood systems, etc.	Familiarise and coordinate as required.	Familiarise and coordinate as required. Design specific ventilation, pressure relief or purge systems as required.	Familiarise and coordinate as required. Design specific electrical supplies as required.	There is often a need to co-ordinate support services for fire protection systems such as power, waste connections, flue outlets, ventilation systems in a pump and valve house or

Coordination Requirement	Fire Engineer Responsibilities	Fire Protection Engineer Responsibilities	Mechanical Services Engineer Responsibilities	Electrical Services Engineer Responsibilities	Notes
					purge, pressure relief and controls interface systems for a gas flood environment.
Room Occupancy numbers	Provide design occupancy for rooms over 250 people and buildings over 1000 people.	Familiarise and coordinate as required.	Familiarise and coordinate as required.	Coordinate for determining emergency lighting design.	Refer also to Occupancy Classifications.
Main switchboard location	Fire engineer to specify MSB position to be engraved onto fire panel mimic and specify fire rating.	Familiarise and coordinate as required.	Familiarise and coordinate as required.	Provide location of MSB to fire engineer and coordinate fire rating.	Fire rating greater than *NZBC* requirements may be appropriate.
Fire alarm interface to services	Fire engineer to identify auxiliary systems linked to fire alarm state.	Fire protection engineer to specify clean contacts or high level interface from the fire panel system for use by services. Detailed design, installation, commissioning, and testing.	Co-ordinate with fire engineer and fire protection engineer of alarm interface requirements.	Co-ordinate with fire engineer and fire protection engineer of alarm interface requirements.	Fire protection engineer to specify details for low level or high level interfaces as described in NZS4512 to the required building services MCCs for use by services for interfacing to security panels,

Coordination Requirement	Fire Engineer Responsibilities	Fire Protection Engineer Responsibilities	Mechanical Services Engineer Responsibilities	Electrical Services Engineer Responsibilities	Notes
					lifts, ventilation, and other services required to activate or shut down on fire alarm. Co-ordination between all parties needed.
Fire Sprinklers	Specify system type and coverage.	Detailed design, installation, commissioning, and testing. This includes determining the water requirements and likely water source, for design by the civil engineer.	Specify high volume drainage for sprinkler test facility.	Familiarise and coordinate as required.	Sprinklers are expected to be installed throughout a public *hospital* providing patient care except in very specific areas. Some ancillary buildings on *hospital* campus sites sometimes do not require sprinkler protection because of their location, use and scale.
Fire Systems Interface Matrix	Responsible for the overall matrix.	Familiarise and coordinate as required. Confirm matrix requirements	Ensure the fire matrix includes services inputs and responses. Confirm matrix requirements during	Ensure the fire matrix includes services inputs and responses. Confirm matrix	This is the *Fire Systems Interface Matrix* showing the intended cause

Coordination Requirement	Fire Engineer Responsibilities	Fire Protection Engineer Responsibilities	Mechanical Services Engineer Responsibilities	Electrical Services Engineer Responsibilities	Notes
		during design, commissioning, and testing.	design, commissioning, and testing.	requirements during design, commission and testing.	and effect functionality of various fire protection related systems linked to various building services systems. Further information and guidance can be obtained from FPANZ COP “Integration of Building Fire Safety Systems with Other Services”.

7 Interior surface finishes, floor coverings and suspended flexible fabrics

7.1Interior surface finishes for hospital buildings

Note: At the time of publication, performance requirements for materials used as internal surface linings are given in Clause C3.4 of the NZBC. Deviation from these requirements requires a modification or waiver from this Code Clause.

7.1.1 *Surface finish* requirements for walls and ceilings shall be as specified in Table 7.1.

7.1.2 If foamed plastics building materials or combustible insulating materials form part of a wall or ceiling system, the completed system shall achieve a *Group Number* as specified in Table 7.1 and the foamed plastics shall comply with the flame propagation criteria as specified in AS 1366 Parts 1–4 for the material being used. This requirement does not apply to building elements listed in Paragraph 7.2.5.

7.1.3 Flooring shall be either *non-combustible* or, when tested to IS0 9239-1, shall have a critical radiant flux of not less than that specified in Table 7.3 (refer to Appendix C2.1 of *C/AS2*). This applies to flexible finishes such as carpets, vinyl sheet or tiles, and to finished or unfinished *floor surfaces*.

7.1.4 In addition to the requirements of paragraph 7.2.3, where floors in multi- storey *hospital buildings* are *fire separations* and where the flooring material is made of wood products (which include boards manufactured from wood fibres or chips bound by an adhesive) the flooring material shall have either a thickness of no less than nominally 20 mm, or the floor assembly shall have an *FRR* of -/30/30 when exposed to fire from the flooring side.

7.1.5 Exceptions to surface finish requirements

Surface finish requirements do not apply to:

1. small areas of non-conforming product within a *firecell* with a total aggregate surface area not more than 5.0 m2, or
2. electrical switches, outlets, cover plates and similar small discontinuous areas, or
3. pipes and cables used to distribute power or services, or

4. handrails and general decorative trim of any material such as architraves, skirtings and window components, including reveals, provided these do not exceed 5% of the surface area of the wall or ceiling they are part of, or
5. damp-proof courses, seals, caulking, flashings, thermal breaks and ground moisture barriers, or
6. timber joinery and structural timber building elements constructed from solid wood, glulam or laminated veneer lumber. This includes heavy timber columns, beams, portals and shear walls not more than 3.0 m wide, but does not include exposed timber panels or permanent formwork on the underside of floor/ ceiling systems, or
7. individual doorsets, or
8. continuous areas of permanently installed openable wall partitions having a surface area of not more than 25% of the divided room floor area or 5.0 m2, whichever is less.

7.1.6 Suspended flexible fabrics

When tested to AS 1530.2, suspended flexible fabrics shall, within all occupied spaces including *exitways* shall*:*

a) have a *flammability index* of no greater than 12, and

b) when used as underlay to roofing or exterior cladding that is exposed to view, have a *flammability index* of no greater than 5.

7.1.7 Building services

Where air ducts are contained wholly within a *protected shaft*, provided the shaft does not also contain lifts, only the interior *surface finish* of the air duct shall comply with Table 7.2.

The surfaces of building services shall be as per Table 7.2.

7.1.8 Building services plant

Where smoke control in air handling systems is required to prevent the recirculation of smoke through an air handling system to other *firecells* in a *hospital building*, these systems shall be as specified in Appendix A A2.1 of *C/AS2*.

Table 7.1 Internal surface finishes for walls and ceilings of *hospital buildings*

<table>
<tr><th rowspan="2">Location within hospital building
(Spaces protected with an automatic fire sprinkler system)</th><th colspan="2">Maximum permitted Material Group Number</th></tr>
<tr><th>Walls</th><th>Ceilings</th></tr>
<tr><td>Building Importance Level 4 Buildings</td><td>2</td><td>2</td></tr>
<tr><td>Exitways</td><td>2</td><td>2</td></tr>
<tr><td>Spaces where care or detention is provided, including the sleeping spaces
Examples include:
• Spaces containing occupants who need assistance to evacuate from fire (Category P1, P2 or P3 occupants)
• Patient wards, including the nurse stations, staff bases, unoccupied rooms and support spaces in those wards
• Sleeping and living spaces in mental health HPUs (Category P1, P2 or P3 occupants)</td><td>2</td><td>2</td></tr>
<tr><td>Sleeping spaces where there is no care or detention
Examples include:
• Sleeping spaces for staff or visitors or whanau
• Waiting areas in maternity delivery suites
• HPUs for imaging, x-ray, ultrasound, MRI, CT scan, LINAC</td><td>3</td><td>2</td></tr>
<tr><td>Crowd Spaces where care or detention is not provided
Examples include:
• Chapels, lecture theatres, auditoria
• Cafeteria for staff and/or public, including patients, provided they are Category P4 occupants</td><td>3</td><td>2</td></tr>
<tr><td>All other unoccupied spaces in firecells where there is no care or detention provided and no sleeping occurs
Examples include:
• Outpatient clinics, provided they are occupied by Category P4 (but not P3) occupants (eg includes diabetes, counseling)
• Waiting areas in HPUs for imaging, outpatient clinics
• Outpatient rehabilitation, mortuary spaces
• Hospital streets
• Meeting rooms
• Office/administration spaces</td><td>3</td><td>3</td></tr>
</table>

Table 7.2 Surface of building services for *hospital buildings* (derived from Table 4.4 of *C/AS2*)

Building services **(Spaces protected with an automatic fire sprinkler system)**	**Maximum permitted *Group Number***
Internal faces of ducts for *HVAC* systems and kitchen exhaust ducts	2
External faces of ducts, acoustic treatment and pipe insulation within *exitways*[1]	2
Acoustic treatment and pipe insulation within sleeping uses	3
External faces of ducts for *HVAC* systems	3

Table 7.3 Critical radiant flux requirements for flooring (kW/m^2) of *hospital buildings* (derived from Table 4.5 of *C/AS2*)

Area of building	
Exitways in all buildings and sleeping areas and treatment rooms	All other occupied spaces,
2.2 kW/m^2	1.2 kW/m^2

8 External fire spread

8.1 Introduction

8.1.1 It is necessary to ensure that the potential for fire spread between buildings located within a *hospital* site is minimised so that a fire within any building does not interrupt the continued operation and occupation of a building containing occupants receiving care in addition to meeting *NZBC* performance requirements. As the *NZBC* is focused on occupant life safety, the associated fire safety *Acceptable Solutions* or *Verification Methods* may not require the necessary *fire separation* and protection requirements relevant to continued functioning and safe occupation of *hospital buildings*. Consideration of the impact of external fire spread also applies to those buildings that provide support services (ie power generation, supply and water reticulation) as well as the impact on smoke (being circulated through *HVAC* systems/intakes).

8.1.2 External fire spread depends on a number of factors including the location and size of the fire, construction materials, configuration of external walls, and proximity and exposure to other buildings. Although all *hospital buildings* complying with the *DGN* are expected to be sprinkler protected, controls on construction materials and the location of external hazards are still necessary.

8.2 Fire separation for hospital buildings on the same site

8.2.1 All *hospital buildings* containing sleeping and care shall be protected from fire spread from external sources. External walls that need to provide fire resistance shall comply with paragraph 8.4.

8.2.2 Buildings containing support facilities and services necessary to maintain continued operation of the *hospital buildings,* containing sleeping and care occupancies, shall also be protected from external fire sources. Examples include standby generator facilities and medical gas enclosures.

8.2.3 Other buildings located within a *hospital* site need only comply with the relevant requirements of the fire safety *Acceptable Solution C/AS2* or *Verification Method C/VM2* as applicable to their design approach.

8.3 Fire separation of clinical areas from other parts of hospital buildings

8.3.1 *Hospital buildings* should be designed to minimise the threat of fires starting in the *non-clinical* areas affecting the *clinical* areas and their escape routes. *Non-clinical* areas, for the purposes of this *fire separation* requirement only, are divided into the following:

- *HPUs* or healthcare units that contain unusually high fire loads and/or hazardous ignition sources, such as plant rooms, boiler rooms or spaces with equipment operating at high temperature or high voltage, or where hazardous materials are stored, should be separated by distance from any *clinical* areas and should not adjoin them horizontally and preferably also not vertically, unless additional precautions are provided.
- *HPUs* or healthcare units that do not contain higher fire load and/or hazardous ignition sources compared with typical clinical areas. These *HPUs* may adjoin *clinical* areas horizontally or vertically, provided they are in separate *firecells*.

8.4 Horizontal fire spread from external walls

Separation

8.4.1 Specific distance separation requirements for unprotected areas in external walls shall be applied in the following circumstances:

a) if, due to the configuration of a single building or the siting of other buildings on the same site, external walls of adjacent *firecell*s are exposed to each other at an angle of less than 135°, or

b) if there are unprotected areas in external walls facing a relevant boundary to other property at an angle of less than 135°.

8.4.2 Protection shall be achieved by using one or more of the following approaches:

a) for all buildings located within the *hospital* site, provide a sprinkler system complying with NZS 4541 with a Class A or Class B2 water supply. This approach also requires limiting unprotected areas in parts of an external wall within 1.0 m of an adjacent building

b) using fire resisting glazing (refer to Section 8.5), or

c) distance separation (refer to Section 8.6), or

d) limiting unprotected areas in external walls (refer to Section 8.6)

8.4.3 If a wall or part of a wall is less than 1.0m from the relevant boundary, a combination of small, unprotected areas and fire resisting glazing is permitted as detailed in Section 8.5.

8.4.4 Table 8.1a, b and c apply only to the permitted unprotected area in external walls 1.0 m or more from the relevant boundary. This can be combined with the areas of fire resisting glazing and small unprotected areas in Section 8.5.

8.4.5 Regardless of the method adopted, all parts of an external wall other than allowable unprotected areas shall have the appropriate *FRR* as specified by the relevant parts of this design guide.

Analysis required for all external walls

8.4.6 The analysis shall be done for all external walls of the *hospital building* to check the permitted unprotected area in each wall.

Notional boundary – *firecells* on the same property

8.4.7 For specific separation requirements for unprotected areas in external walls of *firecells* in the same building, or in separate buildings on the same property, a notional boundary shall be used instead of the relevant boundary. In such cases, when applying Tables 8.1 and 8.2, the words relevant boundary shall be interpreted as notional boundary.

8.4.8 Analysis shall be done separately for each *firecell* with respect to the same notional boundary.

8.5 FRRs of external walls

8.5.1 Building elements that are part of an external wall that is required to be fire rated shall have a *FRR* in accordance with Sections 5.3 and 5.4. If a *safe path* has an external wall, that wall may be 100% unprotected provided any walls between the *safe path* and adjacent *firecells* have an *FRR* determined using the property rating.

8.5.2 Any part of an external wall enclosing a *firecell* and not permitted to be an unprotected area shall have an *FRR* in accordance with Sections 5.3 and 5.4. If the external wall is less than 1.0 m from the relevant boundary the wall shall be fire rated to protect from both directions.

8.5.3 When the unprotected area of an external wall is permitted to be 100%, but the primary elements in the line of that wall are required to be fire rated, the rating of those primary elements shall have an *FRR* in accordance with Sections 5.3 and 5.4.

8.6 Small openings and fire resisting glazing

8.6.1 External wall construction shall be fire rated in accordance with Section 8.5 but may incorporate small unprotected areas no greater than 0.1m2 providing they are located no closer than 1.5m, both vertically and horizontally, to each other.

8.6.2 Fire resisting glazing located greater than 1m from the boundary need only be rated for integrity only with the *FRR* of both the glazing and the external wall shall be in accordance with Sections 5.3 and 5.4.

8.7Table method for external walls

8.7.1 The table method for external walls is a means of satisfying the requirements for the control of horizontal external fire spread and shall be applied to external walls of *hospital buildings* which are parallel to or angled at less than 180° to each other or the relevant boundary.

8.7.2 The maximum unprotected area for external walls shall be as specified in Table 8.1a, for *firecells* containing sleeping and care, otherwise use Table 8.1b.

8.7.3 The table method shall be used to determine the percentage of unprotected area in the external wall of each *firecell* depending on the distance to the adjacent building or relevant boundary from the closest unprotected area.

8.7.4 Tables 8.1 can also be used to determine the required distance from the relevant boundary to the closest unprotected area where the percentage of unprotected area has previously been determined. Select the appropriate percentage (under the rectangle width column) and read the permitted distance to the relevant boundary from the left-hand column of Tables 8.1.

8.7.5 If Table 8.2 does not contain the exact measurements for the *firecell* being considered, use the next highest value for percentage area or next lowest value for boundary distance.

8.7.6 The largest individual unprotected area in the external wall and distance to any adjacent unprotected areas shall be restricted to the maximum dimensions specified in Table 8.2.

Table 8.1a: Maximum percentage of unprotected areas for external walls (derived from *C/AS2* Table 5.2a)

Minimum distance to relevant boundary (m)[1]	Percentage of wall area allowed to be unprotected					
	Angle between wall and relevant boundary ≤ 45°		Angle between wall and relevant boundary > 45° to ≤ 60°		Angle between wall and relevant boundary > 60° to < 135°	
	Width of *firecell* (m)		Width of *firecell* (m)		Width of *firecell* (m)	
	≤5	>5	≤5	>5	≤5	>5
<1	0	0	0	0	0	0
1	70	60	90	66	100	70
2	100	80	100	90	-	100
3	-	100	-	100	-	-

Table 8.1b: Maximum percentage of unprotected areas for external walls for non-sleeping/care *firecells* (derived from *C/AS2* Table 5.2b)

Minimum distance to relevant boundary (m)[1]	Percentage of wall area allowed to be unprotected					
	Angle between wall and relevant boundary ≤ 45°		Angle between wall and relevant boundary > 45° to ≤ 60°		Angle between wall and relevant boundary > 60° to < 135°	
	Width of *firecell* (m)		Width of *firecell* (m)		Width of *firecell* (m)	
	≤10	>10	≤10	>10	≤10	>10
<1	0	0	0	0	0	0
1	40	40	40	40	46	40
2	44	40	50	40	60	44
3	50	50	60	60	78	50
4	60	60	80	60	100	60
5	80	60	100	60		80
6	90	70		80		90
7	100	80		90		100
8		90		100		
9		100				

Table 8.2: Maximum size of largest permitted single unprotected area in external walls (derived from *C/AS2* Table 5.3)

Minimum distance to relevant boundary (m)[1]	Maximum largest single unprotected area (m^2)	Minimum distance to adjacent unprotected areas (m^2)
1	15	1.5
2	35	2.5
3	60	3.5

[1] See Figure 8.1

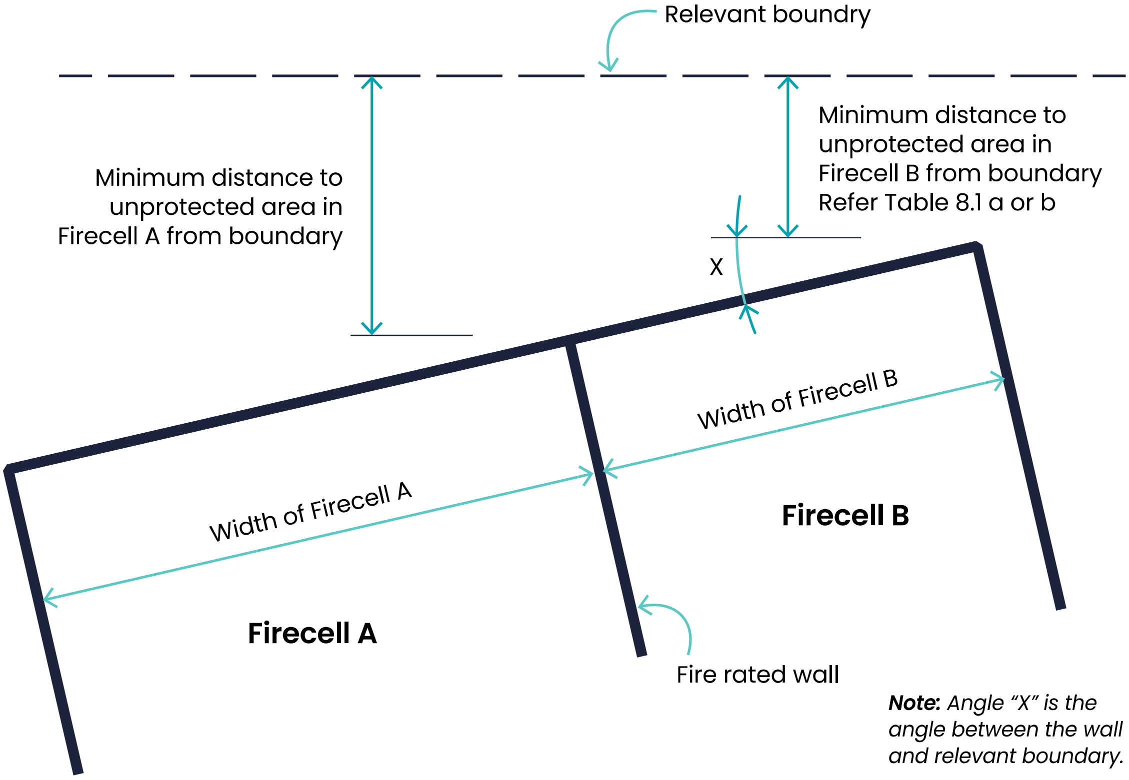


Figure 8.1 Measuring distance to relevant boundary for use in Tables 8.1a or b (from *C/AS2* Figure 5.3)

> Note:
>
> Other diagrams in in *C/AS2*, eg Figure 5.2, may assist in providing separation distances and protection.

8.7.7 As an alternative to the table method, *C/VM2* Appendix C: Methodology for design scenario HS: Horizontal fire spread (Tabular Data) can be used. For the *C/VM2* Appendix C method, the unprotected area tables and the wing/return wall tables must be used together.

8.8 Horizontal fire spread from roofs and open sided buildings

8.8.1 *Hospital buildings* should not be located next to or have non sprinkler protected buildings and exposures located in such proximity to risk fire spread from an external source. For the purposes of this guide, the requirements of the sprinkler standard NZS 4541 section 2.5 should be observed.

8.9 Vertical fire spread

Roofs

8.9.1 Roofs in sprinkler protected buildings do not need to be constructed from *non-combustible* materials nor with systems which provide a fire resistance rating for the purposes of controlling external vertical fire spread. However, the build-up of roofs with combustible materials incorporating voids and cavities should be avoided. For the purposes of this guide, the requirements of the sprinkler standard NZS 4541 section 2.8 should be observed which include requirements for the sprinkler protection of concealed spaces, their subdivision and dimensions where not protected by an approved sprinkler system.

8.9.2 Roof spaces are to be subdivided with *fire separations* such that they do not run across *evacuation zone* boundaries below. *Firecell* separations should extend through any ceiling space to avoid the risk of fire spread via ceiling voids to other *firecells*.

External exitways over roofs

8.9.3 External *exitways* that cross over a roof or are located above or adjacent to a roof on the same or another building, the roof within 3.0 m of any part of the *exitway* and all supporting elements shall have an *FRR* in accordance with Section 5.25.

Primary elements

8.9.4 Primary elements providing support to an area of fire rated roof shall have an *FRR* of no less than that of the roof.

8.9.5 When supporting an unrated roof:

a) primary elements such as columns or walls which are required to be fire rated shall be rated from floor level to the underside of the roof framing members, and

b) any roof framing members connected to these fire rated columns or walls shall also be rated if their collapse in fire would cause the consequential collapse of the rated columns or walls.

Roof storage, plant, services, equipment and vehicle parking

8.9.6 Roofs shall only be used for the siting of plant, services and associated storage, vehicle parking and equipment where they meet the following requirements:

a) storage of combustible materials on a roof is not permitted within 1.5 m of a higher external wall

b) plant, services and equipment should not be located within an enclosure unless that enclosure is protected by the sprinkler system

c) access to any plant, services or equipment, including electrical installations such as solar panels on a roof, shall be as outlined in Section 9

d) where a roof used for vehicle parking is within 10 m of a higher external wall external drencher protection of the wall shall be provided or the wall shall be constructed of *non-combustible* materials and achieve a minimum *FRR* of -/120/120.

8.10 External cladding systems

8.10.1 External walls should be constructed in a way that controls the risk of fire spread externally over the cladding system or internally via cavities and voids. The fire design of *hospital buildings* assumes that fires will not spread via the external cladding system of a building either resulting from an internal fire or from a fire initiated externally to the building that directly impinges on the cladding. The provision of sprinkler systems are assumed to limit the extent of exposure on external cladding from an internal fire. External fires may result from arson events or fires occurring due to storage or other combustible materials located in close proximity to the building. Proactive management to mitigate these risks is required. Fire impacting cladding systems should be expected to cause localised damage. However, the materials used to construct the cladding system and their configuration should not be such that they will contribute to the fuel load or exacerbate external fire spread over the external face of the *hospital building*.

External wall cladding materials

8.10.2 External wall cladding materials shall be:

a) *non-combustible* or *limited combustible* materials; or

b) tested in accordance with the relevant standard test in *C/AS2* Appendix C C7.1 and achieve a Type A classification.

External wall cladding systems for multi-level *hospital buildings*

8.10.3 The entire external wall cladding system shall comply with 8.10.2 and be:

a) *non-combustible* or *limited combustible* materials; or

b) classified in accordance with AS 5113 and achieve an EW classification; or

c) tested in accordance with BS 8414-1 and satisfy the acceptance criteria in BR 135; or

d) tested in accordance with BS 8414-2 and satisfy the acceptance criteria in BR 135.

Cavity barriers

8.10.4 The spread of fire through cavities in an external wall shall be avoided by providing cavity barriers at each floor level. Cavity barriers shall also be provided vertically at the junctions of *firecells*. Cavity barriers shall be fire rated to provide a minimum *FRR* of -/60/60 and may, where required for external wall ventilation and drainage purposes, be open state cavity barriers fire tested to the principles of ASFP TGD19 guidance [3].

Curtain wall systems

8.10.5 Non fire rated curtain wall systems present challenges to fire spread internally and externally as the junctions, structural design and attachment methods to the *hospital building* will depend on the specific design of the system to meet the various performance requirements including wind, thermal, acoustic, seismic and fire. Typical curtain wall systems include construction tolerance gaps between the floor and wall junctions that require adequate sealing to prevent horizontal and vertical fire and smoke spread between *firecells*. Curtain wall systems shall comply with:

a) ANSI/ASTM E2307 Standard Test Method for Determining Fire Resistance of Perimeter Fire Barriers Using Intermediate-Scale, Multi-story Test Apparatus, or

b) BS EN 1364-4:2014 Fire resistance tests for non-loadbearing elements.

[3] https://asfp.org.uk/page/Publicationslist. TGD 19 - Fire Resistance Test for Open State Cavity Barriers

9 Access, safety and facilities for firefighting

9.1Introduction

9.1.1 The *fire brigade* shall be provided with adequate facilities to ensure the protection of life and property. Particular matters which require consideration are:

a) site access

b) vehicular access around the buildings for fire appliances

c) access into the building for the firefighting personnel

d) the provision of building hydrant systems within the building

e) private fire hydrants

f) venting for heat and smoke from basement areas.

It is recommended to engage with local Fire and Emergency Operations at an early design stage to agree access for firefighting vehicles and also on the location of firefighting facilities such as the fire alarm panel, inlets, etc.

9.2 Site access

9.2.1 When considering site access for the *fire brigade*, the following should be accounted for:

a) the location and number of site access points

b) the design of the internal roadways with respect to width, radii of bends, gradients, clearance between and under buildings, load capability

c) the weight and turning circle of the fire appliances.

9.2.2 When not part of the public road, a fire service vehicular access shall:

a) be able to withstand a laden weight of up to 25 tonnes with an axle load of 8 tonnes or have a load-bearing capacity of no less than the public road serving the property, whichever is the lower, and

b) be trafficable in all weather, and

c) have a clear passageway of at least:

   i) 3.5 m wide at site entrances, internal entrances and between buildings, and

   ii) 4.0 m wide elsewhere along the vehicular access way, and

d) have a minimum height clearance of 4.0 m throughout, and

e) have corners and bends with minimum inner and outer radii in accordance with Figure 9.1 for the appropriate type of appliance (also refer Table 9.1), and

f) not have kerbs that are higher than 250 mm and not have obstructions within 300 mm of a kerb face (see Figure 9.2), and

g) have a gradient no steeper than 1:8, reduced to 1:16 for the first and last 4.0 m of any section steeper than 1:16 to provide a smooth transition on entry/exit, and

h) where the fire service vehicular access way exceeds 20 m in length and there is no through road, be provided with:

   i) at the end, a turning circle with a diameter of at least 25 m, or

   ii) within 20m of the end of the access way a hammerhead, “T” configuration or “Y” configuration with a minimum inside radius as per Figure 9.1 and a minimum length of any turn-around arm, measured from the centre line of the perpendicular access way to the curb face, of 18 m.

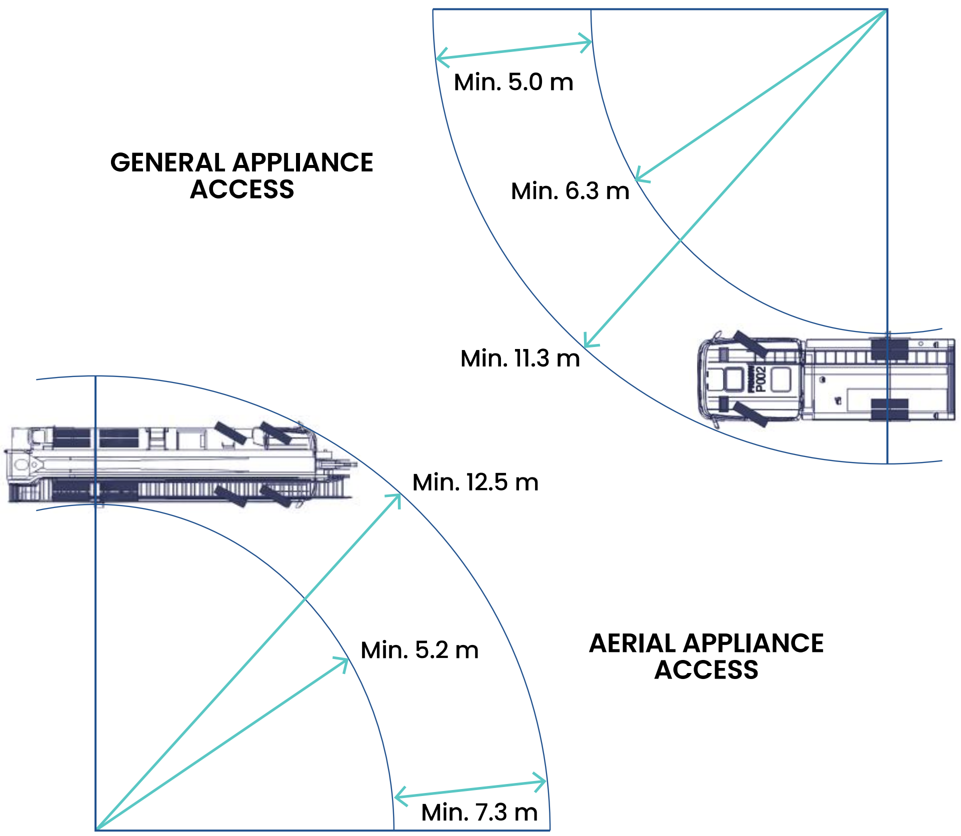


Figure 9.1 - Vehicular access way radii
(from FENZ Designers' Guide F5-02GD Figure 3)

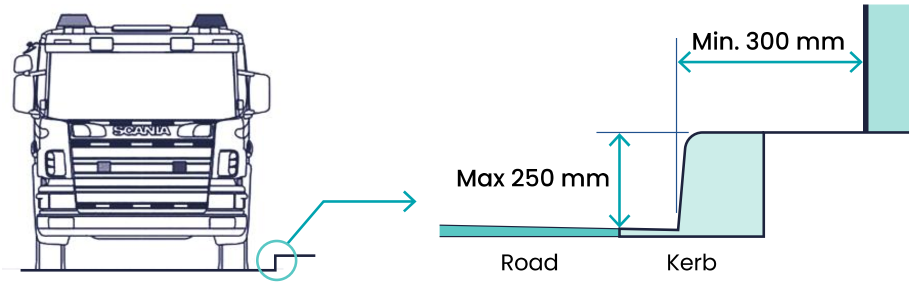


Figure 9.2 - Kerb obstruction
(from FENZ Designers' Guide F5-02GD Figure 6)

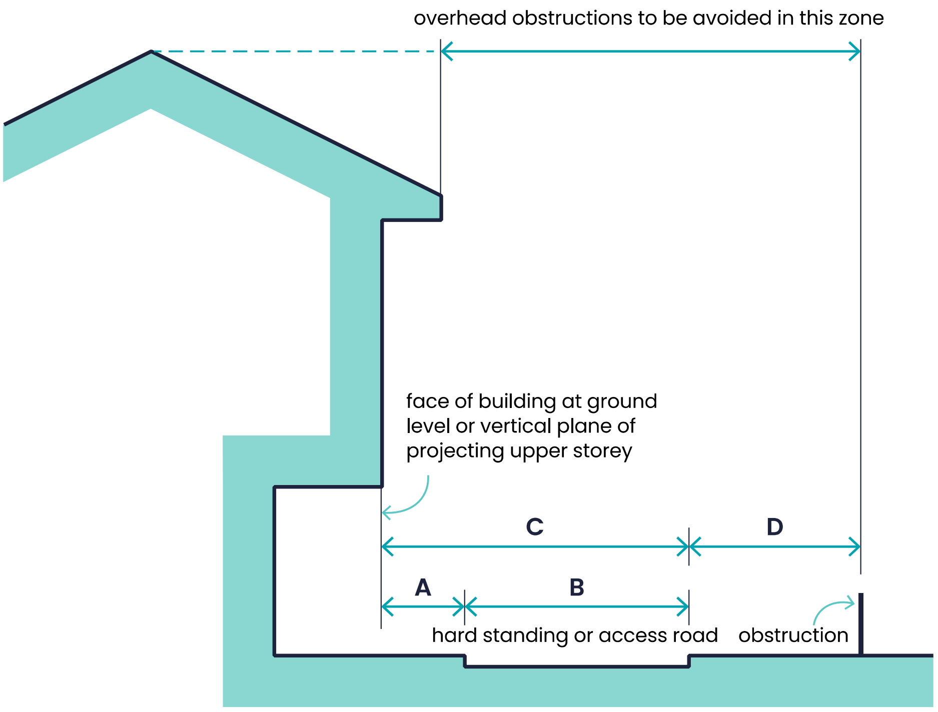
9.2.3 For sites that feature two buildings or more, a minimum of two access points to the site, suitable for use by the *fire brigade*, should be provided for fire appliances. Their location should be agreed with all relevant authorities. One access point for the *fire brigade* may be an emergency access point dedicated solely for the use of the *fire brigade.*

9.2.4 New *hospital* roads that may be used by fire appliances shall comply with paragraph 9.2.2.

9.3 Access around the building

9.3.1 Access around a building on a *hospital* site is required to enable aerial appliances to be used where necessary, and to enable pumping appliances to supply water and equipment for firefighting and rescue activities.

9.3.2 Where access is provided to an elevation in accordance with Table 9.1, overhead obstructions should be avoided in the zone indicated in Figure 9.3.



	TYPE OF APPLIANCE	
	Turntable ladder Dimension (m)	Hydraulic platform Dimension (m)
A Maximum distance of near edge of hard standing from building.	4.9	4.9
B Minimum width of hard standing	5.0	5.5
C Minimum distance of further edge of hard standing from building.	10.0	7.5
D Minimum width of unobstructed space (for swing of appliance platform)	N/A	2.2

Note:
1. *Hard standing for high-reach appliances should be as level as possible and should not exceed a gradient of 1 in 12.*
2. *Fire appliances are not standardised. Some fire services have appliances with a greater weight or different size. In consultation with the fire-and-rescueauthority, the building control body should adopt the relevant dimensions and ground-loading capacity.*

Figure 9.3: Relationship between building and access roads or hard standings for aerial appliances
(from HTM-05-02 Figure 26)

9.3.3 Access for fire appliances to *hospital buildings* not fitted with internal building hydrant systems should comply with the *DGN* in Table 9.1.

Table 9.1: Vehicular access for buildings not provided with hydrant systems (adapted from HTM 05-02 Table 9)

Total floor area (m^2)	Requirement for aerial access to buildings over 10m escape height
Up to 2,000	15% of perimeter
2,000 to 16,000	50% of perimeter
16,000 to 24,000	75% of perimeter
Over 24,000	100% of perimeter
Note: The total floor area is the aggregate of all floors within the building.	

9.4 Hard-standings

9.4.1 *Hospital buildings* should be provided with at least one *hardstanding*.

9.4.2 *Hospital buildings* may be provided with additional *hardstandings* to provide a means of satisfying the requirements of Table 9.1, or as necessary to ensure adequate access inside the building as per paragraph 9.5.1 without providing a hydrant system.

9.4.3 A section of the carriageway of a public road may be a *hardstanding*, as long as it satisfies paragraphs 9.4.4 to 9.4.7.

9.4.4 Distances from a hard-standing to a building should be measured from the closest point of the hard-standing to the outer face of the building's wall.

9.4.5 The distance between each designated *hardstanding* and the building should be more than 5 m but less than 20 m.

9.4.6 The firefighter building access point should be located within 20 m of at least one *hardstanding*.

9.4.7 An access route into the building should be located within 20 m of each additional *hardstanding* that is necessary to satisfy paragraph 9.5.1.

9.4.8 *Hardstandings* that are necessary to satisfy paragraphs 9.4.4 to 9.4.7 and are not the carriageway of a public road should:

a) comply with the vehicular access requirements of Section 9.2 and 9.3, and

b) have a plan area that will contain a rectangle of at least 4.0 m wide and 15 m long, and

c) have a gradient no steeper than 1:50 in any direction, and

d) have no roof and no overhead obstructions along its entire area.

9.4.9 Where a building hydrant system is installed, the distance from the edge of the *hardstanding* to the hydrant inlet should not exceed 20m. This distance should be measured taking into consideration obstructions to directly laying out a hose run, such as buildings, fences, waterways and storage or parking areas, and should not contain any acute angles.

9.5 Access and facilities for firefighters

9.5.1 Provisions for firefighter access into the *hospital building* shall ensure that the most remote area of the building can be reached within 75m hose run from a designated hardstanding.

9.5.2 Where parts of the *hospital building* cannot be reached within 75m of a *hardstanding*, a building hydrant system complying with NZS 4510 must be provided.

9.5.3 Firefighter access shall be provided to any roof that is used to locate plant, services and associated storage, vehicle parking and equipment as per paragraph 8.9.6. The roof of a single storey building no more than 6m above the adjacent ground level may be exempted from this requirement.

9.5.4 The hose run distance is to be measured from the *hardstanding* to the furthest point in the building as follows:

a) the hose run distance should be measured along an access route, and

b) the measured hose run distance should avoid any security features that prevent free access except:

i) security features that automatically deactivate and unlock in the event of a fire, and/or

ii) a door at the *final exit* that need not automatically unlock in the event of a fire, and

c) the measured hose run distance should:

i) take into account obstructions such as internal and external partitions, fittings, furniture, storage and machinery, or

ii) where the layout is not yet known, the hose run should be measured orthogonally, and

d) the hose run distance should not contain any acute angles.

9.5.5 In low-rise buildings without deep basements, the needs of the fire brigade will often be met by a combination of the normal means of escape and the measures required for vehicular access around the building.

9.6 Number and location of firefighting shafts – hospital buildings not provided with a hospital street

9.6.1 For *hospital buildings* not provided with *hospital streets*, *firefighting shafts* shall be provided in accordance with Table 9.2.

Table 9.2 The number of *firefighting shafts* (adapted from HTM 05-02 Table 11)

	Area of largest floor			
	Less than 900 m^2	Between 900 m^2 and 1800 m^2	Between 1800 m^2 and 3300 m^2	Over 3300 m^2
Below Ground				
Two basement storeys	Not required	1	2	3 plus 1 for every additional 1500 m^2
Basement depth over 10 m (see note 2)	1 + lift	1 + lift	2 + lift	3 + lift plus 1 for every additional 1500 m^2
Above ground				
Escape height over 18 m (see note 2)	1 + lift	2 + lift	2 + lift	3 + lift plus 1 for every additional 1500 m^2
Hose run coverage (see note 3)	In line with NZS 4510			

Notes for Table 9.2:

1. Depth of basements and heights of storey above ground are all measured from fire service vehicle access level.
2. One *firefighting shaft* should also include a firefighting lift.
3. Firefighting shafts, irrespective of building height, should be located to meet the maximum hose run distances. In order to meet the coverage criteria it may be necessary to provide additional fire mains in escape stairways. This does not imply that these stairs should be otherwise designed as firefighting shafts.

Note: The over 18 metre escape height is measured from the floor level of the top floor to the ground. Therefore, assuming that there is an average floor-to-floor height of 4.5 metres, then the requirement for firefighting shafts or hospital streets will be for buildings six storeys and above (floor level on 5th floor would have an escape height of 4.5 x 4 =18 m, therefore not required).

Firefighting is difficult on the upper floors of a building and is likely to be an internal firefighting attack as opposed to an external attack. Therefore, a *firefighting shaft* can protect firefighters and other building users as well as minimise disruption in and around areas where care and treatment are administered. The following items need to be considered in relation to firefighting shafts or hospital street:

- the location of the breathing apparatus entry control point. This can often be within a stairwell. If located within a stairwell that is not a firefighting shaft, the stair can become compromised and contaminated with smoke
- the requirement to take firefighting equipment up various flights of stairs can be arduous for firefighters depending on the number of stair flights required to be travelled. Therefore, a protected lift within a firefighting shaft would result in faster firefighting response
- the maintenance of a clean stair environment. A stairwell that is not a firefighting shaft can become compromised and contaminated with smoke
- FENZ vehicular access to multiple sides of a building may not be possible. Therefore, internal access to the building may be restricted and/or delayed.

In a hospital setting extra considerations are required which could appear to be beyond what may be expected in most other multi-level buildings. This is due to the following reasons:

- horizontal evacuation strategies
- the maintenance of sterile or highly sanitary environments
- the desire to keep patient disruption to a minimum
- access to the fire via circulation areas that form part of an another evacuation zone is not desirable.

9.6.2 If a *firefighting shaft* is required to serve a basement it need not also serve the upper floors unless they also qualify because of the height or size of building. Similarly, a shaft serving upper storeys need not serve a basement that is not large or deep enough to qualify in its own right; however, a firefighting stair and any firefighting lift should service all intermediate storeys between the highest and lowest storeys that they serve.

9.6.3 *Firefighting shafts* should serve all floors through which they pass.

9.7 Design and construction of firefighting shafts

9.7.1 Where a *firefighting shaft* is required, it should combine the firefighting stair and firefighting lift (if provided) with a firefighting lobby, such that firefighting stairways and lifts should always be approached from inside the *hospital building* through a firefighting lobby.

The enclosure of the *firefighting shaft* should be designed to achieve a two-way 60-minute fire resistance where it interfaces with care spaces, and two-way 90-minute fire resistance where it interfaces with non-care spaces (ie laboratories, office spaces, etc.). Doors in these walls shall have the same *fire resistance rating* as the wall.
NOTE: If the structural fire resistance is derived from performance-based assessment (eg burnout calculation) rather than the prescriptive values in Section 10, the fire resistance of the *firefighting shaft* enclosure should be either the burnout value or 60/90 minutes depending on the space immediately adjacent to the *firefighting shaft*, whichever is greater.

9.7.2 Construction internal to the *firefighting shaft* which separates the various components from each other should be designed to achieve a 60-minute fire resistance rating, including any doorsets.

9.7.3 An example of typical layout of *firefighting shafts* is shown in Figure 9.4 below.

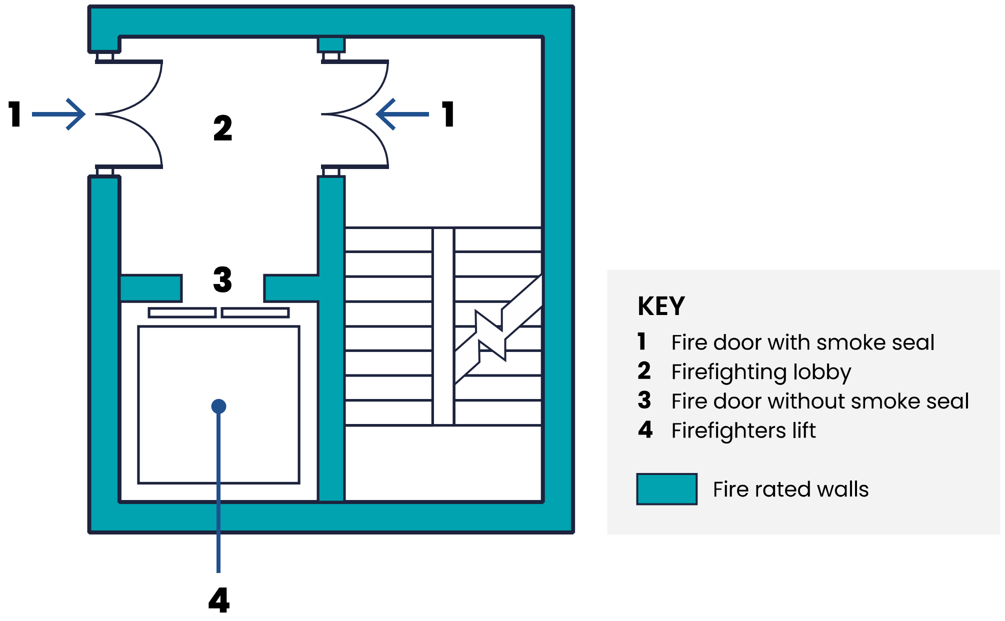


Figure 9.4: Typical layout of *firefighting shafts* (adapted from BS 9999)[4]

9.7.4 *Firefighting shafts* should have provisions to protect the firefighting stair from smoke ingress. This can be either a *smoke control system* in the firefighting lobby, or a pressurisation system in the stair. Either system should be designed to AS 1668.1.

9.7.5 Where *firefighting shafts* include firefighting lifts, a firefighting lift installation includes:

a) the lift car itself

b) the lift shaft; and

c) the lift machinery space together with the lift control system and the lift communications system.

9.7.6 Firefighting lift installations should conform to BS EN 81-72.

9.7.7 It is permissible for additional passenger lifts to be included within the *firefighting shaft*. Where this occurs, the passenger lifts must be fully located within the enclosure of the *firefighting shaft* on every level.

NOTE: A goods lift (as defined by NZS4332) is not permitted in a firefighting shaft. A firefighting shaft may provide access to fire separated service shafts and may contain services serving the remainder of the building.

[4] Permission to reproduce extracts from British Standards is granted by BSI. British Standards can be obtained in PDF or hard copy formats from BSI Knowledge:https://knowledge.bsigroup.com or by contacting BSI Customer Services for hardcopies only: Tel: +44 (0)20 8996 9001, Email: cservices@bsigroup.com.

9.8 Hospital buildings provided with a hospital street

9.8.1 *Firefighting shafts* are not required in *hospital buildings* provided with a *hospital street* on all floors containing clinical *HPUs*.

9.8.2 In these buildings a minimum of two stairways should be provided, and with a *final exit* that is within 20m of a suitable fire service access point.

9.8.3 All *hospital streets* should have building hydrant outlets located at *HPU* entrances so that every part of every storey is within a 40m arc measured from the outlet. Fire hoses may wedge open cross-corridor *fire doors* designed to prevent the passage of smoke along the corridor; to prevent this it is recommended that sections of the *hospital street* that provide access to a *HPU* should be provided with a fire hydrant outlet within that section of a *hospital street*.

NOTE: hydrant outlets located outside protected stairs may not automatically comply with NZS 4510, but the 2022 version of the standard provides a mechanism for acceptance of such outlets (refer NZS 4510: 2022, Appendix A).

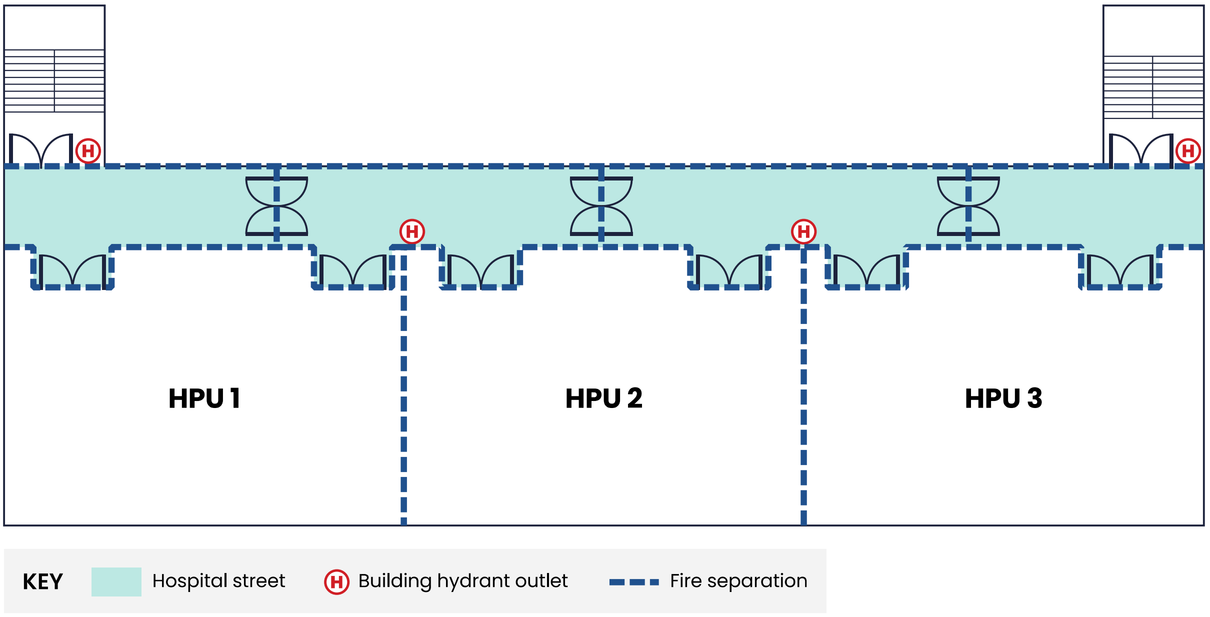


Figure 9.5: *Hospital streets* on upper floors

9.8.4 Where *hospital buildings* with a *hospital street* have upper storeys over 18m above fire service vehicle access level, or a basement at more than 10m below ground or fire service vehicle access level, lifts shall be provided for use by firefighters. Lift should be:

a) located immediately adjacent to a stairway

b) accessed directly off the *hospital street* (lift landing doors located within the *hospital street)*

c) located within 18m of an entrance suitable for use by the *fire brigade*.

> The *fire brigade* should be consulted on any additional requirements they may have for the lift to be suitable for their use.

9.9 Building hydrants

9.9.1 Building hydrant systems shall be designed and installed in accordance with NZS 4510.

9.9.2 In *hospital buildings* provided with *firefighting shafts*, building hydrant outlets shall be located in every *firefighting shaft* (see Table 9.2) as a minimum, with additional outlets located in other stairs as necessary.

9.9.3 In *hospital buildings* featuring a *hospital street*, building hydrant outlets shall be located as required by paragraph 9.8.3.

9.10 Provision of in-ground fire hydrants

9.10.1 Where a *hospital building* is being erected more than 135m from an existing in-ground fire hydrant, additional hydrants should be provided such that:

a) one or two hydrants within 135m of a designated *hardstanding* for the building providing a combined flow of at least 750 L/min; and

b) one or two hydrants within 270m of the designated *hardstanding* for the building providing a combined flow of at least 750 L/min.

9.10.2 Each in-ground fire hydrant should be in accordance with NZS 4522.

9.10.3 Where no reticulated water supply is available or there is insufficient pressure and flow in the water main, or an alternative arrangement is proposed, the alternative source of supply should be provided in accordance with the following recommendations:

a) a charged static water tank of at least 45,000 L capacity; or

b) a spring, river, canal or pond capable of providing or storing at least 45,000 L of water at all times of the year, to which access, space and a hard standing are available for a pumping appliance; or

c) any other means of providing a water supply for firefighting operations considered appropriate by the *fire brigade*.

9.10.4 Where a static water supply is provided, a *hardstanding* meeting the requirements of paragraph 9.4.8 should be provided within 6m of the supply and with unobstructed access.

If the static water supply is below the level of the hardstand, the vertical distance to the hardstand shall be considered in the locating of the hardstand.

9.10.5 The distance between water supply and *hardstanding* or should be measured taking into consideration obstructions to directly laying out a hose run, such as buildings, fences, waterways and storage or parking areas, and should not contain any acute angles.

9.10.6 The guidance above ensures that adequate water supplies are provided for those *hospital buildings* which are not constructed within easy access of public hydrants.

9.11 Venting of basements

9.11.1 In case of fire there may be a need to remove heat and smoke from basements. In a fire involving a basement, the products of combustion tend to escape via stairways, making access difficult for the *fire brigade*. Venting can reduce this problem, improve visibility and lower temperatures, making access for the fire service less difficult.

9.11.2 If the basement is fitted with a sprinkler system to NZS 4541, a mechanical extract system may be provided.

9.11.3 The system should provide at least 10 air changes per hour. It should come into operation automatically on the activation of:

a) the sprinkler system, and/or

b) the fire detection and alarm system.

9.11.4 The basement air extraction system should be designed as a *smoke management system* as defined in Section 6.8.

For the purposes of Sections 9.11 and 9.12, basements include a normally occupied space but located underground. Infrequently accessed subfloor foundation/piling zones, sealed voids, seismic isolation spaces, crawl space and the like are not considered to be basements.

9.11.5 Natural venting can be provided rather than mechanical extraction using smoke outlets to provide a route for heat and smoke to escape to the open air from the basement level(s). They can also be used by the *fire brigade* to let cooler air into the basement.

9.11.6 Smoke outlets connected directly to the open air should be provided from every basement storey, except for any basement storey that:

a) has a floor area of less than 200m^2

b) has a floor level not more than 3m below the adjacent ground level.

9.11.7 Smoke outlets should:

a) be positioned at high level in the space they serve

b) be evenly distributed around the perimeter of the *hospital building*

c) discharge into the open air outside the building.

9.11.8 In each basement *firecell or smokecell*, the combined cross-sectional area of all smoke outlets should be not less than 2.5% of the *firecell or smokecell* floor area.

9.11.9 If the outlet terminates at a point that is not readily accessible, it should be kept unobstructed and covered with a metal grille or louvre.

9.11.10 If the outlet terminates at a point which is readily accessible, it may be covered by a suitably indicated panel or pavement light which can be broken out or opened.

9.11.11 Outlets should not prejudice the use of *escape routes*.

9.12 Construction of outlet ducts and shafts

9.12.1 Outlet ducts and shafts, including any bulkheads over them, should be enclosed in *non-combustible* fire-resisting construction.

9.12.2 Where there are natural smoke outlet shafts from different basement *firecells* of the same basement storey, or from different basement storeys, they should be separated from each other by *non-combustible* fire- resisting construction.

10 Structural fire resistance

10.1 Prescriptive fire resistance ratings for structure

10.1.1 This Section applies to fire resistance for structural elements. For *hospital buildings* it is necessary to maintain structural stability for the duration of fire burnout in order to provide an unconstrained time frame for building occupants to exit the building or reach an internal or external *place of safety*.

Structural elements are parts of structure that are loadbearing (supporting applied gravity loads from floors, walls or roofs) and includes the structural elements which maintain structural stability. These are elements which are almost always designed by a structural engineer.

In *hospital buildings* the egress strategy usually relies on partial or sequenced evacuation for occupants exposed to immediate threat from fire, and either an implicit or clearly defined stay in place strategy for the remaining occupants, depending on the balance of risk associated with moving them and not moving them. Occupants may be expected to remain on floors above the floor of fire origin that are not yet impacted by fire or smoke or may be directed to refuge areas for an extended period (hours) while firefighters conduct firefighting or assist with evacuation operations.

10.1.2 Two general methods are available for selecting an appropriate level of structural fire resistance: 1) prescriptive approach or 2) performance-based structural fire engineering (refer to Section 14). This section prescribes fire resistance for structural elements. Where structural fire resistance is not provided in accordance with the table below (prescriptive *fire resistance ratings*), the level of adequate fire resistance for the structure shall be determined by calculation using one the methods described in Section 14 herein for performance-based structural fire engineering (this includes the option to calculate fire resistance for burnout using time equivalent fire severity).

Prescriptive fire resistance ratings do not directly translate to exposure (of structure to fire) in real time and may not provide sufficient levels of protection to resist total burnout in all cases. If this uncertainty around structural performance is considered to present a risk to building occupants remaining inside the building awaiting assistance or further instruction, then it is likely that fire resistance of the structure will need to consider the “real time” impact of fire on structural stability. In contrast to the challenging fires routinely considered for occupant life safety, design basis fires for structural fire resistance are concerned with the consequence associated with infrequently occurring fully-developed post-flashover fires (ie a fire scenario where sprinklers fail to operate or are not effective in limiting fire growth and when fire fighters do not intervene to control and/or suppress the fire).

Additional caution is needed for design of mass timber buildings if designers are relying on establishing compliance for structural stability with prescribed levels of fire resistance (eg from prescriptive codes). Prescriptive fire resistance ratings for structure fire resistance have been developed using empirical correlations for application to *non-combustible* structures.

10.1.3 Prescriptive fire resistance ratings for structure in *hospital buildings* shall be provided in accordance with the following table. The fire resistance rating is assessed on a *firecell* basis and applies to the structure exposed to a fire in the *firecell* containing the type of occupancy described. Where a *firecell* contains spaces with a mix of *occupancy types*, the highest applicable fire resistance rating is required for all structure within that *firecell*.

Table 10.1: Prescriptive Fire Rating requirements

Firecell occupancy	Fire resistance rating
Contains spaces where occupants sleep or are provided with care, including spaces routinely occupied by these occupants when awake, including support spaces (eg bathrooms, amenities). Support spaces with low fire hazard. Includes plant rooms not containing or using combustible fuels. Includes laboratory spaces with very limited quantities of combustible fluids (ie not storage). Large volume spaces with low fire load (not storage), including lobbies, foyers, reception areas, waiting areas, spaces with furniture that is not upholstered or with limited amount (eg occupying less than 50% *firecell* floor area) of upholstered furniture. Spaces containing imaging facilities (eg X-ray, ultrasound, MRI, LINAC). Any space characterised by a design *FLED* of 400 MJ/m^2.	60 minutes
Spaces used predominantly (more than 50% floor area) for office, administration or similar *hospital* functions not containing occupants receiving care. Includes laboratory spaces with other than very limited quantities of combustible fluids. Any space characterised by a design *FLED* of 800 MJ/m^2.	90 minutes

10.1.4 Structural elements shall have an *FRR* no less than:

- that required of any building element within the same *firecell* to which they provide support
- that required of any building element within the same *firecell* to which they are structurally connected.

Structural elements providing structural support to any building elements that are required to have a fire resistance rating shall be designed so the structural element performance during fire will not cause consequential collapse affecting the fire resistance performance of the building elements. Support includes lateral and vertical support as required to keep the supported element in position.

Part 3: Performance-based fire engineering design requirements

11 Fire engineering performance-based design

11.1 Introduction

11.1.1 The purpose of this Section is to provide high-level guidance on fire engineering performance-based design of Aotearoa New Zealand public *hospital buildings*, ie design which is outside the prescriptive requirements provided in this guide. The Section is not intended to provide detailed values or scenarios to be used in the design process, but rather to highlight some of the important consideration that need to be made.

11.2 Design principles

11.2.1 Well-established design principles shall be used whenever fire engineering performance-based design in applied. Although the explanations provided in this chapter are based on ISO 23932 – 1:2018 Fire safety engineering — General principles – Part 1, general, guidance provided in the following publications can be used as an alternative to ISO 23932:

- International Fire Engineering Guidelines (IFEG)
- SFPE Handbook, 5th Edition
- BRE Design Fires for use in Fire Safety Engineering
- Fire Engineering Design Guide, 3rd Edition (FEDG).

11.2.2 Irrespective of the design principles chosen for fire engineering performance-based design of New Zealand public *hospital buildings*, the design shall always comply with the *NZBC*. Figure A1 in Appendix A shows a schematic representation of the regulatory framework in Aotearoa New Zealand, and illustrates how performance-based design (verification methods and alternative solutions) fits in the framework.

11.3 The fire engineering performance-based design process

11.3.1 ISO 23923 explains the Fire Safety Engineering (FSE) process, of which the fire engineering performance-based design process is a subset (left hand side of Figure 11.1). As can be seen in Figure 11.1, the FSE process is iterative in nature. If the process is followed, the fire engineer shall explore the answers to key questions posed in decision nodes. The answers to these questions can require that steps of the process be repeated. This procedure is illustrated by the decision nodes (rhombi) and the associated iterative loops (Yes/No) in the figure.

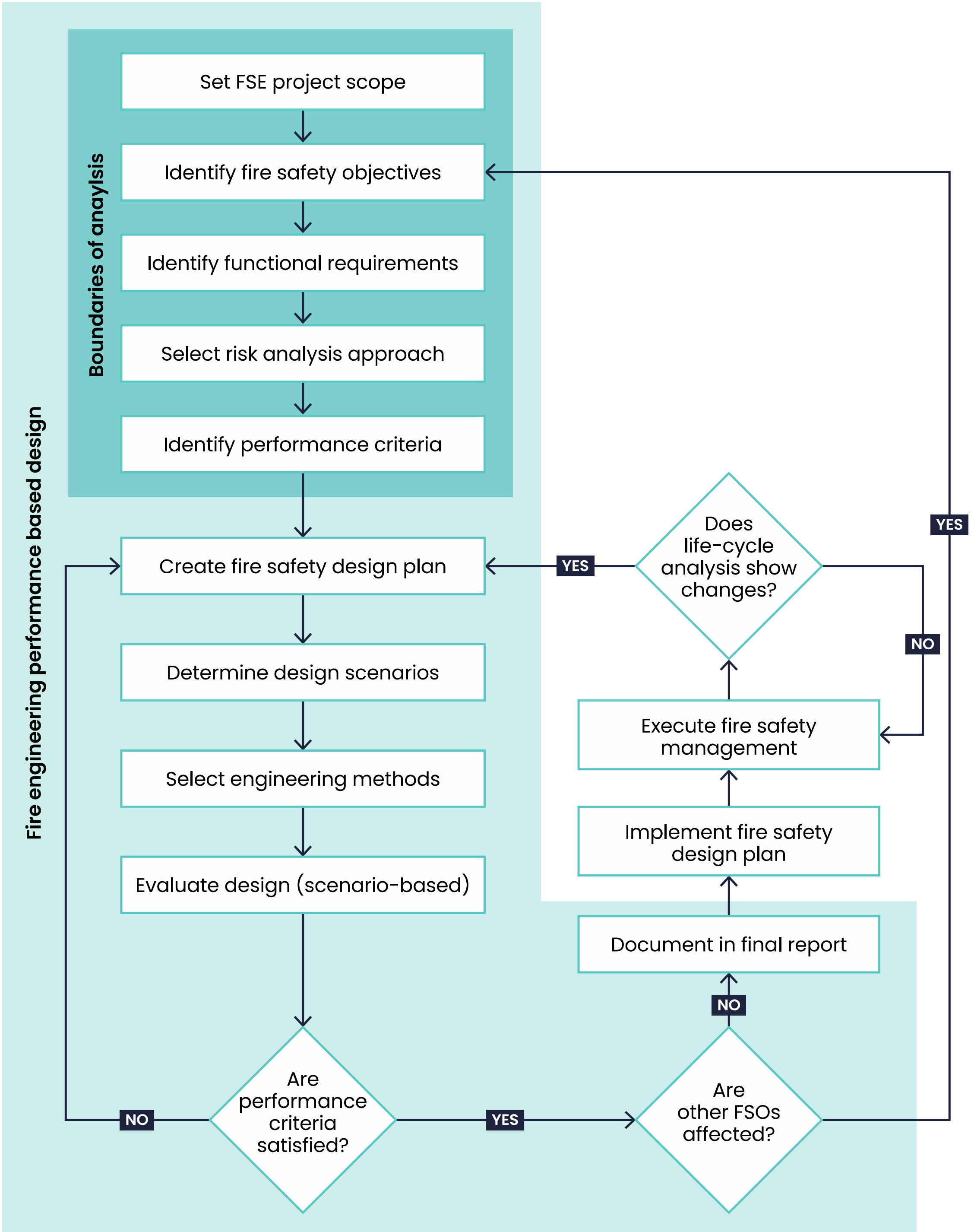


Figure 11.1: The FSE process
(adapted from ISO 23932, Figure 1)

11.3.2 In the first stage of the fire engineering performance-based design, the boundaries of the analysis shall be clearly defined. Initially, the overall project scope shall be decided and documented, eg if it is a new building, renovation, expansion, and so forth. The project scope, within the context of the overall project, shall then be identified, agreed, and documented. The project scope statement shall contain a description of project relevant information, eg characteristics of the built environment, affected parties (stakeholders) and external environmental factors, but shall also include a clear explanation of what will be analysed with the fire engineering performance-based design. In the New Zealand context, the scope shall be documented in a *Fire Engineering Brief* (*FEB*), see Sub-Section 11.4.

11.3.3 For New Zealand public *hospitals*, relevant affected parties (stakeholders) should include, but is not limited to: client or client's representative (such as a project manager), fire engineer, architect or designer, other design consultants, *FENZ*, *BCA*, representative of owner's insurance company, *hospital* user groups and facilities management.

11.3.4 In the next steps, the *Fire Safety Objectives* (*FSO*) and Functional Requirements (FR) shall be identified, which shall be done by the fire engineer in collaboration with relevant affected parties (stakeholders).

11.3.5 *FSOs* are high level objectives that shall be met by the design. For New Zealand public *hospital buildings*, the following objectives from the *NZBC* shall be considered:

- people who use buildings can do so safely and without endangering their health,
- buildings have attributes that contribute appropriately to the health, physical independence, and wellbeing of the people who use them, and
- people who use buildings can escape from the building if it is on fire.

The three *FSOs* stated above are all Life Safety objectives that are relevant for occupants and first responders (fire and emergency personnel). An additional *FSO* from *NZBC* that should be considered is:

- buildings are designed, constructed, and able to be used in ways that promote sustainable development.

In addition to the above *FSOs*, the affected parties (stakeholders) can agree to include additional FSOs stated in ISO 23932, such as Property Protection, Continuity of Operations, Protection of the Environment and Protection of Heritage. For New Zealand public *hospital buildings*, inclusion of *FSOs* related to Continuity of Operations shall always be considered due to the potential longer-term impact on Life Safety of patients.

11.3.6 FRs translate objectives into required functionality and can be seen as a specification of the *FSOs*. For example, an *FSO* related to the safe use of buildings can translate into a FR specifying that people should not be exposed to concentrations and/or doses of toxic species that prevents evacuation or has adverse long-term health effects.

11.3.7 In the following step, the relevant affected parties (stakeholders) shall agree on the risk analysis approach used for the fire engineering performance-based design. Figure 11.2 illustrate the four main types of risk analysis approaches used in design. Although these approaches are briefly explained and exemplified in this guide in the context of New Zealand public *hospital buildings*, the reader is referred to ISO 23932 for more in-depth explanations.

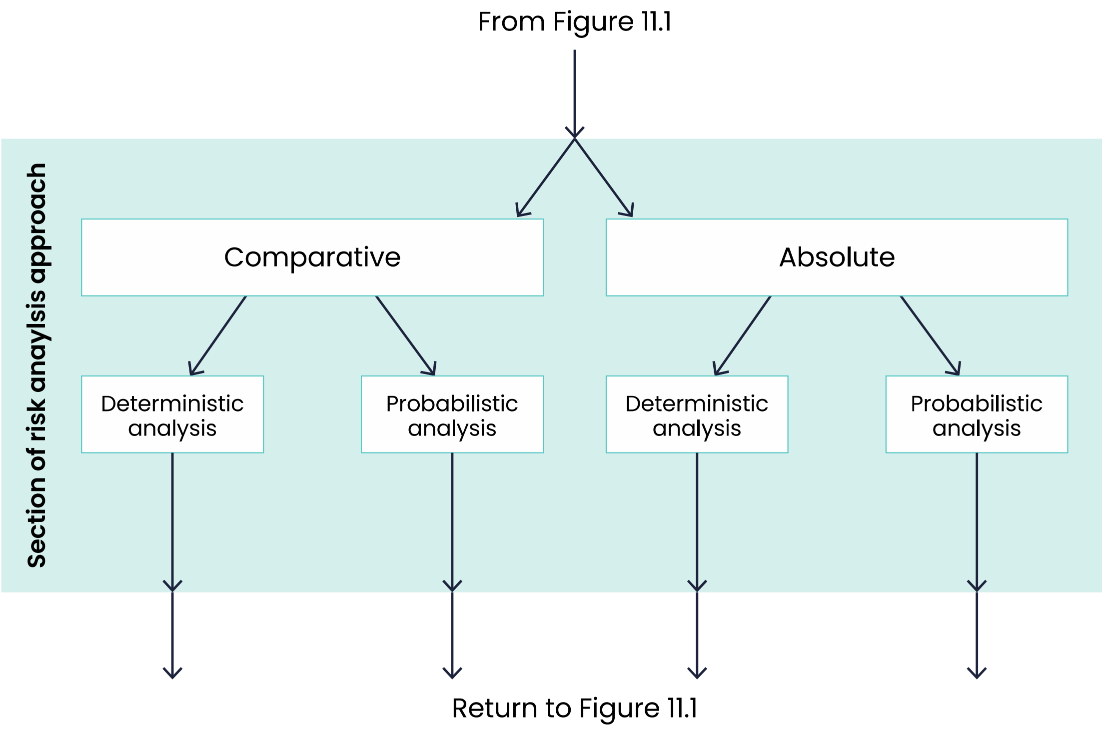


Figure 0.2: The four main types of risk analysis approaches (adapted from ISO 23932 Figure 2)

11.3.8 As can be seen in Figure 11.2, a risk analysis can be either **absolute** or **comparative**. In a comparative approach, the risk level of the design building is compared with the risk level of a benchmark building. The benchmark shall be designed according to prescriptive guidance, which implicitly defines a risk level for comparison. The fire safety design is considered to provide a sufficient level of safety if the risk level of the design building is equal to or lower than the risk level of the benchmark building. It is important to only use the comparative approach for minor and relatively well-established changes from the prescriptive requirements to ensure a valid comparison between the level of risks.

11.3.9 In an absolute approach, the risk level shall be explicitly stated in the design process and agreed upon by the relevant affected parties (stakeholders). Some regulations and standards, eg *C/VM2* and INSTA950, may be used when deciding risk level, and fire statistics can inform the process.

11.3.10 As can be seen in Figure 11.2, the two main types of risk analysis approaches are **deterministic** and **probabilistic**. A deterministic analysis involves the evaluation of a limited number of worst credible case scenarios, ie 5-10 scenarios that represent a severe, but not unlikely, challenge for the trial design. Deterministic analyses involve detailed quantitative analyses of the consequences of a fire, with the frequency of occurrence only implicitly considered (ie a rare, but not unlikely, scenarios). In the New Zealand context, a *C/VM2* analysis would represent a partially prescribed deterministic analysis.

11.3.11 A probabilistic analysis explicitly considers the consequence and the frequency of occurrence of the scenarios being evaluated. The probabilistic analysis can be either semi-quantitative or quantitative. In many cases, a quantitative risk analysis is used, which involves a quantitative comparison of the combined risk of evaluated scenarios.

11.3.12 In the next step, the relevant affected parties (stakeholders) shall agree on the Performance Criteria (PC) to be used. PCs, which are the quantification of the FRs, will depend on the chosen risk analysis approach. For deterministic analyses, the PCs will be expressed as a tolerable consequence of the worst credible case scenarios used in the analysis, eg *FED* = 0.3. In contrast, PCs used in probabilistic analyses include both *consequence* and *frequency of occurrence* component, eg 1 fatality/10^{-6} years. PCs for probabilistic analyses shall normally include both individual and societal risk measures.

11.3.13 When choosing PCs for fire engineering performance-based design of New Zealand public *hospital buildings*, it is important to consider the inherent sensitivities of *hospital* populations. For example, a ward with patients who have pulmonary diseases may require PCs related to smoke irritancy, eg *FEC*, in addition to PCs related to hypoxic effects, eg *FED*. In addition, some situations may require adjustment of typical PCs to account for the fact that the hospital population is more sensitive. As an example, *FEC* = 0.3 will lead to incapacitation of 11.4% of a general population, but can represent a significantly higher rate of incapacitation for a geriatric ward.

11.3.14 Once the boundaries of the analysis are set, a trial design shall be created. Design scenarios and engineering methods are used to evaluate the trial design, which is done in relation to the defined PCs. If the PCs are met, then the trial design can be considered to have met the *FSOs*. If the PCs are not met, then revision of the trial design is required. Usually, more than one trial design can fulfil the *FSOs.*

11.3.15 Once an acceptable trial design has been found, the fire engineering design process should be documented. The documentation shall be done in the *Fire Engineering Report*, which usually takes its starting point in the *FEB*.

11.3.16 Although not covered explicitly in this report, care shall be taken to monitor the implementation of the fire engineering design during the building process. Proper construction monitoring can ensure that the final *hospital building* adheres to the design intent. Furthermore, continuous fire safety management shall be performed for the finished *hospital building* and any changes influencing the original design intent shall be identified and addressed.

11.3.17 As the above paragraphs are not a complete guide to fire engineering performance-based design, the reader is referred to guidance provided in the standards and guidelines mentioned in paragraph 11.2.1, as well as other relevant publications.

11.4 The role of the FEB in the design process

11.4.1 For each project, the fire engineer should prepare a *Fire Engineering Brief* (*FEB*). A *FEB* is a living document that is continuously updated during the fire engineering performance-based design process. Initially, it may only contain a description of project scope, including a list of stakeholders, but as the design process develops it shall be expanded with clear explanations of the chosen *FSOs*, FRs, risk analysis approach and PCs. Furthermore, any trial designs and performed risk analyses shall be continuously documented in the *FEB*.

11.4.2 Once an acceptable trial design, ie one that fulfils the *FSOs*, has been identified and chosen as the final design, the entire design process shall be documented in a *Fire Engineering Report* (*FER*). The *FER* usually takes its starting point in the *FEB*.

12 Performance-based design inputs for calculating Required Safe Egress Time (RSET)

12.1 Introduction

This Section provides guidance to the engineer undertaking performance-based approach for demonstrating compliance with the *NZBC*. The Engineer carrying out the *RSET* Analysis is expected to use engineering judgement in selecting the relevant inputs. It is also essential that the selected inputs are presented and accepted by the stakeholders as part of the *FEB*. Data and sources are provided below. However, they shall not be used without first verifying that they are applicable for the specific project.

12.1.1 The Required Safe Egress Time (*RSET*) is the amount of time (also measured from fire ignition) that is required for occupants to evacuate a building or space and reach the building exterior or a protected exit enclosure.

12.1.2 *RSET* is the sum of the alarm time, the evacuation delay time (sometimes called the pre-movement time), and the movement time. Alarm time is the time at which occupants first become aware of a fire through a building's automatic or manual fire alarm system (occupant notification). The evacuation delay time, or pre-movement time, is the time that elapses between activation of the occupant notification system and the time at which occupants make the decision to begin evacuating.

12.1.3 Pre-movement activities might include an investigation to determine if the fire system activation is a confirmed fire emergency, preparation of patients, mustering staff for moving patients, informing operations team, etc. Depending on the type of occupancy within the *hospital building*, the pre-movement time maybe 60 seconds to up to 5-10 minutes. Finally, the movement time is the time required for occupants to reach a *safe place* inside protected exit enclosure or outside of the building once the decision to evacuate has been made and occupants begin moving toward exits.

12.1.4 The movement time is calculated by applying empirical relations for walking speed and occupant flow rates through egress elements such as doors, stairs, and corridors, or by applying evacuation modelling such as FDS-EVAC, Pathfinder, Steps etc. Due to uncertainties associated with human behaviours it is recommended to apply a worst credible case approach (and occasionally the alarm time, pre-movement time, and evacuation time) before the *RSET* is calculated.

12.1.5 The *Required Safe Egress Time* (*RSET*) for ambulant occupants to evacuate the building, as shown in Figure 12.1, is determined by the following equation:

$$t_{RSET} = (\Delta t_{det} + \Delta t_a) + (\Delta t_{pre} + \Delta t_{trav}\ (or\ \Delta t_{que}))$$

Where

Δt_{det} = detection time (s)

Δt_a = notification time (s)

Δt_{pre} = pre-movement time (s)

Δt_{trav} = travel time (s)

Δt_{que} = queuing time (s)

12.1.6 This equation is generally applied when calculations are carried out by hand or simple spreadsheet assessments. The *RSET* time can be directly used as an output from Evacuation Modelling Software.

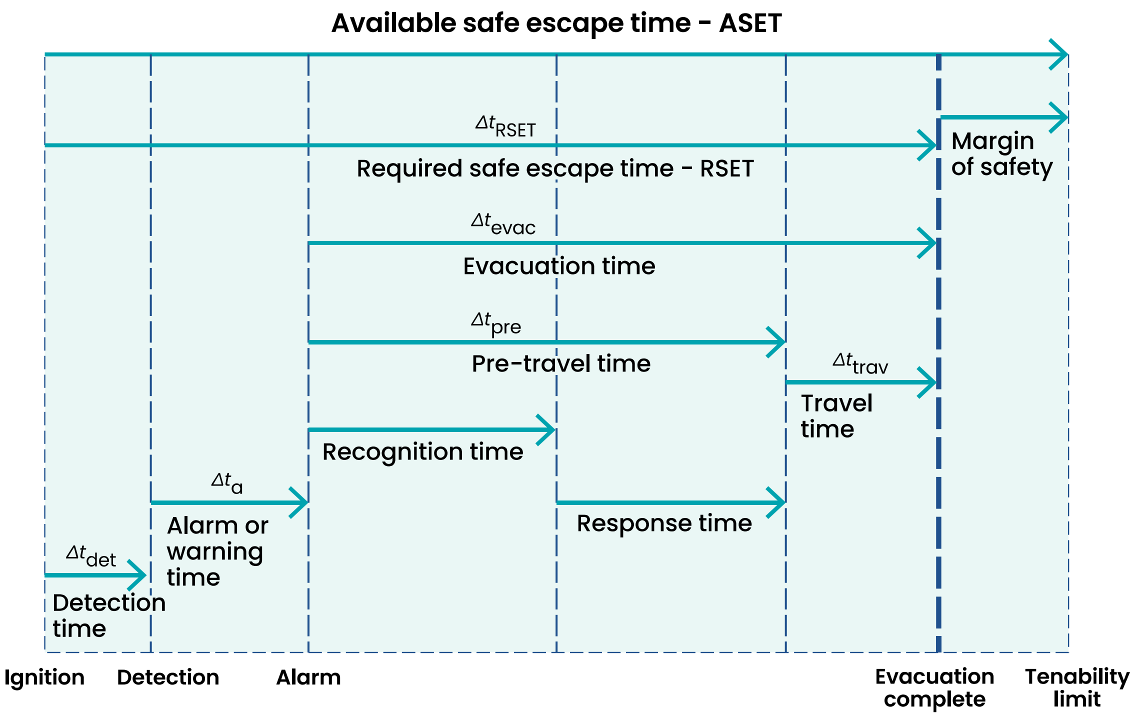


Figure 12.1: Simplified schematic of processes involved in escape time (*RSET*) compared to available escape time (*ASET*)

Table 12.1: Inputs for *RSET*

Nomenclature	Description	Calculation Methods
t_{det}	detection time (s)	As calculated by fire modelling.
t_a	alarm (notification)time (s)	Initial smoke detector activation to VDUs at nurse stations for notification of staff is set to the maximum of 30 seconds as per NZS Fire Alarm Standard (clause 204.6 & 204.7 in

		NZS 4512:2010. Or Clause 2.4,6 & 2.4.7 in NZS 4512:2021)
t_{pre}	pre-movement time (s)	From data from the literature, field studies or simulated evacuations.
t_{trav}	travel time (s)	As calculated.
t_{que}	Queuing time (s)	As calculated.

12.1.7 While the general inputs for calculation for *RSET* in Table12.1 is directly applicable for ambulant patients and visitors, for non-ambulant patients and staff, there are further factors to consider for the egress process. These additional steps in evacuation sequence are shown schematically in Figure 2 below. Note that *clinical* area evacuation would be to an adjacent *firecell* or *evacuation zone*.

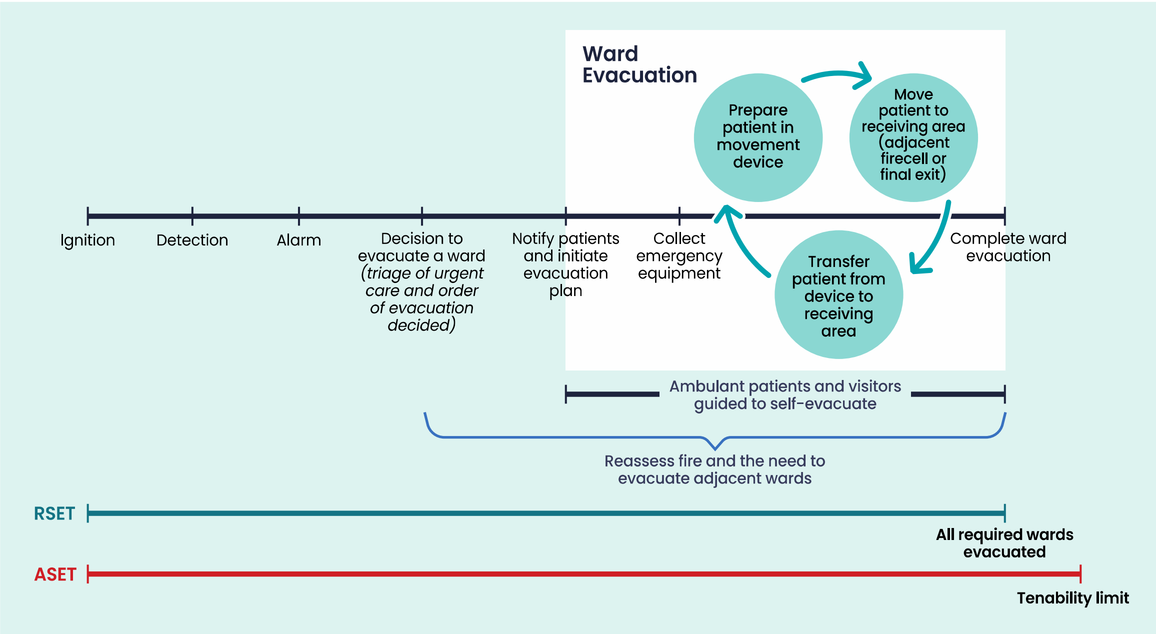


Figure 12.2: *Hospital building* evacuation egress timeline sequence (adapted from presentation by S. Gwynne, FEMTC 2020)

12.2 Pre-movement time

12.2.1 The pre-movement time is the time interval between when the *clinical* staff become aware of the emergency (ie by becoming aware of the fire alarm) and the time when they begin to move patients away from the fire impacted area.

12.2.2 The pre-movement times are to be specifically determined by engineering analysis rather than using qualitative approaches.

12.2.3 In accordance with Section 1.8.4 of IFEG, the pre-movement time shall be determined by:

a) data from the literature, field studies or simulated evacuations; and

b) engineering judgement applied to the assessment.

12.2.4 The delay between detection and alarm is usually to provide for an inspection and verification time for the staff to avoid nuisance alarms. As noted in Figure 12.2, this pre-evacuation time accounts for the following actions:

- time for staff to investigate and verify alarm condition (viewing VDU)
- decision time to evacuate ward
- triage of urgent care and order of evacuation decided
- notify patients, prep patients and initiate evacuation to the adjacent firecell / Evacuation zone.

12.2.5 For the analysis using a pre-movement time of 60 seconds would be minimum starting point, however the pre-movement time is to be determined by the type of patient prep times which will reflect the acuity of the patients and therefore apply a worst credible case approach. It is noted the pre-evacuation times are taken for staff only, as patients are assumed to remain in place until evacuated by staff.

12.2.6 Table 12.2 provides some approaches to selection of ,pre-movement times. It is recommended that the Engineer carrying out the *RSET* Analysis uses engineering judgement in selecting the pre-movement time. It is also essential that the selected inputs for pre-movement time is presented and accepted by the stakeholders as part of the *FEB* Process.

Table 12.2: Pre-movement time

Reference	Pre-movement time	
	Mean (s)	Range (s)
The Swedish National Board of Housing, BBRAD (2013), Table 2	60	--
SFPE Handbook 5th Ed. (2016) Table 64.10	44.1	16 - 91
Rahouti Et al. (2020) – Table 9	46.5	8.0-141.0

12.3 Travel/movement time

12.3.1 Movement time will generally be derived from evacuation modelling and will require inputs for travel speeds representing the worst credible scenarios when moving patients.

12.3.2 For smoke-free conditions, travel speeds allocated to staff in the evacuation model are indicated in Table 12.3. The fire engineer is expected to select the relevant speed based on engineering judgement and present them for acceptance by the stakeholders as part of the *FEB* Process.

Table 12.3: Range of travel speeds

Individual classification	SFPE Handbook (m/s)	Dutch Report (Hoondert, 2017) (m/s)
Nurse / Staff (1)	1.2 – 1.8	1.42
Fully Ambulant (2)	1.2 – 1.8	0.95
Ambulant Walking Assist (3)	0.57	0.57
Non-Ambulant Wheelchair (4)	1.3	1.3
Non-Ambulant Bed user (5)	-	0.88

Example Only Justifications when selecting Travel Speeds.
Values included below are illustrative and actual values used will need to be accepted as being appropriate for the specific case during the FEB process.

- A travel speed of 1.42m/s is proposed for the staff response speed, which is the mean travel speed stated for staff response (Hoondert, 2017). This speed is considered reasonable as nurses are familiar with the environment, trained and highly motivated.

- A travel speed of 0.95m/s is proposed for all fully ambulant occupants, which is the travel speed stated for reduced self-reliant patients (Hoondert, 2017). The same report states a travel speed of 1.6m/s for self-reliant. In addition, the SFPE Handbook considers a walking speed for fully ambulant speed for people to be within 1.2m/s – 1.8m/s. (Shi, Xie, Xudong, Zhou, & Zhang, 2009
- A travel speed of 0.57m/s is proposed for all non-ambulant walking occupants referenced from the Dutch hospital report (Hoondert, 2017). It is the lowest travel speed of all stated reduced self-reliant travel speeds and is based on the travel speed of someone using a rollator. In addition, the SFPE Handbook also considers a mean travel speed of 0.78m/s for locomotion disability, the higher percental travel speed being 1.40m/s. (Boyce, Shields, & Silcock, 1999)
- A travel speed of 1.3m/s is proposed for non-ambulant wheelchair patients, for staff assisted wheelchair movement only. This is based on the mean travel speed for assisted horizontal movement speed (m/s) for people with disabilities. (Boyce, Shields, & Silcock, 1999). In addition, 1.3m/s is also the stated assisted wheelchair by Hoondert, 2017.
- A travel speed of 0.88m/s is proposed for non-ambulant bed user patients, as per Hoondert, 2017 for bed-ridden patients, with uncoupling. In addition, Strating, 2013 determined the mean speed for bed-ridden patients at 0.88m/s.
- For perspective on the above proposed travel speeds, it should be noted that the SFPE Handbook, Table 64.23, Summary of crawling speed data, provides a range of mean travel speeds for people crawling of 0.65m/s – 0.87m/s, with the lowest percentile for all data stated as 0.54m/s (Kady, Kady & Davis and Muhdi et al.).
- In addition, it should be noted that hospital staff are highly trained and skilled in assisting patients including assisting in life threatening situations for those in their care. These staff will be trained in evacuation procedures, familiar with their surroundings and escape routes, therefore, can be expected to perform much better than average person in an evacuation scenario.

12.4 Movement through smoke

12.4.1 Where re-entry is applicable in this assessment, a portion of the staff is acknowledged to turn back rather than continue through smoke-filled environment to evacuate patients. This proportion is taken to be 30% (Bryan, 1977). 70% of staff re-entering is deemed a feasible assumption due to the large number of occupants in the wider building who can assist in evacuation. Note, the assessment should only consider staff from the level of fire location.

12.4.2 Movement through smoke is expected to reduce travel speeds. When moving through smoke it is proposed that unobstructed travel speeds (smoke-free conditions) are used for visibility >3 m. When visibility is below 3 m Fridolf, Ronchi, Nilsson, & Frantzich, 2019 have shown the following relationship between smoke and walking speed, w:

$$w = \min\left(w_{smoke-free}; max\left(0.2; w_{smoke-free} - 0.34 \times (3 - x)\right)\right)$$

12.4.3 This relationship should be incorporated within the evacuation model and coupled with fire and smoke modelling. An unimpeded baseline speed is allocated to the evacuation agent depending on if they are staff, staff with bed etc. then their travel speed is progressively reduced with respect to visibility.

12.4.4 For example, a nurse moving through smoke with visibility of 1.4 m, would have a walking speed of:

$$w = \min\left(1.42; max\left(0.2; 1.42 - 0.34 \times (3 - 1.4)\right)\right) = 0.88\ m/s$$

12.4.5 Tunnel and corridor experiments for walking speeds in smoke are proposed due to the limited guidance and data currently available. The relationship above is considered conservative and may overpredict the uncertainty for a specific design scenario, (Fridolf, Ronchi, Nilsson, & Frantzich, 2019)
ie the experiments were conducted in tunnels and corridors with simple geometry and a general population unfamiliar with the area. Within a hospital environment, the staff are trained and generally familiar with the building and their work area. Therefore, this approach may be considered to be conservative.

12.5 Queuing time

12.5.1 Queue formation occurs when the number of occupants at the exits exceeds the maximum occupant flow rate that can be sustained through the exits. As such, queuing time will also be considered as part of the *RSET* calculation where applicable.

12.5.2 Flow calculations are incorporated in the evacuation model which are based on SFPE fundamental diagrams by default.

12.6 Patient preparation time and door passage time

12.6.1 It is noted *RSET* calculation must also account for the following actions noted in Figure 12.2 related to movement of non-ambulant patients; noting the time taken to prepare patients for movement will vary between different types of occupancies within *hospital buildings*:

- collect emergency equipment and prepare patient for movement

- prepare patient in movement device (Bed/Wheelchair/Gurney etc.)
- move patient to receiving area (adjacent firecell/Evacuation Zone)
- delays for moving through doors on egress routes
- transfer patient from movement device to receiving area.

12.6.2 The only patient preparation time data available was in the Dutch Hospital report by Hoondert, P. As part of an exercise for the review of one of the Clinical buildings in Auckland City Hospital (formerly Auckland District Health Board, ADHB) data have been assimilated based on trial evacuations as a comparison. The fire engineer is expected to select the relevant speed based on Engineering judgement and present them for acceptance by the stakeholders as part of the *FEB* Process.

Table 12.4: Patient prep times

Department	Patient type	Auckland City Hospital Prep Times (s)	Prep Times from Hoondert, 2017 (s)
PICU/ICU	Total assist / confined to bed HDU	180	119[7] 100[3]
	Total assist / confined to bed ICU	300	119[7] 100[3]
Operating Theatre	Bed evacuation	600	558[1]
PACU/Recovery	Bed evacuation	300	54[5] 41[4] 41.3[6]
Ward 24A: Paediatric Surgery	Bed evacuation	30	11.5[2] 41[4] 41.3[6] 8.6[9]
	Walking evacuation	30	-
Ward 24B: Paediatric Surgery	Bed evacuation	60	11.5[2] 41[4] 41.3[6] 8.6[9]
Ward 25: General Paediatrics	Walking evacuation – adolescent	15	-
	Bed evacuation – under 2's	15	84.2[8]
	Bed evacuation – critical patients	120	41[4] 41.3[6] 8.6[9]
Ward 26A: Paediatric Neuroservices	Bed evacuation – non-high dependency	30	41[4] 41.3[6] 8.6[9]
	Bed evacuation – high dependency	300	119[7] 100[3]
Ward 26B (Medical Specialties)	Bed evacuation – ventilator/dialysis (critical)	240	119[7] 100[3] 23[10]
	Bed evacuation – remainder of patients	60	41[4] 41.3[6] 8.6[9]
Ward 27B: Paediatric cancer and blood	Bed evacuation	180	41[4] 41.3[6] 8.6[9]

	Independent walking	30	-

Notes related to Table 12.4

The data extracted from Hoondert, 2017 above only includes the uncoupling times for first time tests as a conservative approach. Uncoupling times decreased after the first round where staff were searching for what to disconnect and in the correct order. Inexperienced staff subsequently achieved faster uncoupling times. It is emphasised that the preparation times can be greatly influenced with regularly training staff.

1. Results from a fire incident in an operating theatre in Hamilton NZ (single test). Approx. 9min 18sec preparation time with 8+ staff. Noted to envision a longer preparation time for more complex surgeries. (Scott, 2009)
2. 75% fractile given (90% not available). Placing time has not been included in this data set, uncoupling time for bed ridden occupants. (Strating, 2013)
3. 75% fractile given (90% not available). Intensive care unit uncoupling times, experimental results from 10 evacuation drills performed on 2 dummies by 3 staff. (Strating, 2013)
4. 90% fractile given. Traditional hospital uncoupling times. (Hoondert, 2017)
5. 90% fractile given. Recovery ward uncoupling times. (Hoondert, 2017)
6. 90% fractile given. Regular hospital uncoupling times. (Hoondert, 2017)
7. 90% fractile given. Intensive care unit. (Hoondert, 2017)
8. 90% fractile given. Neonatal Intensive care unit (specialising in the care of ill or premature new-born infants). (Hoondert, 2017)
9. 90% fractile given. Basic patient uncoupling times. (Hoondert, 2017)
10. 90% fractile given. Dialysis patient uncoupling times. (Hoondert, 2017)

12.6.3 Door passage time is taken as 10 seconds. This is based on the mean value from Hoondert, 2017, and is considered conservative when compared to a recent trial evacuation in another Auckland healthcare facility. (Rahouti, Lovreglio, Jackson, & Datoussaid, 2018)

12.7 Patient evacuation time

12.7.1 The evacuation time per patient, $t_{p,\ evac}$ can be expressed as:

$$t_{p,evac} = \frac{\text{travel distance}}{\text{staff travel speed}} + \text{prep time} + \text{door transit} + \frac{\text{evacuation distance}}{\text{evacuation speed}}$$

12.7.2 Where, evacuation speed is dictated by the type of movement device (bed, wheelchair etc). Note this approach is applied within the Pathfinder evacuation model.

13 Performance-based design inputs for calculating Available Safe Egress Time (ASET)

13.1 Introduction

This Section provides guidance to the engineer undertaking performance-based fire engineering design. The Engineer carrying out the A*SET* analysis is expected to use engineering judgement in selecting the relevant inputs. The inputs selected and the basis for their selection are expected to be considered as part of the *FEB* process.

13.2 Fire scenarios to consider

Occupants in *hospital buildings* are more likely to need assistance to evacuate, or to be more susceptible to injury when exposed to smoke or take longer to evacuate to a place of safety. To compensate for these vulnerabilities, the fire engineer should consider a suitably wide range of challenging design fire scenarios. These should include:

- Low energy fires such as smouldering fires of constant heat release rate and fires with a slower fire growth rate than used for routine fire design (e.g. slow or medium t^2 fire growth rate)
- Fires which do not create fire conditions which activate automatic sprinkler systems.
- Fire scenarios which result in delayed activation of automatic fire detection systems (either due to fire location, or fire growth rate and/or heat release rate)
- The consequent effect of delayed automatic detection on staff notification and response and consequent delay in providing assistance to evacuate occupants who rely on that assistance.
- Design robustness may include considering a delay in activation of smoke detectors or sprinklers due to air flow from ventilation systems or induced by pressure differences required for infection control.
- Considering the impact of system interventions, such as ‘double-knock’ smoke detection before an alarm signal is registered, or the influence of detection delay on staff response procedures that include an investigation phase or alarm activation acknowledgement before evacuation procedures begin.

> Where a fire scenario constructs a design fire based on natural fire or test fire characteristics (e.g. HRR, temperature as a function of time) engineers should refer to the literature for data on hospital-specific fires, such as fires in hospital rooms, heat release rates for burning objects such as hospital mattresses, etc.
>
> Refer to the Bibliography for further information.

14 Structural stability during fire

14.1 Introduction: the structural fire design scenario

14.1.1 Structures constructed using common materials (reinforced concrete, structural steel, masonry and mass timber) are inherently resistant to the routine challenging fire scenarios that are assessed for protection of the building occupants. Structural material strength is typically not significantly affected until the structure is heated to temperatures of several hundred degrees Celsius, requiring exposure for around 10 minutes or more to fire temperatures which are of similar or greater magnitude. A fire needs to reach flashover and full development in order to create the fire conditions which are necessary to significantly degrade structural material strength. This type of fire produces conditions in a *firecell* which are beyond the range which are survivable for the building occupants.

14.1.2 A fire severe enough to threaten stability of structure in the firecell also causes substantial damage and disruption to a *hospital's* short-term functionality. In the event of such a fire, all furniture, *hospital* equipment and building services within the *firecell*, and building services reticulated through the *firecell* without robust fire protection are likely to be destroyed. Water damage from firefighting efforts will affect electrical equipment, building services and the ability to provide healthcare services in spaces on two or more levels below the *firecell* or origin. The floor slab above the *firecell* of origin will need to be replaced, which affects all things suspended from or supported by this floor. It becomes evident that avoiding a major fire in a *hospital building* is fundamentally important not only for life safety but to protect the investment in maintaining undisrupted delivery of healthcare services.

14.1.3 As a consequence, all of the fire systems and features in a *hospital building* which improve life safety by reducing the risk and impact of a major fire also reduce the likelihood and severity of fires which could threaten structural stability.

14.1.4 These fire scenarios which threaten structural stability occur only when a number of the fire systems provided in a *hospital building* all simultaneously fail to perform as designed or the event is outside the range of the design parameters. On a fire timeline which starts at ignition and considers fire consequences as a fire grows and spreads, the potential for structural instability due to fire is typically one of the last systems whose performance is affected. A fire needs to start, spread beyond the item ignited to the involve other items in a space, grow unsuppressed by the building occupants or a fire sprinkler system, and continue growing without firefighter suppression until the enclosure is fully involved in fire. If a source of outside air is not available, or created by breaking windows, the fire is not likely to continue growing. If fresh air is available to fuel the fire, then post-flashover fire conditions can occur, and the structure can be heated to temperatures which may reduce strength and stiffness. All contents in the *firecell* will be destroyed by the time at which the fire affects the structure.

14.1.5 Fortunately the occurrence of this type of fire in buildings is very rare – a very low probability event treated as an 'ultimate limit state' design condition in structural engineering terms, where the consequences can be significant, but the likelihood of occurrence is rare. The design process aims to protect life during extreme events by ensuring that the probability of structural collapse is kept to an acceptably low level, the same classification applied to maximum credible earthquake design conditions. Among other things, large fire-induced structural deformations are expected to occur (without collapse), and structural damage may occur even when structural load-bearing capacity remains adequate. This is distinctly different from the serviceability limit state design condition, which considers events occurring more frequently than accidental events such as a major fire in a sprinkler-protected building.

14.2 Performance objectives for fire resistance

14.2.1 In *hospital buildings* the egress strategy usually relies on partial or sequenced evacuation for occupants exposed to immediate threat from fire, and either an implicit or clearly defined stay in place strategy for the remaining occupants, depending on the balance of risk associated with moving them and not moving them. Occupants may be expected to remain on floors above the floor of fire origin that are not yet impacted by fire or smoke or may be directed to refuge areas for an extended period (hours) while firefighters conduct firefighting or assist with evacuation operations.

14.2.2 Accordingly, it is necessary to maintain structural stability for the duration of a total fire burnout in order to provide an unconstrained time frame for building occupants to exit the building or reach a place of relative safety. This is an important requirement to satisfy overall fire life safety objectives for *hospital building* design. The Standard Fire Test measures structural temperature and stability during the heating phase but not during the cooling phase. As a result prescriptive fire resistance ratings do not directly translate to exposure to fire in real time and may not provide sufficient levels of protection to resist total burnout. For some hospitals this distinction might be important. If this uncertainty around structural performance is considered to present a risk to building occupants remaining inside the building awaiting assistance or further instruction, then it is likely that fire resistance of the structure will need to consider the "real time" impact of fire on structural stability.

14.2.3 Discussion amongst the key stakeholders is necessary to confirm the project brief, design needs and any building-specific or local context. Some examples of some questions to consider include:

- what levels of fire resistance provide appropriate protection for exposure to a full duration fire?
- if performance-based structural fire analysis techniques are used, what level of analysis is satisfactory to meet the desired performance objectives? (eg assessing individual structural elements in the temperature domain, advanced quantitative analysis of a structural assemblage in the strength domain) in order to understand the structure's real performance in fire?
- what fire scenarios (fire size, severity, location, number of stories affected) are reasonable for design?
- is there benefit in specifying more resilient detailing for structural components than is prescribed in codes?
- what is an acceptable level of downtime for structural repair?

14.3 Fire scenarios for structural design

14.3.1 In contrast to the challenging fires routinely considered for occupant life safety, design basis fires for structural fire resistance are concerned with the consequence associated with infrequently occurring fully-developed post-flashover fires (i.e. a fire scenario where sprinklers fail to operate or are not effective in limiting fire growth and when fire fighters do not intervene to control or suppress the fire). This corresponds to a fire that has developed uncontrolled past the growth phase to a stage when all combustible contents in the compartment are burning. It is during this phase of the fire and during the cooling phase when a structure can be affected. The peak fire temperature, time duration of near-maximum fire temperature are a function of the quantity of combustible fuel load and amount of ventilation (or openings) provided in the external wall of the *firecell*.

14.3.2 In some cases, adopting as the basis for design a post-flashover fire scenario with uniform conditions throughout the firecell may not always be the correct approach. If a fully developed fire exposure with uniform conditions throughout the firecell is deemed to be unlikely, a suitably severe localized fire, travelling fire or external fire may be more appropriate for design.

14.3.3 The project brief should consider whether it is necessary for the structure fire resistance to account for the possibility of an uncontrolled fire also spreading beyond the *firecell* of fire origin: potentially spreading to adjacent *firecell*s on the same floor and/or spreading vertically to other floors. The consequence of these fire scenarios is increasingly worse and the likelihood of the scenarios is increasingly unlikely. This may be influenced by the facade design and materials, or by open internal connections between floors.

14.4 Methods to determine fire resistance

14.4.1 Once the performance objectives for the project have been agreed, an acceptable approach for determining, evaluating, and demonstrating the fire resistance of the *hospital building* should be determined. Two general methods are available for selecting an appropriate level of structural fire resistance: 1) prescriptive approach or 2) performance-based structural fire engineering.

14.4.2 While standard fire resistance testing is an integral part of the regulatory system, it is well documented in the literature that these tests are primarily comparative thermal tests and not intended to be predictive of actual structural performance under real fire conditions.

14.4.3 This is because of the many limitations of the standard fire exposure (eg infinitely long heating phase with no cooling phase, no assessment of stability during the cooling phase) and physical test setup (eg not full-scale, unrealistic boundary conditions). Because of these limitations, the hourly fire resistance ratings are not indicative of a specific duration for which a structural element will withstand collapse in an actual fire.

14.4.4 The performance-based structural fire engineering approach involves analysis of the structural system under realistic fire conditions. The results are used to determine an appropriate level of fire resistance. The fire severity (how impactful the fire might be on the structure) is characterised by the amount of fuel load in a *firecell*, the ventilation available to a fully developed fire (given that it reaches this state; ventilation is typically related to the number of frangible elements on the perimeter, such as glass windows) and the geometry of the enclosure/*firecell* in terms of height and volume. These factors determine the key fire severity measures: (i) the temperature of the fire environment and (ii) the length of time that this heated environment exists.

14.4.5 The final design basis may consist of a combination of methods (prescriptive and performance-based) at different scales of analysis, to provide sufficient confidence regarding the structure's performance in fire conditions. This may mean that the fire severity in certain portions of the *hospital building* that reflect traditional forms of construction and exposure (eg building services plant rooms and support spaces) can be assessed using prescriptive methods, while other fire exposure to structure in other parts of the building are analysed using performance-based methods.

14.4.6 However, structure responses cannot be accurately predicted or quantified using single element fire resistance tests resulting from exposure to the standard fire curve, as the actual response is specific to the interactions of numerous building features: availability of alternative load carrying mechanisms, capability for load redistribution, structural and fire protection redundancies, size of *firecell* and location of *firecell* boundaries.

14.5 Performance-based structural fire analysis

14.5.1 Various types of performance-based structural fire analysis can be used, ranging from simple single element checks to analysis of sub-models to advanced, non-linear finite element models of multiple floor levels of structure.

14.5.2 In real building fires, structural elements/systems can undergo significant thermally induced expansion/contraction forces (axial and bending), geometric elongation/shortening and thermal curvature throughout the heating and cooling phases of the fire. In *hospital buildings* where the structural floor system needs to accommodate an extensive distribution network of building services (eg beams with a significant number of penetrations for building services), the floor support structure is often more vulnerable to these localised thermal effects (eg web and/or buckling in steel beams). These influences on structural stability need to be considered when assessing structural fire performance. Refer to the relevant structural material standards for specific design requirements.

14.5.3 *Hospital building* structures in which there are combination gravity-lateral load resisting systems tend to be more resilient to some of these local thermal effects.

14.5.4 The relatively intensive subdivision of the floor plate in a *hospital building* into a number of separate *firecells* affects the extent of structure likely to be heated simultaneously. Localised heating of part of the structural floor plate can have a beneficial effect on reducing the vulnerability to structural instability.

14.5.5 Sample performance metrics for detailed structural stability fire analysis (eg. advanced 3D, non-linear analysis of steel or concrete buildings) include:

- the primary structural systems (columns, beams, connections, load-bearing walls, lateral load resisting system) shall maintain the applied design loads in the fire limit state for the full duration of the fire (including cooling)
- strains do not exceed ductility upper limits for slab reinforcement and structural steel in fire conditions
- stresses do not exceed the limits of the relevant material properties at elevated temperatures
- connections deformations do not exceed limits for rotation and ductility for fire conditions
- structural stability is verified by control on the maximum rate of deflection (non-combustible structural materials).

14.6 Consideration of the cooling phase

14.6.1 The cooling phase of a fire is a critical period which can influence the response and performance of a structure for several hours after the fire has burnt out. This is especially critical for mass timber structures, where charring and reduction in strength can occur long after the fire appears to have burnt out or been extinguished.

14.6.2 The effects of the cooling phase on the performance of key connections must be considered in the design (eg provide enough ductility or tensile force capacity). If connection components have impacted on structural elements or have buckled during the heating phase, high tension forces can develop during the cooling phase as the structure thermally contracts and tries to return to its original shape and position.

For steel-concrete composite structures, some requirements for structural detailing to provide resilience and ductility to resist fire-induced deformations are given in in AS/NZS 2327.

For mass timber structures, refer to structural and fire design guidance published by the timber industry.

14.7 High challenge fire hazards

14.7.1 Areas with high fuel loads should be identified and addressed when assessing structural fire resistance. Examples include rooms containing liquid or gaseous fuel storage, lithium-ion energy storage, significant quantities of storage, and routes for or shafts containing piped liquid or gaseous fuels. It may be necessary to provide a greater level of thermal insulation in these spaces in which it is reasonably foreseeable to contain high fuel load.

14.8 Seismic isolation systems

14.8.1 Large *hospital buildings* are often constructed with resilient seismic isolation systems installed near foundation level, to minimize earthquake induced damage to the *hospital* contents. These systems are often required to accommodate seismic movements of around one metre or more. Most common fire protection methods (eg spray applied fire resistant materials, board protection, etc.) are not designed to accommodate 100 mm or more of movement. In this case, performance-based structural fire engineering approaches may be required for structure in this high movement zone, to determine an appropriate design that can satisfy both operational seismic needs and fire safety requirements. This would apply in cases where it is difficult or expensive to regularly check and/or replace fire protection to structure in the high-movement zone.

14.9 Buildings with mass timber elements

14.9.1 Although mass timber is not currently a common structural material for *hospital building* structures, this may change as a result of an increased interest generally in using structural mass timber. The fire design approach for mass timber buildings varies, depending on whether the timber is fully encapsulated or partly exposed (eg some parts encapsulated, some parts exposed), or fully exposed. Mass timber structures can achieve high levels of fire resistance, due to an insulative char layer forming on the exposed timber surface. However, this results in the irreversible reduction of the load-carrying capacity of the structural element. This process of charring the exposed mass timber also influences the enclosure fire dynamics and internal flame spread.

14.9.2 Where designers are relying on establishing compliance with prescribed levels of fire resistance (eg from prescriptive codes, which have been developed using empirical correlations for application to *non-combustible* structures) additional caution is needed.

14.9.3 In *hospital buildings*, where the time required for a partial or full building evacuation requires structural stability to be confidently maintained until burnout, mass timber structures might be more appropriately protected from fire by full encapsulation, with less reliance on the inherent fire resistance contributed by charring of the structure (ie encapsulation may provide a more reliable strategy for maintaining structural stability). The performance requirements for a full encapsulation system (acceptance criteria, test methods, etc.) are given in design guidance for mass timber structures. Specific details of encapsulation system performance are usually provided by the suppliers of protective lining systems. The encapsulation systems must be capable of staying in place and ensuring no significant charring of the timber.

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Appendix A – Legislative requirements (informative)

Legislative requirements to be observed for fire safety design of *hospital buildings* include compliance with the Building Act 2004 and regulations, the Building Code, the Fire and Emergency New Zealand Act 2017, Fire and Emergency New Zealand (Fire Safety Evacuation Procedures and Evacuation Schemes) Regulations 2018.

A summary of relevant provisions is provided below. Reference should always be made to the authoritative sources for Aotearoa New Zealand legislation, https://www.legislation.govt.nz, the Building Performance branch of MBIE website, https://www.building.govt.nz, and the Fire and Emergency website, https://www.fireandemergency.nz. The summary below is derived from the MBIE website and is subject to crown copyright that MBIE gives permission to reproduce.

Building Legislation

Figure A1 shows the Building Code regulatory framework as a triangle with a series of tiers. The top two tiers are mandatory requirements from Aotearoa New Zealand legislation and include the Building Act and the Building Code. The Building Act is at the top of the triangle. It sets out the rules that every building must meet. It is the primary legislation of the building industry, and it ensures people's health, wellbeing, and independence are maintained.

The Building Code is secondary legislation and sits directly below the Building Act. It outlines the minimum requirements for buildings to achieve. The Building Code includes Objectives, Functional requirements and Performance criteria. It's a performance-based system, which means the Code only states how a building must perform, rather than describing how it must be designed and constructed. By focusing on how buildings perform rather than how they are built, designers, architects, and builders can meet the building standards in flexible and innovative ways. A building owner has to achieve the minimum performance criteria set out in the Building Code. To issue a building consent, a *building consent authority* (usually the council) must accept evidence of compliance with the Building Code.

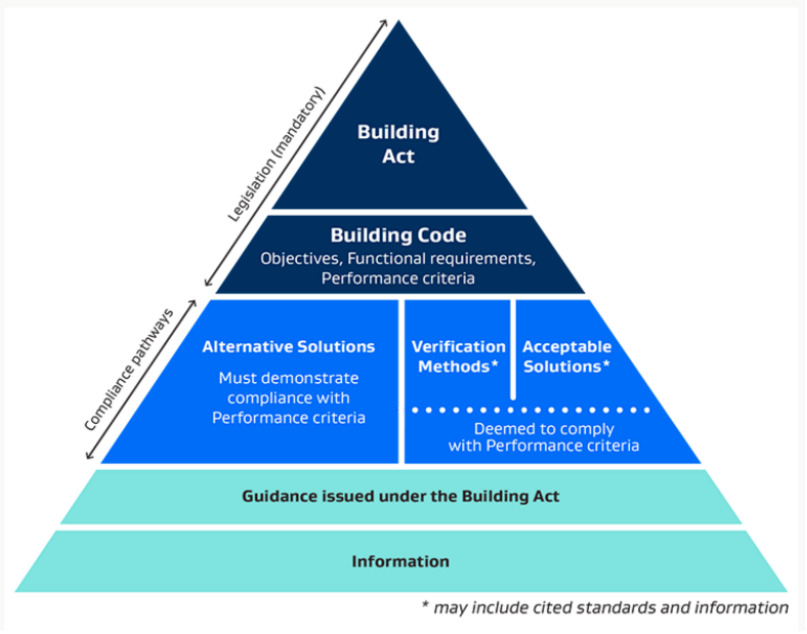

Figure A1: Regulation framework showing some ways to comply with the Building Code (from MBIE)

The next tier in the triangle includes different compliance pathways to comply with the Building Code. These pathways include *alternative solutions, verification methods or acceptable solutions*. An *alternative solution* is a flexible option that promotes innovation. It allows the use of an innovative method or material provided it can be shown to comply with the performance requirements of the Code.

Deemed to comply solutions include either *verification methods* or *acceptable solutions*. Deemed to comply methods are the easiest ways to ensure a building meets the performance requirements set out in the Building Code.

As *hospital buildings* are not within the scope of the relevant *verification method C/VM2* and *acceptable solution C/AS2*, all designs following this *DGN*, whether they follow the prescriptive Sections of Part 2 or a performance-based approach following Part 3, are *alternative solutions*.

This *Design Guidance Note* is represented in Figure A1 within the lower tier of the triangle, Information. The *DGN* provides the sector with robust fire engineering design advice endorsed by *MBIE* and *FENZ* that will meet the requirements of the Building Code and the needs of *Te Whatu Ora*. *BCAs* need to be 'satisfied on reasonable grounds that the provisions of the Building Code would be met' (BA s 49) to issue a building consent. This *DGN* aims to provide those reasonable grounds.

Building Code

All building designs need to meet Building Code provisions. The most relevant Building Code clauses for the design of *hospital buildings* include:

- C1: Objectives of clauses C2 to C6 (protection from fire)
  The objectives of clauses C2 to C6 are to:
  - safeguard people from an unacceptable risk of injury or illness caused by fire
  - protect *other property* from damage caused by *fire*, and
  - facilitate firefighting and rescue operations
- C2: Prevention of fire occurring
- C3: Fire affecting areas beyond the fire source
- C4: Movement to a place of safety
- C5: Access and safety for firefighting operations
- C6: Structural stability
- D1: Access routes
- D2: Mechanical installations for access
- F6: Visibility in Escape Routes
- F7: Warning systems
- F8: Signs

Refer to:
https://www.legislation.govt.nz/regulation/public/1992/0150/latest/DLM162576.html?search=ts_act%40bill%40regulation%40deemedreg_Building+regulations+1992_resel_25_a&p=1
for detailed Functional requirements and performance objectives of Building Code Clauses

FENZ involvement in consenting

Section 46 of the Building Act requires the *BCA* to provide a copy on receipt of the consent application of *Alternative Solutions* to *FENZ* (as published by MBIE in Gazette Notice Number 2012-go2694, Page Number 1406, Issue Number 49). Under s. 47, *FENZ* may within 10 working days pass comment by way of a memorandum back to the BCA on:

- the provisions for means of escape from fire, and
- the needs of persons who are authorised by law to enter the building to undertake firefighting.

FENZ are not entitled to ask for any performance criteria in excess of that already laid down in the *NZBC*.

If *FENZ* does not comment within ten working days then the *BCA* may proceed to determine the application without the memorandum from the *FENZ*.

Appendix B – Fire evacuation survey (informative)

This *DGN* expects the fire design to be based on a collective agreement and understanding of the evacuation procedure and staffing levels in a *hospital building*. Fire designers, healthcare managers and evacuation consultants need to determine the evacuation procedure and staffing levels in a *hospital building* during the design phase, to provide confidence phase that a sufficient number of trained staff will be reliably available at the time of a fire emergency.

Initial discussion and information gathering during the FEB stage may include a Fire Evacuation Survey. These survey questions relate to a significant fire event which threatens the life safety of all in the unit, and not a non-threatening trial evacuation scenario. Survey questions could include:

- how many staff will normally occupy the unit?
- is there a minimum staff / patient ratio for the unit?
- how do hours of operation or different staff shifts impact on this?
- what are the 'Admission and Discharge' criteria?
- describe the occupant characteristics relating to evacuation?
  eg characterise people into the following groups:
  - XX percentage who are who are responsive, and receive minor assessment / treatment and should be able to evacuate with minimal or no assistance, even if mobility is slow
  - YY percentage who are incapable of removing themselves from danger exclusively by their own efforts and require assistance to evacuate
  - ZZ percentage who are not capable of being moved immediately who would require assistance to evacuate and would be moved only as a last resort
  - plus ?? visitors who require no / little assistance to evacuate.
- for each occupant group, what evacuation delays would you expect to experience during a significant emergency? This may include the need to disconnect / move medical equipment and/or connect patients to portable equipment?
- what is the planned min/max duration of a patient in the unit?
- what features are needed in the *evacuation zone* the occupants would be moved to if under threat from the fire? How long should it take to make ready and then move a patient requiring assistance to this location(s)?
- which staff in the unit are trained to provide assistance with evacuation of other spaces (*Evacuation Zones*) when required to as part of the building evacuation procedure?
- does the unit require staff from other spaces (*Evacuation Zones*) to provide assistance to evacuate occupants in the unit?

Appendix C – Evacuation using lifts in Hospital Buildings (informative)

Section 4.12 provides a prescriptive approach for lift evacuation for occupants categorised P1 or P2 who are in close proximity to the fire. Appendix C provides further informative guidance discussing the considerations that would need to be addressed and agreed during the FEB process if a performance-based design approach was being considered.

Part A – Design Approach and Key Considerations

A fire design strategy involving lift evacuation should demonstrate how the lifts can be safely controlled in an emergency, how the lifts are provided with a high degree of reliability, and are appropriately protected during a fire emergency.

In the absence of specific NZBC applicable design guidance for lift evacuation, the information within this appendix has been internationally benchmarked against standards and guides such as:

- EN 81-76 – Evacuation of persons with disabilities using lifts
- BD 2466 – Emergency Use of Lifts for Evacuation & Fire Rescue Operations
- HTM 05-03 – Part E Escape Lifts

Whilst these international documents provide many useful and relevant details which those involved in the design and approval of the evacuation lift should be familiar with, they have not been written around the New Zealand regulatory environment, nor with specific regard to hospital buildings, and they do not provide full prescriptive details to design and implement lift evacuation. The guides recognise that many features of the building beyond the lift will influence safety. A risk-based holistic fire engineering design approach is therefore to be used to appropriately incorporate this safety feature into a building. Lift evacuation details should be incorporated into the FEB process. The holistic design needs to consider such issues / hazards as:

- the risk of fire or smoke in or near the evacuation lift (eg. lift shaft, lift lobby, machinery spaces)
- the risk of water on the operation of the evacuation lift, during both a fire or non-fire event
- the number and placement of evacuation lifts
- the capacity of evacuation lifts
- the active and passive fire safety features provide in the building
- the risk of entrapment in the lift or lift waiting area
- the risk of failure (full or partial) of building services and structural elements which support the use of the evacuation lift
- the management of the lift
- the maintenance of the lift.

The information within this appendix highlights how these risks should be addressed as part of a risk-based holistic fire engineering design approach. Final lift evacuation details will be 'project specific' and are likely to vary depending on how the relevant risks are controlled / managed.

Key design principles

Key design principles which need to be agreed early during the design stage (eg. during the FEB process) include:

- The availability of the lift for evacuation.
  Specifically, the scenarios (fire or non-fire events) for which the lift be available for evacuation should be identified. These scenarios may be planned or unplanned, such as scheduled lift maintenance, a floor fitout, lift replacement or a fire event. As it is not possible to design for 100% availability, the design needs to clearly communicate how this risk is to be managed.
- The robustness of the lift for evacuation.
  The design reliability and redundancy to be incorporated into the lift design should be carefully considered. All relevant elements of the lift system should be reviewed to avoid or manage single points of failure.

The different modes of vertical evacuation using stairs and lifts is presented in Table C.1. If lifts are to be used for hospital evacuation, 'Mode 2' shall apply.

Table C.1: Modes of Vertical Evacuation

Mode	Stair Usage for Evacuation	Lift Usage for Evacuation
Mode 1 'normal'	Stairs available for use by all relevant building occupants. No stair design changes permitted given the presence of lifts in the building.	Lift never used by building occupants, except by suitably trained emergency responders (for example the Fire Brigade) upon manual activation of the emergency recall switch prescribed under NZS4332). Lifts operate fully in accordance with lift standards prescribe under NZBC (they are not automatically shut down by the fire alarm system). Signage dissuades all use of lifts during fire events.
Mode 2 'enhancement'	Stairs available for use by all relevant building occupants. No stair design changes permitted given the presence of evacuation lifts in the building.	Lift used by a limited number of building occupants, based on minimizing risks to staff, patients and other building occupants associated with carrying out vertical evacuation using stairs. The building, lift system, and emergency management arrangements would be suitably reviewed to establish the final lift evacuation details (based on a risk-based holistic fire engineering design approach). Signage dissuades the use of lift in fire events except under direct instruction from trained hospital staff or firefighters.

Mode 3 'specialised' (Note: Mode 3 is not being contemplated for use in New Zealand public hospitals)	Stairs available for use by all relevant building occupants. Some stair design changes may be permitted given the presence of evacuation lifts in the building (based on a risk-based holistic fire engineering design approach).	Lift specifically designed for use by most / all building occupants. The building, lift system, and emergency management arrangements would be suitably reviewed to establish the final lift evacuation details (based on a risk-based holistic fire engineering design approach). Signage supports the use of lift in fire events.

The design of lifts for evacuation requires considerations beyond those applied to meet NZ regulatory requirements for normal passenger and goods lifts. Elements of EN 81-20 and NZS 4332 will remain relevant even with need for additional features and systems to enable the use of Lift Evacuation. The fire engineer and vertical transportation engineer shall coordinate these details and relevant documentation.

Lifts used for evacuation service should be part of the building's normal vertical transportation system, so that they are in regular use (they provide a monitored circulation function). Lifts intended for non-passenger service (eg dumb waiter), especially where they serve only a limited number of floors in the building are unlikely to be suitable for lift evacuation.

Lift shafts (serving one or more lift cars) shall be designed so that any failure of the lifts in one shaft, or compromised by fire conditions, does not impact on safe use of a lift shaft in another fire evacuation zone.

It is noted that an evacuation lift may not be considered a firefighting lift. An evacuation lift is a lift provided with features to supports it use during an emergency, with or without the direct support of building management, staff or rescue services.

A firefighting lift is primarily a facility for firefighting. They are provided for tall buildings due to the height limitations of external fire-fighting approaches. They help avoid delay and to support more effective actions by fire and rescue service personnel. A lift designed for use by firefighters during an emergency fitted with systems to provide additional resilience to support emergency operations, often for an extended time period. In small or low-rise buildings firefighting lift aren't normally needed. However, the taller the building, the longer it takes and the more energy we use to reach the emergency, and the greater the benefit provided by a firefighting lift. A firefighting lift is likely to be considered an evacuation lift.

Recommended Briefing Process to Incorporate Lift Evacuation in Hospital Buildings

As lift evacuation is to be addressed as part of a risk-based holistic fire engineering design approach, the following briefing process should be followed to help define the suitable lift evacuation availability and robustness. This briefing is expected to enable the project client / building operator review and agree the key expectations of the evacuation lift design. This information would also expected to be incorporated within the Fire Engineering Brief for regulatory stakeholder review.

The following steps should occur by the project fire engineer, supported by multiple building and engineers design specialists (eg architect, evacuation consultant, vertical transportation engineer, electrical engineer):

- Review the buildings spatial design. This will help to determine where the evacuation lift(s) could be provided

- Consider the expected emergency response of the building occupants, especially the hospital staff. Will a ‘driver assisted’ or ‘unassisted’ lift mode be utilised? What training is required?
- Review the risks to lift operation from the relevant fire events (scenarios). How long will the lift be available for evacuation? What features are to be provided to manage this risk?
- Review the risks to lift operation from the relevant non-fire events (scenarios). What provisions are relevant for evacuation when the lift is unavailable? What features are to be provided to manage this risk?
- Consider how lift evacuation will be communicated to building occupants. How will this change if any lift is unavailable?

At the conclusion of this briefing, roles and responsibilities of the lift evacuation design should be agreed, including defining if/how design and management documentation for the building is to be modified.

Standard NZS4332 Design Features

To provide a design basis for lifts provided in NZ buildings, some key emergency management features of NZS 4332 are noted below. This information is intended to assist the evacuation lift designers as they determine how a standard lift is to be modified to support its use during an emergency. Refer to NZS 4332 for full details.

Section 25 of the standard prescribes the emergency response operation of the lift during a fire. During a fire, all lifts remain in use (they are not requirement to shut down). To facilitate a manual operation of the lift (by suitably trained emergency responders, for example the *fire brigade*), they are provided with an emergency recall switch at the nominated main floor.

A non-illuminated engraved sign adjacent to each landing call button plate stating ‘do not use lift in event of fire’ is required (note: F8/AS1 also prescribes similar signage on each landing). Section 25 requires this recall switch for lifts have a vertical travel exceeding 15m, but recommends the provision for all buildings.

Upon the manual operation of the lift emergency recall switch:

- All existing lift landing calls to be cancelled and landing buttons to be inoperative
- The lifts travel non-stop to the prescribed floor and remain parked with the doors open
- Movement of a lift in this mode:
    - is only achieved by the person within the lift pushing lift floor buttons (all lift landing calls are ignored)
    - normal automatic and protective devices on lift doors are inoperative (continuous pressure of door open/close buttons in the lift car is required)

Normal lift service is re-established (when determined safe to do so) via the manual deactivation of the recall switch.

NZ4332 does not permit the interruption of electric supply to the lift by interface with the fire alarm system. Fire alarm smoke or heat detection does not control the lift, nor does the activation of a sprinkler system. The lift system incorporates heat detectors [5] which when activated, automatically drives the lift car to the nominated main floor then deactivate the operation of the lift until manually reset by lift service personnel. Signage within the lift car(s) automatically illuminates to indicate this high temperature safety feature. In addition to the high temperature control, the lift also automatically stops under earthquake conditions if the counterweight derailment switch is activated. In this scenario, the lift system automatically drives the lift car to the next possible floor, opens the door and remains parked (until manually reset by lift service personnel).

Lifts are designed to manage the ingress of water into the lift shaft. They are to have waterproof construction so the lift pit remains dry. They also require a

- Lift pit sump drain, and one of the following features
- An open ended drain connected to the sump, capable of removing the water expected during an emergency. In this scenario, the water threat is managed and the lift system remains operational.
- A permanent sump pump, capable of removing the water expected during an emergency. In this scenario, the water threat is managed and the lift system remains operational.
- Sensors in the pit, designed to automatically stop the lift operation before it reaches the level of any electrical or other equipment vulnerable to water damage. In this scenario, the lift system automatically drives the lift car to the next possible floor, opens the door and remains parked (until manually reset by lift service personnel).

NZS4332 recommends that additional water sensors are installed at levels lower than the critical water level so that early warning of a water problem is given. This should enable the problem to be rectified without the need to take the lift out of service.

Key Spatial Design Considerations

Just as stairways for fire egress are located with consideration to the risk that an escape routes may be unusable due to the location of the fire or any other reason, lifts used for evacuation require similar consideration.

A design based on the use of multiple lift cores suitably separated (by distance and passive fire features) from each other is encouraged and is expected to be a more effective solution. This separation could be provided within a building with a medium or large floorplate or equivalently via linking separate buildings with a bridge, walkway or similar. Figure C.1 (same as figure 4.3) provides an example of this concept, where the lift used for evacuation (Lift Core A) is placed at least two *Evacuation Zones* away from the fire. A design based on suitable separation may remove or reduce the need for design features (eg. smoke management system) to address the risk of fire, smoke or water in or near the evacuation lift (eg. lift shaft, lift lobby, machinery spaces). A design utilising a single lift placed within a small floorplate is discouraged. The placement of these lifts on primary circulation routes and in close proximity to stairs is also encouraged.

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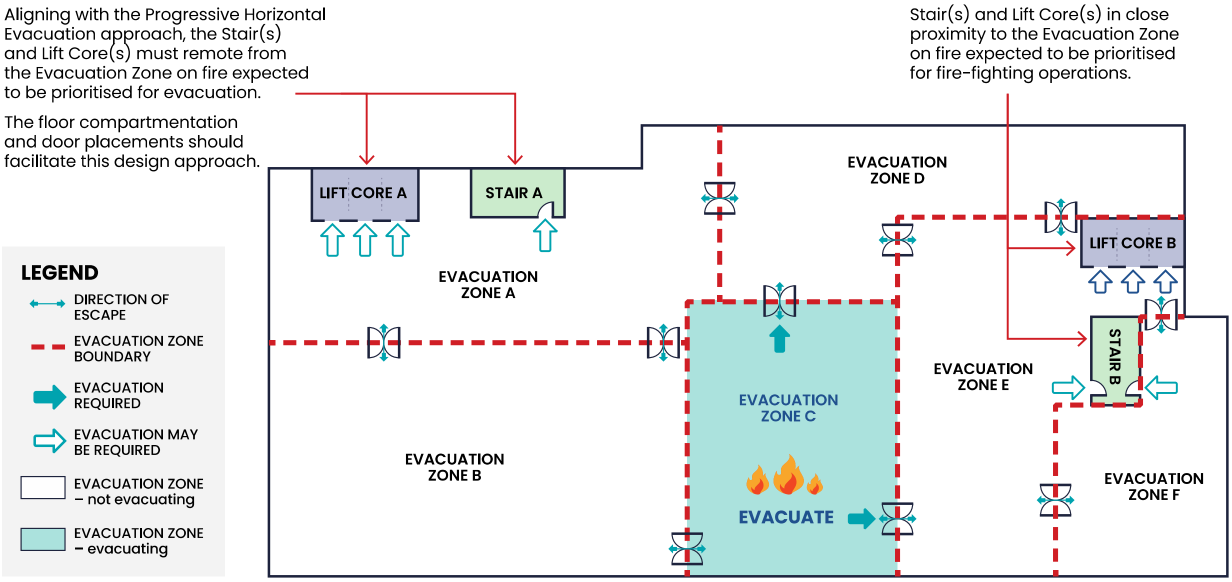
[5] Heat detectors in the lift shaft operate at 75°C or 11°C below the sprinkler head operating temperature, whichever is the lower. Heat detectors in the lift machine room operate at 45°C or 11°C below the sprinkler head operating temperature, whichever is the lower.



Refer to Figure 5.1 for which identifies how a typical Evacuation Zone can be further subdivided into firecells or smokecells, which provide additional control to possible fire or smoke spread

Figure C.1: Building floor plan showing evacuation response for different *evacuation zones*

Whilst the details within this appendix focus on a 'driver assisted' lift mode (ref EN81-76), the simplest design for lift evacuation may be an 'unassisted' lift mode which is provided, possibly with additional availability and reliability enhancements (refer to section 'Standard NZS4332 Design Features'). For this approach, it may be possible to present a design which shows a lift is sufficiently remote from the fire incident to be in a state representative of a normal non-fire scenario (ie. the effects of the fire are kept away from the evacuation lift(s) for the time period they are expected to be used). This approach of comparable to maintaining normal clinical functionality in remote *Health Planning Units* (eg wards) during a fire. In both locations (remote *HPUs* and lifts) proactive decision-making by staff, supported by the provision of suitable safety features (eg design redundancies and automatic warnings) would dynamically determine how each space operates.

The dimensions of lifts and lift lobbies intended to be used during a fire emergency by occupants who need assistance for evacuation should comply with Figure C.2 below. This check applies particularly to lifts (such as visitor passenger lifts) which are not normally used for moving occupants who need assistance.

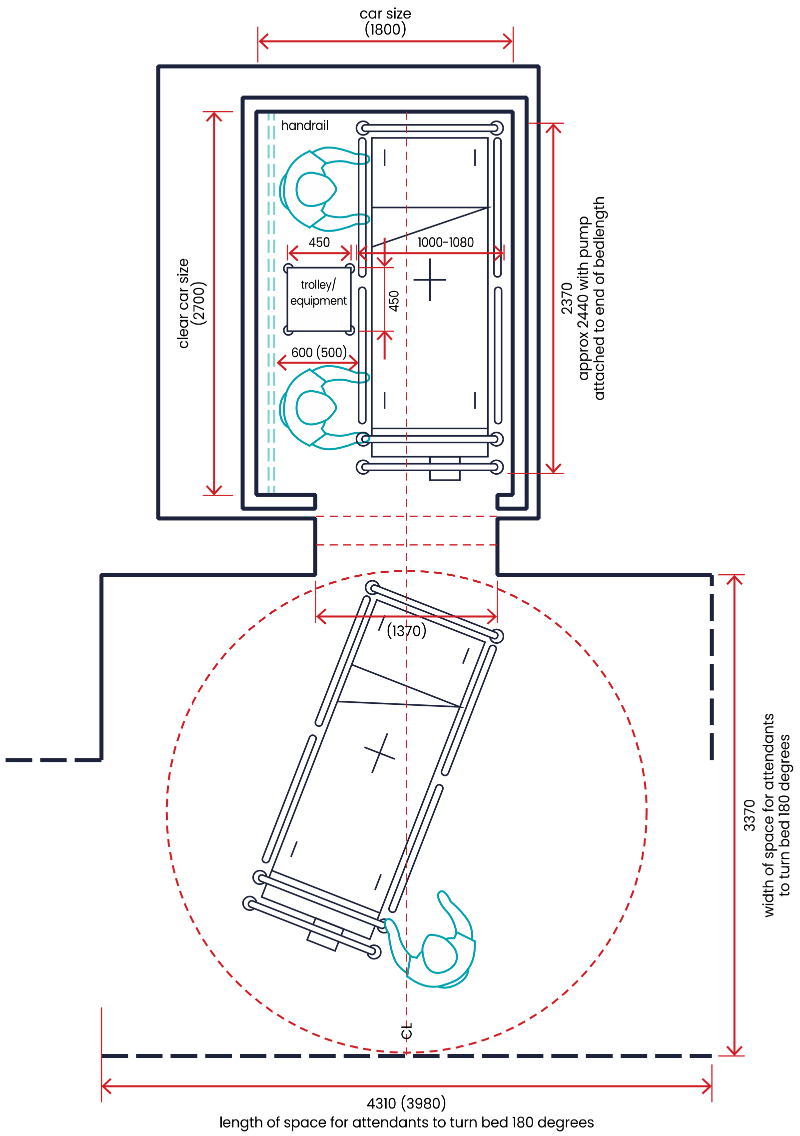


Figure C.2 Dimensions of escape lifts and lobbies (from HTM 05-02 Figure 9)

> The dimensions in Figure C.2 should be regarded as indicative likely minimum values. Actual dimensions required should be verified as suitable based on the project (eg. for the movement of bariatric patients in beds may require up to 1350mm clear width), and the health planning unit and type of occupants using the lift.

Key Emergency Management Considerations

Hospital building evacuation is a dynamic event which requires proactive decision-making by staff. During a fire incident, decisions may need to be taken by *hospital* staff about which areas of the building will be evacuated and in which order (supported by the building's fire alarm cause/effect matrix and fire alarm system's notification features). These decisions, including how the movement of people is prioritised, will seek to minimise risks to staff, patients and other building occupants associated with carrying out vertical evacuation using stairs or lifts.

Evacuation of occupants in lifts is expected to be controlled by:

- *hospital* staff for patients in beds
- *hospital* staff for occupants not in beds but requiring assistance.

The building's *Evacuation Scheme* and its supporting documentation shall incorporate the procedures for vertical evacuation using stairs or lifts. Coordination between the fire engineer, the evacuation consultant and *hospital* management is expected during the project's design stages to agree on these procedures. A sufficient number of *hospital* staff capable of carrying out the necessary duties should be appointed to the role and trained to assist in the management of any fire evacuation, including the lift evacuation. For a 'driver assisted lift mode' (ref EN81-76), these roles may include:

- Primary Lead Fire Warden = The designated person within the location of fire origin responsible for implementing the evacuation policy and procedures relevant to this zone. They have primary *clinical* and life safety decision-making responsibilities of the occupants of the zone they manage. This position is to be permanently held during the hours of operation of the building zone.
- Lift Warden = The person responsible for operating the lift in Lift Evacuation Service Mode. They would receive the person requiring vertical lift evacuation from designated staff on the floor of fire origin and transfer them to the receiving floor. The hospital Orderlies may be the most appropriate person for this role as its likely to closely align with their existing lift control / security clearance and existing training procedures.
- Receiving Floor Fire Warden = The designated person on the receiving floor responsible for the continued care of patients evacuated from the location of fire origin. They have primary *clinical* and life safety decision-making responsibilities of the occupants of the zone they manage. This position is to be permanently held during the hours of operation of the building zone.

  The 'receiving floor' is considered to be floor to where the evacuation lift is taken to unload its occupants. There may be more than one receiving floor; the decision (by staff managing the evacuation) as to which receiving floor is appropriate will depend on a number of factors including the continued care of patients.

These roles need to considered with due regard to the building-wide Fire Warden role and when lift evacuation by an 'unassisted' lift mode is used. The building's Evacuation Scheme shall clearly define the roles and responsibilities of Fire Wardens and other key personnel support the horizontal and vertical movement of people.

The following steps highlight how the building's vertical evacuation may proceed:

1. Decision to move vertically: In accordance with the buildings '*RACEE*' evacuation procedure, occupants within the *firecell* of fire origin shall be evacuated away from the danger from fire and smoke. The initial strategy would be to move people horizontally to a remote *evacuation zone*. As part of the dynamic management of the fire situation, and under the direction of the Primary Lead Fire Warden, a decision to move a person vertically may be made.

2. Enacting vertical evacuation: The Primary Lead Fire Warden would direct staff to enact the written emergency management procedures and protocols for vertical evacuation. Staff would manually activate the Lift Evacuation Service Mode. Those requiring vertical evacuation would be promptly prepared to evacuate and be moved toward the lift. For patients, persons on the receiving floor would follow standard emergency procedures and prepare for the arrival of a person from the fire origin. For other persons (eg public in wheelchairs), they are assisted to exit the building.
3. Vertical evacuation via lift: The Lift Warden is given the necessary instructions from staff about the person being moved, and promptly moves the person to the receiving floor.
4. Person arrives on receiving floor: Staff on the receiving floor provide the relevant care for the person. The Receiving Floor Fire Warden actively manages the staff and other persons on this floor. For *clinical* patients, ongoing medical care is provided.

2 The need for staff training, processes, and procedures for this feature form part of the evacuation consultant's remit and the fire engineer should remain engaged with the evacuation consultant to assist in the development of this information. A means to communicate actions relating to the lift evacuation process should be provided.

In coordination with the vertical transportation engineer, the lift service modes should be defined. For a 'driver assisted lift mode' design, these may include:

- Lift Mode 1: Standard passenger transfer
- Lift Mode 2: Patient transfer (Standard patient transfer, Emergency bed transfer, Helipad patient transfer)
- Lift Mode 3: Lift Evacuation Service mode (manual mode)

The Lift Evacuation Service Mode = The operation of a selected lift under an agreed system of management and control for the evacuation of occupants in the case of fire. Normal functions of the lift would stop.

Part B – Features for Possible Consideration

As the issues raised in Part A are addressed, the details below provide features which may be relevant for the final lift evacuation details (based on a risk-based holistic fire engineering design approach.

Passive Fire safety features

Lift shafts shall be enclosed in construction which provides a fire resistance rating. The fire resistance rating for fire separations protecting lift shaft and for fire separations creating evacuation zones located between a fire location and a bank of lift shafts shall meet the fire resistance rating as specified in section 5.3.

The provision of smoke stopping and smoke rated dampers to evacuation zone boundaries etc should also be considered to delay the movement of smoke throughout the building.

Active Fire safety features

Lift shafts, lift landings and lift machine rooms should be safeguarded from fire and smoke risks during their period of intended operation.

The need for specific active fire safety features (eg fire alarm controls, smoke ventilation or pressurisation) within or near the lifts would be determined by risk assessment. The inclusion of sprinklers within the building is expected, but the spatial placement of lift(s) within the building and the provided passive fire features will influence the risk assessment.

It may be appropriate to interface the lift control with the fire alarm system to manage the risk of fire or smoke in or near the evacuation lift (eg lift shaft, lift lobby, machinery spaces).

Automatic and addressable heat or smoke detection could be provided at the top of the lift shaft and in spaces adjacent to the lift (eg lift lobbies and lift plant rooms), to automatically stop the lift use (except upon manual emergency recall switch operation).

The size of the detection zone provided by these localised detectors would be based on a risk assessment, considering the movement of people, fire, smoke, water etc.

To facilitate the management of the evacuation lift, a fire alarm visual display unit should be provided in all lift landings.

Lift system reliability including Electrical systems

The entire lift electrical and control system should be designed to avoid single failures points. This may include the provision of dedicated cabling routes to individual lift cores.

Where evacuation using lifts is a formal part of the evacuation procedures, the electrical engineer shall design the lift system to have suitable electrical robustness (which may be beyond normal *NZBC* requirements).

The provision of backup power should be provided to the evacuation lifts and any associated control equipment. The duration of this backup power supply shall be appropriate for the time period where lift evacuation would be used.

Electrical power supply to the lift should be provided through an essential services switchboard (separate to the main electrical switchboard) as appropriate for life safety systems.

All lift control equipment and signals should be run local to the lift cores they serve.

Planned or unplanned lift car maintenance should not impact all cars within the core (ie maintenance to occur on a single lift car at any one time). Key locations should have signage to warn maintenance staff of this requirement and shall be detailed in the lift specification / manual (locations to be agreed with hospital operator and lift maintenance contractor).

Lift machine spaces, lift shafts and lift landing areas outside the lift shall be monitored for the presence of smoke or high temperatures using the building fire alarm systems. If an alarm condition occurs, a signal from the lift system should inform a central hospital security point and any BMS that the lifts in this shaft are no longer ‘in service’. The relevant lift car and lift lobbies should also have visual indicators that the lift is not in service.

Risk of lift entrapment or failure

Lift cars should be provided with a local battery automatic self-recovery system, which upon total main and secondary power failure would move lift car to closest landing and open the lift door.

The additional safeguards detailed for a firefighting lift (see EN 81-72 and F5-08 GD) should be considered, which details lift features (eg lift car roof trap door and ladders) so occupants can escape if the lift car is immobilised for any reason.

Remote lift surveillance

Where beneficial to the operation of the lifts for evacuation, CCTV could be provided to lift lobbies on all floors and transmitted to the central hospital security / management point.

Communication system

A means to communicate the emergency actions between the lift warden, clinical staff and the central hospital security point to facilitate lift evacuation service mode should be considered. This communications system should align with the holistic communications approach used across the hospital / hospital campus / hospital region. This could dictate a separate system for the lift but this might not be the best outcome. This system should be separate from the normal lift emergency communication device (to an offsite service provider).

A means to communicate with emergency services (firefighters and/or central hospital security) from the lift car should be provided if deemed beneficial to the local Fire Brigade. This could be via walkie-talkie handsets provided in the Fire Control Room or similar.

Initiation and cancellation of evacuation service

The design, maintenance and operational requirements of a lift designed for an evacuation service mode should take precedence over other relevant lift details prescribed by other standards where they provide safety enhancements.

For a ‘driver assisted lift mode’ design

- The Lift Evacuation Service Mode (Lift Mode 3) should be initiated by authorised staff by a code/key/card (as agreed by the building operator) on the landing control station on each level. The means of system initiation should be provided on every lift landing and be visually indicated when in this mode (eg a digital sign within the lift car and landing control station to indicate “In Lift Evacuation Service Mode”).
- For a lift in ‘Lift mode 1’: Upon receipt of a Lift Evacuation Service Mode signal, any designated lift shall slow down and stop in a controlled manner at the first available floor. To provide audible and visual information to lift car occupants stating “Lift entering evacuation service mode. Exit the lift when doors open”. Once all occupants have exited the lift, it is to return to the level required for evacuation.
- For a lift in ‘Lift mode 2’: Upon receipt of a Lift Evacuation Service Mode signal, any designated lift to continue and complete its transfer. Once all occupants have exited the lift, it is to return to the level required for evacuation.
- Upon arrival at the evacuation floor the doors should stay open to provide adequate time for loading.
- Lift call functions to be manually controlled by authorised staff. All functions to be controlled by a device which shall be designed to prevent against unauthorized / unwanted lift use.

- Evacuation service mode shall be terminated by a manual reset by an authorized person (ie not automatically cancelled by the fire alarm system).
- Lift control modules should be provided to allow the lifts to be specifically controlled and operated during a fire emergency.

FENZ lift control

Lifts should be provided with fire recall switches in accordance with NZS 4332. These switches are provided in a location as agreed with the Fire Brigade and be placed outside each lift. Where multiple lift cars are provided in a group, each switch is to control only a single lift.

Building signage

Evacuation Plans throughout the hospital building should indicate which lifts may be used for evacuation. Fire Action Notices should specifically identify in those areas that lifts may be used for evacuation, they should reference the Evacuation Plans for lift locations and any related evacuation control procedures.

Lift signage

If a lift is removed from service (for any reason) or the fire recall switch manually operated, it shall be visually identified (using suitable static or dynamic signage) from the lift lobby on all relevant floors.

In buildings where lift evacuation is provided, all lifts should have signage in close proximity to the lift to identify if the lift may or must not be used (see positive and negative reinforcement signs).

If considered necessary, wayfinding signage may be provided in strategic locations within the building (wall or ceiling mounted) to provide general directional guidance. Signs should follow the signage protocols of NZBC F8/AS1 and may be illuminated or non-illuminated. Where used, include arrows to the sign as required.

Figure C.3: Possible Lift signs

- place in strategic locations on 'fire action notices' to facilitate general understanding
- place in strategic locations within the building (wall of ceiling mounted) to facilitate general understanding
- add arrows to the sign as required
- sign may be illuminated or non-illuminated

Figure C.4: Possible wayfinding signs

Protection from ingress of water

In addition to the water protection features defined within NZS4332, additional safeguards from the ingress of water into the lift shaft could be provided, especially when evacuation lifts are expected to be used when they are locally threatened by water. Water ingress warnings should be sent to the central hospital security point and any BMS.

Possible features to minimise ingress of firefighting water into the lift shaft are floor drains or floor slope at the threshold of the lift landing doors. Floor drains at the threshold to lift landing doors are often preferred instead of ramps in the floor surface because they interfere less with movement of beds, trolleys and other equipment with wheels. These would also prevent excessive amounts of water being redirected towards other areas in close proximity to the lift such as the stairwells. The provision of floor drains elsewhere in the building may also support the management of this risk.

Floor drains should be provided with sufficient drainage capacity, likely to be a percentage of the total sprinkler water flow. Annex N of BS 9999 provides information to keep 'firefighters lift' wells free from water which may be relevant. This standard notes within BS 9990 that the minimum flow rate from a fire main recommended in is 1,500 l/min, and this is stated as an assumed representation of likely flow rates from other sources. It also notes a (min) 25mm raised threshold at the lift landing doors.

As noted in EN 81-72 Annex D, electrical equipment within the lift shaft could be protected against water using IPx1, IPx3 and IP67 ratings.

Additional water sensors any also be warranted to manage water ingress risks and to stop the operation of the lift.

Information to be provided to the building owner

A lift O&M manual should describe how the lift system is to operate in evacuation service, the importance of proper comprehensive maintenance, and the level of checks the owner should make to ensure the system continues reliable operation. Key elements of the evacuation strategy/scheme should also be included in the O&M manual.

Lift passenger announcement

In buildings with fire alarms with voice messaging, the spoken message may include information about the possibility to evacuate utilising the lift.

System commissioning

Robust commissioning of the lift evacuation design is expected, to check end-to-end operation of the systems (refer to FPANZ Code of Practice for the Integration of Building Fire Safety Systems with other Services). The development of this information should begin during the design stage and include all relevant designers.

This commissioning should include the Evacuation Consultant (and Fire Engineer) so that any emergency policy, procedures and training details are coordinated.

Trial evacuation

Trial evacuations (detailed within the Evacuation Scheme) should include using the lift evacuation service.

Part C – Supplementary guidance

There is no specific NZ Standard for the use of lifts for the evacuation of buildings. A risk-based design approach can also consider relevant information from the following international documents:

This document specifies the additional requirements to EN 81-20:2020 for passenger and goods passenger lifts, which can be used to support faster evacuation of persons with disabilities and persons with walking difficulties, including in case of fire alarm.

- EN 81-76 (2022) – Evacuation of persons with disabilities using Lifts.
    - This document specifies the additional requirements to EN 81-20 for passenger and goods passenger lifts, which can be used to support faster evacuation of persons with disabilities and persons with walking difficulties including in case of fire alarm.
- BD 2466 (2009) – Emergency Use of Lifts for Evacuation and Fire Rescue Operations. Aspects covered in this *DGN*:
    - describes aim of reducing evacuation clearance times by using lifts for disabled occupants
    - emphasises the need to involve well trained staff and to develop a clear procedure to manage the lift evacuation for priority occupants
    - describes the control mechanisms within the lift that are important in maintaining appropriate communication and functionality of the lift(s), as well as changing the state of an evacuation lift from 'normal' to 'emergency'.
- HTM 05-03 (2006) – Part E Escape Lifts.
  This technical specification details safety rules for lifts during a fire emergency. Aspects covered:
    - redundancy considerations for available escape lifts
    - pre-determined strategy for relocating disabled occupants to the next best staging area, ensuring time between transporting occupants is minimised
    - appointment of lift wardens to take control of escape lifts
    - specially protected power supply with redundancy, segregation (between lift banks), special lift controls + communication system

- aligned fire protection systems including suitable fire rating of structural systems and control of vertical spread of fire.
- BS 9999 (2017) – Fire safety in the design, management and use of buildings – Code of practice
- This standard provides technical guidance on fire safety is provided at three different levels. This permits a design approach to be adopted that corresponds to the complexity of the building and to the degree of flexibility required. The three levels are; general approach, advanced approach, fire safety engineering
- FENZ F5-08 GD (2021) – Firefighting Operations in Lifts
- This guidance document describes the lift design considerations to support FENZ operations within multi-level buildings. It also recognises the additional opportunity to support evacuation especially for persons with limited or no mobility.

Appendix D – Helipad design (informative)

Many *hospitals* include a helicopter landing site primarily for helicopter medical transport operations. The facility may be located on or near a *hospital* site and may be at ground level (a ‘surface level heliport’) or elevated (an ‘elevated heliport’). Elevated Helipads are generally located over the In-patient building with direct access to acute *hospital* services.

Whilst the heliport is to be designed by an aviation specialist, the fire engineer should provide input / feedback into this design so that it aligns with the holistic fire safety design of the building. Additionally, this collaboration may extend to reviewing operational and emergency response documentation. In general, *hospital* heliports can be considered as normally unattended installations with reference to fire risk management.

The CAA publish Advisory Circulars (AC) which contain information about acceptable means of compliance. The applicable AC for Heliports is AC139-8 Aerodrome Design: Heliports and provides guidance on the general requirements for design and layout of heliports. Further detailed information can be found in International Civil Aviation Organization (ICAO) Annex 14, Volume II, Heliports, Chapter 6 – Heliport Emergency Response. Additional international references include UK CAP 1264, NFPA 418. Details from existing heliports installed elsewhere in NZ may also be of relevance. The approval of the final heliport details is expected to be based on stratifying the requirements of stakeholders.

Key stakeholders for the design of a heliport are expected to include:

- Local / Regional Rescue Helicopter Service Provider
- *BCA* / Peer Reviewer
- *FENZ*
- Insurer
- Building owner / operator
- Evacuation Consultant / Fire & Emergency Evacuation Advisor
- Civil Aviation Authority (CAA)
- NZ Defence Force

Fire risk management measures for the heliport are determined by the type of facility.

A ‘surface level heliport’ is expected to be positioned a sufficient distance from *hospital buildings* to avoid conflict with the movement of others entering or departing the *hospital building* and to enable the *Fire Brigade* to undertake their normal operations.

An ‘elevated heliport’ presents a number of fire safety challenges for evacuation, fire containment and fire-fighting. The fire report needs to document suitable fire safety measures for a fire located on the heliport. It is expected that should a fire occur elsewhere in the building, helicopters would not land on the heliport, or if already present on the heliport, would leave immediately.

Hospital staff who have operational access to the heliport are to be trained in the use of hand-held firefighting equipment and procedures for responding to a fire at the heliport.

Surface level heliports should be provided with suitable hand-held fire extinguishers.

The fire design features for an ‘elevated heliport’ may include:

- helideck and access/egress routes to be separated from the building below by a fire rated floor system
- two independent NZBC clause D1 compliant egress routes are to serve the helideck, provided with NZBC clause F6 emergency lighting and NZBC Clause F8 escape route signage
- fire hydrant outlet located adjacent to the access point to the helideck
- firefighting appliances suitable for liquid and electrical fires located in the vicinity of the primary access point
- provisions for capturing un-burnt split fuel / oil
- a passive fire retarding deck system (typically constructed in the form of a perforated surface or grating)
- crash box containing rescue equipment (eg adjustable wrench, fire resistant blanket, fire resistant gloves, etc.) with breakable tie on lid. (CAP 437).

Appendix E – Project documentation (informative)

Contract works documents will typically indicate comprehensive requirements for the preparation, submission and review of as-built documentation referred to within the various project specifications. This would include drawings and records of products and materials, approved substitutions, accepted alternatives and any other approved changes and deviations. System commissioning results, warranty documentation and operations and maintenance requirements including equipment manuals and operating instructions will be made available to enable continued operation of the building to meet the design intent for the lifetime of the building and performance requirements for the intended operating design life of the required systems.

Documentation and completion of as-built drawings and other requirements will typically be required for various reasons throughout the course of the design, construction and initial building operation stages. The following information is specific to fire information requirements to support regulatory approvals which includes the need for designers and product suppliers to provide regulatory approvals information that demonstrates products and systems can comply with the relevant standards and performance requirements of the project's fire safety provisions.

Product and system compliance 'Path to compliance'

It is common for various fire engineering features and systems to have their compliance with the requirements of the design (and by extension various relevant standards and the *NZBC*) demonstrated by various forms of evidence and documentation such as Product Technical Statements, datasheets, certification, and fire test information provided by the manufacturers of those systems. For example, *fire rated door sets*, *fire stopping systems*, *fire and smoke dampers*, wall/floor systems, cladding construction, etc, would be expected to be supported with sufficient evidence verifying compliance. The fire designer for the project should take a lead role in satisfying themselves that the systems proposed indeed meet the requirements of the Code, relevant standards, and the fire design by reviewing the 'path to compliance' for the construction or system concerned. This will include:

- review of the compliance claims made in product information and literature against the referenced technical documentation provided by the supplier or manufacturer
- review of any assessments or formal opinions against the underlying test reports to satisfy themselves the assessments are robust and based on relevant test information/results
- review of any test variations to check the actual construction proposed is aligned with all of the system/variations covered, and all aspects of the construction proposed are captured by either test or else formal opinion/assessment (that complies with the relevant standard)
- review of the technical documentation to make sure it is robust, does not omit any key details, and is current (not beyond the certification or reports expiry date)
- making sure the specific installation details and any ancillary construction or components align with the technical and manufacturer's requirements. For example, alignment and spacing of firestopping, service penetration within size limits, correct door frame proposed, door hardware selected from approved (tested/certified) list, etc.

This review can be greatly assisted by the supplier or manufacturer presenting their compliance information by way of a Product Technical Statement and in a clear form that robustly explains the 'path to compliance' for the specific system or item proposed, and how the datasheets, assessments and test information are connected (as opposed to simply submitting various datasheets, test reports, and assessments in bulk and without explanation).

Alternatively, this assessment can be carried out ahead of time by an independent certification body, who would provide evidence (certification) in a form acceptable to the fire engineer and the *Building Consent Authority* that the above review has been carried out and the specific element of construction or fire safety feature complies.

Appendix F – Performance-based design process (informative)

This Appendix provides guidance on what issues should be addressed in the *Fire Engineering Brief* (*FEB)*.

Preparing a Fire Engineering Brief

The flow chart in Figure F.1 illustrates a formalized process by which the *FEB* is expected to be conducted and refers to the IFEG. However, the process will vary for any particular project and steps may be re-ordered, omitted or an iterative process introduced. The fire engineer should ensure that the process actually followed is appropriate for the design or evaluation being undertaken.

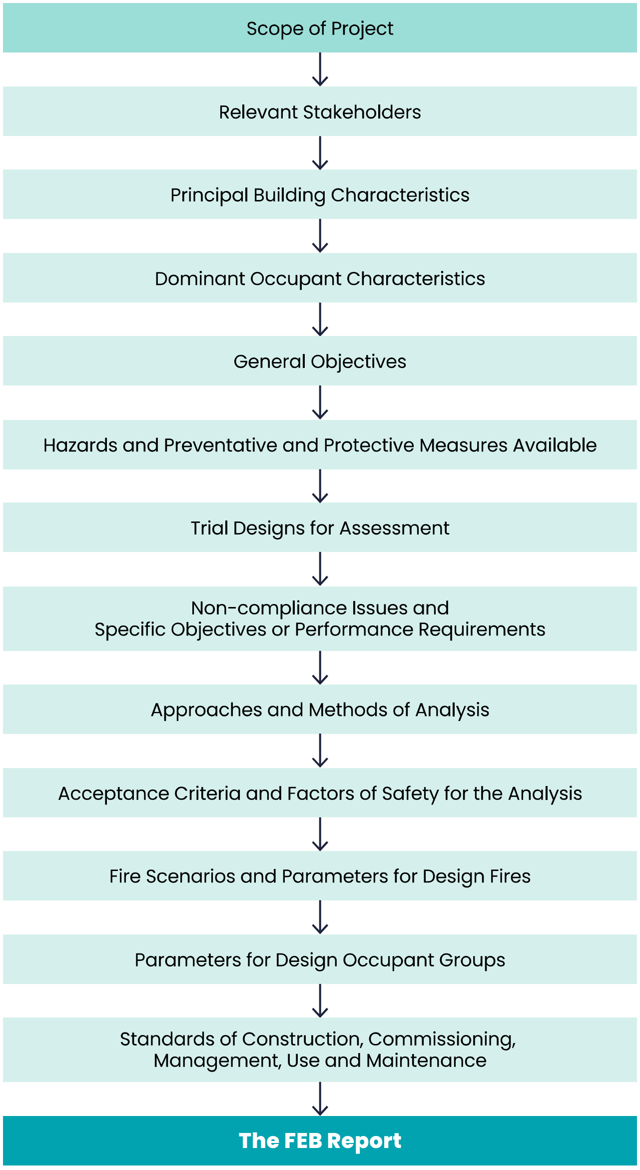


Figure F.1: A process for developing an *FEB* (from IFEG Figure 1.2)

In principle, the *FSOs*, FRs, risk analysis approach, PCs and proposed trial designs shall all be agreed before the analysis commences. However, in practice, preliminary calculations may be carried out to establish the likelihood of success before trial designs are proposed and the full analysis carried out.

Where a trial design is found, by analysis, to be unacceptable (it does not meet the objectives or performance requirements) the *FEB* process is revisited and a further trial design developed.

Sometimes, as the analysis of a design proceeds or as a project develops, it may be appropriate to revise the *FEB*, adopting the same consultative approach as with the original. The 'final' *FEB* will be incorporated into the overall report.

The following sections will go through the expected content in an *FEB.*

Defining the Scope of the Project

In order to contribute effectively to the process, each stakeholder should understand the scope and intent of the project as per points below:

- contractual context
- regulatory framework
- project schedule
- relevant stakeholders.

Principal building characteristics - In order to evaluate or design a building's fire safety system, it is important to understand the building's characteristics and its normal mode of functioning. The principal characteristics should be identified early in the *FEB* process in order to facilitate the decisions that need to be made and issues to be resolved. These are listed in Table F.1 below but are not necessarily limited to characteristics included.

Table F.1: Summary of principal building characteristics (from IFEG Section 1.2.3)

Characteristics	Examples
Occupancy building classification	Usage, particularly unusual uses
Location proximity to other buildings and boundaries	Proximity to building of high importance (eg building used for post disaster recovery) Proximity to other hazards Proximity to fire station(s) Fire services access
Size, shape & number of floors	Area of each floor General layout
Structure construction materials	Hidden voids Openings, shafts and ducts Ventilation and air movement Unusual features
Hazards	
Fire preventive and protective measures	
Management and use	Regular inspections of preventive and protective measures Training of occupants
Maintenance	Frequency and adequacy of maintenance regimes Availability of repair personnel / parts
Environmental conditions	Ventilation and prevailing internal air currents Prevailing patterns of wind and snow
Value capital	Community Infrastructure Heritage
Other	Environmental impact of a fire Firefighting concerns

Fire engineer to define the dominant occupant characteristics – Refer to Section 3 for identifying the occupant characteristics.

The Fire Engineer should define the agreed fire safety objectives for the project. In order to define the objectives, it is useful to first identify the objectives of each stakeholder (which may be different). The project objectives can be divided into three broad categories, building regulatory objectives, other regulatory objectives and non-regulatory objectives. (Refer to IFEG)

Hazard assessment

A systematic review should be conducted to establish potential fire hazards (both normal and special) of the building. The information gathered in determining the principal building characteristics forms the basis for this review.

The various preventive and protective measures that already exist, are planned or could be used to address the hazards should then be identified.

General layout	Dead end corridors Unusual egress provisions Location of hazardous materials / processes Exposures to external radiant sources
Activities	Repair and maintenance Process and construction Disregarding safety procedures
Ignition sources	Smoking materials Electrical equipment Heating appliances Unusual ignition sources
Fuel sources	Amount of combustible materials Location of combustible materials Fire behaviour properties Dangerous goods and explosives

Figure F2: Examples of hazards (from IFEG Section 1.2.6.1)

Preventive and Protective measures can be categorised as below:

- fire initiation, development and control
- smoke development and spread and control
- fire spread and impact and control
- fire detection, warning and suppression
- occupant evacuation and control
- Fire Services intervention.

Trial designs

A fire safety strategy should be developed bearing in mind many other factors, such as aesthetics, cost, ease of everyday use, speed of construction, and the importance of maintenance.

The *FEB* team should select one or more trial designs for detailed evaluation. The trial designs may incorporate measures which are not required by the relevant deemed-to-satisfy or prescriptive provisions in order to compensate for non-complying design features.

In addition, trial designs should incorporate redundancies to compensate for potential failures of components of the fire safety system of the trial design. Quantification of these redundancies should be carried out by using the sensitivity studies. Further trial designs will need to be developed in the event of the trial designs selected not meeting the required performance criteria.

Each trial design being considered should be clearly identified and all its features, including those relating to fire safety, should be described. Principal Building Characteristics and Preventative and Protective Measures should provide the necessary information for a description. This description needs to be sufficiently detailed so that the essential features of the design are readily identifiable for the purposes of the analysis and future reference.

Approaches and methods of analysis

Having determined the non-compliance issues or the relevant specific objectives or performance requirements, the next step is to select the approaches and the methods of analysis which are to be used to determine whether the trial design meets the acceptance criteria.

Methods of analysis will reflect decisions made with respect to approaches adopted. There are many forms of analysis methods:

- formulas, equations and hand calculations
- spread sheet calculations
- statistical studies
- experiments with physical scale models
- full-scale experimental tests such as fire tests or trial evacuations of real buildings
- computer simulation of fire development and smoke spread
- computer simulation of people movement.

The methods chosen should:

- be well documented (especially their limitations and assumptions) either in the literature or by the fire engineer
- be well validated
- be suitable for the task
- generate outputs that can be compared with the acceptance criteria agreed for the analysis
- have clearly defined limitations and assumptions that are well documented.

The *FEB* report should record, as appropriate, the above information for each method chosen.

Sensitivity studies, redundancy studies and uncertainty studies should be incorporated into the process of quantitative evaluation and are described below. The nature and extent of these studies may be influenced by the approaches and the methods selected. Some Examples are noted in Figure F.3 below.

Examples: Sensitivity studies
Typical examples are:

- **a design fire with a rate of growth chosen to be the most credible might be modified to have a rate of growth several times greater**
- **the capacity of smoke management equipment might be reduced to assess partial failure**
- **the movement time component of an evacuation study may be estimated using significantly lower travel speeds**
- **a building complex may have a variety of egress options such as fire stairs, fire passageways, main exists and exits to parking areas; the movement time component of an evacuation study may be conducted using only a limited**

number of exits; this would examine the robustness of the trial design with regard to alternative means of egress.
Example: Uncertainty study Fire safety equipment, such as smoke exhaust fans, will have uncertainties associated with their stated performance characteristics. An uncertainty study uses such data on uncertainties as input in order to determine the impact on the analysis.
Example: Redundancy study A trial design for a shopping centre may include provision of sprinklers, smoke control, smoke detectors, fire alarm and public address equipment amongst other measures. In the event of fire, the fire may be detected by the public or staff, smoke detectors or sprinklers. Smoke control equipment may be activated by a signal from the fire detectors or sprinklers or manual activation by staff or the fire brigade. In each case, there are multiple, redundant paths or operation. In the event that one component fails or does not operate to its full capacity, there is back up from the redundant system, and no single point of failure or situation where an equipment failure is not recognised by building managers or fire authorities.

Figure F.3: Examples Sensitivity, redundancy and uncertainty studies (from IFEG Section 1.2.9.5)

Acceptance criteria

In order to determine whether the results of the analysis of a trial design meet the specific objectives or performance requirements, acceptance criteria and associated factors of safety need to be set for the analysis and the collation and evaluation of results. Some examples are noted in Table F.2 below.

Table F.2: Typical acceptance criteria (from IFEG Section 1.2.10.1)

General Objectives	Criteria Parameters*
Protect building occupants Expected risk to life	Expected risk to life ASET/RSET margin** Smoke layer height Temperature of hot layer Radiant heat from hot layer Smoke optical density Carbon monoxide level
Facilitate fire services intervention	Radiant heat from hot layer Structural failure Water supply Resources at fire scene
Protect adjacent property	Radiant heat from fire Flame impingement
Limit damage	Monetary loss Smoke release
Maintain *Hospital* operation	Monetary loss

	Corrosive gases
Protect heritage	Monetary loss Hot layer gas temperature
Limit environmental effects	Toxicity of effluent gases Impoundment of water Expected risk to flora and fauna

Margins of safety

The magnitude of the margins of safety adopted should be based on a consideration of:

- the extent of redundancy in the trial design
- the reliability of the various components of the fire safety system
- the analysis methods used
- the assumptions made for the analysis
- the results of an uncertainty analysis
- the acceptance criteria used
- the consequences of a fire.

As some of the above may not be quantified until the analysis has been completed, actual numerical values for the factors of safety may not be determined at the *FEB* stage. In such cases the *FEB* may give guidance on acceptable values and the fire engineer will need to justify the actual values used in the report.

Margins of safety should only be applied at the end of a calculation sequence, and not throughout the analysis steps because this could lead to over conservative outcomes. In a comparative evaluation, it should not be necessary to include explicit margins of safety because the same methods and assumptions for the analysis would be used for both the deemed-to-satisfy or prescriptive design and the proposed design.

For the purposes of sensitivity studies, less rigorous margins of safety may be appropriate in order to avoid overly conservative outcomes.

Fire scenarios and parameters for design fires

Design fires need to be specified in order to carry out a fire engineering evaluation. The selection of appropriate design fires is therefore a crucial step and the validity of the data obtained by analysis and the conclusions drawn in the fire engineering evaluation rely upon the validity of the design fires.

In order to specify the design fires that are to be used in a fire engineering evaluation, three steps should be undertaken:

- determine potential fire scenarios
- from these possibilities, select the design fire scenarios to be used for developing the design fires
- for each of these design fire scenarios, specify a schematic design fire.

Parameters for design occupant groups[6]

A building may contain more than one type of occupant group and each group may contain a diverse range of individual occupants. The recommended approach is to identify the most common, influential or vulnerable occupant groups and base the analysis on these groups. The selected occupant groups are referred to as design occupant groups. This approach is similar to the selection of design fires for fire and smoke modelling.

The *FEB* team should identify the design occupant group or groups to be used for the analysis and, if appropriate, describe which group will be used in each step of the analysis of the evacuation process.

Example: Design occupant groups
In a hospital, examples of design occupant groups categories are the staff and the patients. As the design fire used for the evaluation should be based on a likely severe fire scenario (ie fire occurring at night, other possible occupant groups such as visitors may be ignored). The staff may be used as the design occupant group to assess the detection and pre-movement phases. However, it will be the patients, as a design occupant group, who will determine the movement time. The detection and pre-movement times for the staff occupant group can be adopted as the universal times for the whole or part of a hospital. The time for all patients to move to a *place of safety* will be determined by the type of patient (eg intensive care, surgery, and this may vary from ward to ward).

Figure F.4: Example design occupancy groups (from IFEG Section 1.2.12)

Standards of construction, commissioning, management & use and maintenance

The Fire safety strategy should be able to sustain over the lifetime of the building and will be highly dependent on elements other than the approved design. Such elements include:

- construction—how the design is transformed into reality
- commissioning—how the building is commissioned to become a working entity
- management and use—how the occupants and the fire hazards are managed and how the building is used
- maintenance—how the building and its fire safety system are maintained.

The *FEB* should assess any tangible measures for the above elements to be maintained over the life of the building. During the preparation of the *FEB*, all parties should agree as to what standards for these various elements should be assumed and determine how these standards might best be:

- incorporated into working documentation
- achieved during construction and commissioning
- achieved throughout the life of the building.

Analysis of a trial design

[6] Note: The terminology of occupant groups used in performance-based design is from the IFEG document and is used in a different sense to *occupant categories* from Section 3.

Typically, each building project is unique and similarly, each fire engineering evaluation is unique. It is not sensible, therefore, to set down detailed guidance on how the fire safety analysis should be undertaken. Instead, it is the responsibility of the fire engineer to plan the analysis for the particular project, based on the decisions taken during the preparation of the *FEB.*

Conducting the analysis

Figure F.5 shows the factors which will influence the analysis strategy and which will have been agreed upon in the *FEB* process. The figure also shows that the analysis process is iterative when one or more trial designs are shown to be unacceptable, that is, they do not meet the acceptance criteria set for the analysis.

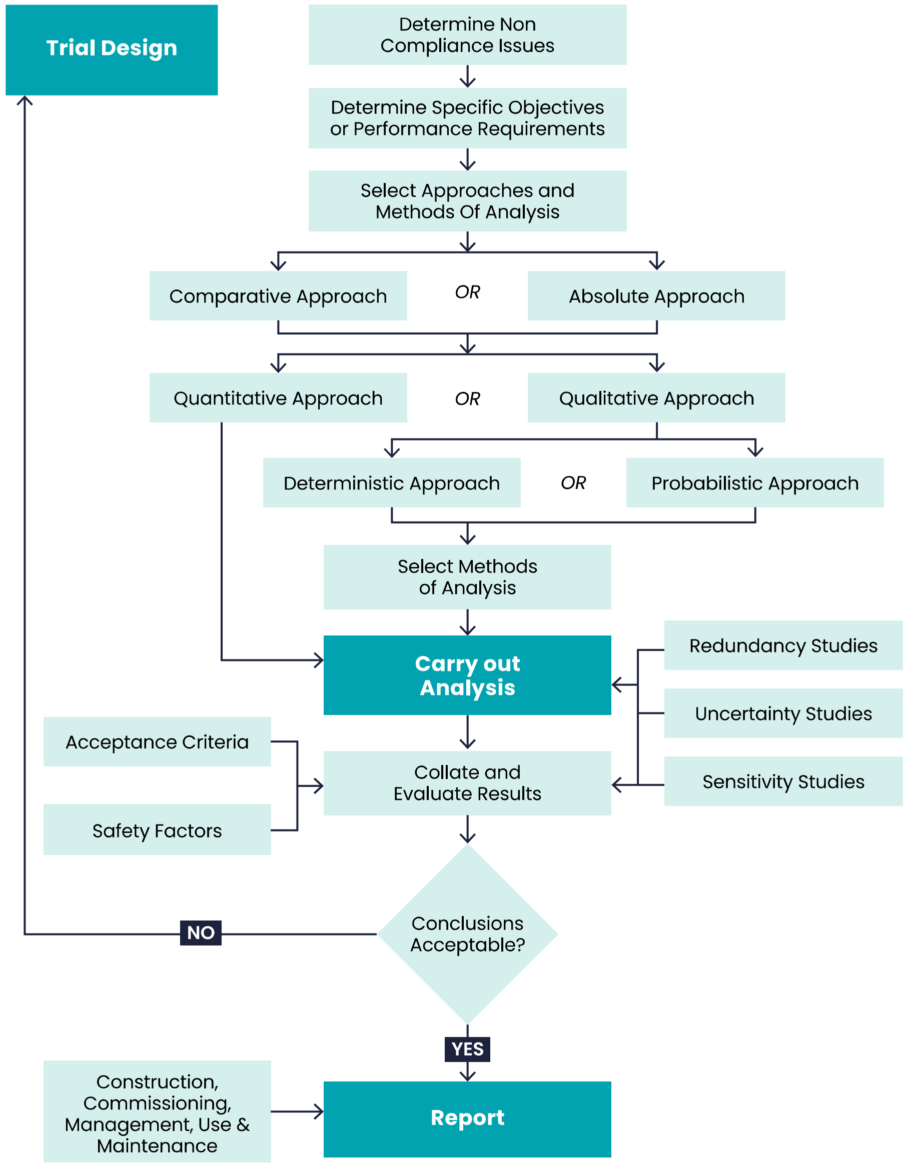


Figure F.5: Analysis of trial designs (from IFEG Figure 1.3.2)

The analysis is required to ensure various features in the building are analysed in terms of meeting the performance requirements and interactions with one another. IFEG specifies that the analysis be done by a convenient split of sub-systems as shown in figure F.6 below.

Figure F.6: Typical sub-systems recommended by IFEG

The sub-systems used in the analysis strategy are chosen on the basis of:

- the non-compliance issues
- the specific objectives or performance requirements
- the inputs and outputs of the sub-system
- the approaches and methods of analysis selected.

Appendix G – Background to occupant categories (informative)

This Appendix describes the background to development of *occupant categories* and provides a guide to the categories of occupant usually present in the different *HPUs*. The *occupant categories* are used to determine some design inputs and controls for occupant protection and/or safe evacuation in the event of fire.

A range of risk factors were considered, which influence the expeditious evacuation of occupants in the event of a fire emergency, and the timeliness of receiving assistance from a sufficient number of suitably trained staff who need to make evacuation happen safely.

The approach for developing the *occupant categories* in this *DGN* has been risk-informed, starting with a range of risk factors which influence the safety of occupants in a *hospital building*. This process developed a more relevant approach to fire safety compared with the historic, generic but vague descriptors of spaces where people are 'sleeping', or 'receiving care'.

The risk factors considered in this process were focused on occupants who need assistance to evacuate and include:

1. mobility impairment and level of assistance required: need for staff assistance to move or accompany an occupant when evacuating during a fire emergency
2. preparation/setup time to ready an occupant for movement
3. post movement setup time to stabilise or maintain healthcare to an occupant after they have been moved to a *place of safety*
4. movement speed while moving to a *place of safety*
5. cognitive reception: awareness of the situation and the occupant's surroundings and willingness to follow instructions or move
6. staff response time to reach the location where they can assist with occupant prep/setup, or post movement stabilisation or provide assistance with movement.

A weighting was applied to the risk factors, to help prioritise those factors which were judged as potentially most adversely impactful on safety, hence having the most important influence on a safe outcome during a fire emergency. This weighting was subjective, based solely on judgement and experience, and tested with input from fire engineers, *hospital building* designers and health workers with *clinical* experience. In a risk sense, the ranking is also influenced by the range of occupant vulnerabilities. That is, whether the risk factor is applicable to the singular most vulnerable occupant in the unit, or whether it is considered to represent an average value of occupant vulnerability.

A comprehensive list of the range of *Health Planning Units, HPUs,* that might be present in a large important hospital was reviewed as a prompt to test whether the list of risk factors was complete and relevant. Using the range of *HPUs* as a guide, the types of occupants most likely to be present in various spaces were ranked based on weighted risk factor totals, from most vulnerable/needing highest level of assistance (*category P1 occupants*) to those least vulnerable. The correlations between *HPUs*, the types of occupants that might be present in each, and the relevance of the fire evacuation risk factors were also tested with input from health planners, architects, and health workers with *clinical* experience.

A review of this rankings table suggested that categories of occupant could be defined with broadly similar levels of vulnerability and dependence. This approach (and number of categories) aligned with occupancy risk factors in NFPA 101A Guide on Alternative Approaches to Life Safety for Fire Safety Evaluation for Health Care Occupancies.

There is a trade-off between the range of factors and the level of specificity within a category, and the number of categories needed to capture all the variations. The fewer the number of categories, the greater the number and variety of *HPUs* that have occupants who are covered by the descriptions for each category. One of the most important design principles for *hospital buildings* is the need for flexibility and adaptability to changing needs or healthcare system demands. Therefore, the *DGN* has adopted four occupant categories, which capture enough of a variation in risk factors to make the differentiation meaningful, but still allowing an appropriately wide range of occupant types to fit within each category.

Occupants with broadly similar demands for assistance have been aggregated into groups, which in turn informed a risk ranking system for occupant categories, used for the purpose of assessing overall occupant vulnerability in a general sense. These categories are described as follows:

1. Category 1: Occupants who are not immediately movable
2. Category 2: Occupants who are movable but are dependent on assistance
3. Category 3: Occupants who are responsive, mobile but move slowly, may benefit from assistance but are not totally dependent on assistance
4. Category 4: Occupants who are responsive and can move with at least near-typical speed and range of movement, with minimal or no assistance.

The range of risk factors was initially prepared with reference to occupants in a physical healthcare environment. The risk factors were also reviewed for relevance to occupants in a mental healthcare environment. The specific disruptions of fire risk factors were adjusted slightly to be the same for occupants who might be classified as being in one or both types of healthcare.

This discussion revealed how wide the range of occupants can be within hospital departments when the occupants are classified according to fire safety risk factors. This highlighted the importance of focusing design requirements on the types of occupants that might be in a space, rather than presuming that departments typically contained occupants that could all be described with a similar well-defined set of fire risk factors. Accordingly, the *DGN* refers to spaces containing occupants of certain categories, rather than referring to the type of *Health Planning Unit* itself.

Application of these categories of occupant dependency and level of assistance needed for fire evacuation is shown in Figure G.1 for a selection of *HPUs*.

	Probable Occupant risk factors						
	A 1-3	B 1-5	C 1-3	D 1-3	E 1-4	F 1-3	
Health Planning Units (examples)	cognitive impairment	mobility impairment	staff response time	prep/setup time prior to start patient moving	movement speed while escaping	post movement setup time & need for ongoing staff supervision	Category for Level of Assistance or Dependence
Critical Care; HDU, CCU, PICU	1	1	3	1	1	1	1
Operating Unit, Interventional Imaging, Theatres	1	1	3	1	1	1	1
Intensive Care Unit	1	1	3	1	1	1	1
Renal Dialysis Unit; Chemotherapy	2	1	2	1	2	1	1
Day Surgery / Procedure Unit	1	2	3	1	1	1	1
Neonatal Care Unit	1	2	3	1	1	1	1
Cardiac Care Unit	2	2	2	1	2	1	1
Maternity Unit	2	2	2	2	2	2	2
Acute Assessment Unit	2	3	2	2	2	3	2
Paediatric Adolescent Unit	1	3	2	2	3	3	2
Emergency Unit	1	4	2	2	2	3	2
Inpatient Units: Medical, Surgical, Geriatric	2	3	1	2	3	3	3
Radiation Oncology Unit	2	3	2	2	3	3	3
Cardiac Investigation Unit	2	3	2	3	3	3	3
Medical Assessment Unit	2	4	1	3	3	3	3
Oral Health Unit	2	3	2	2	3	3	4
Allied Health / Therapy Unit	2	3	1	3	4	3	4
Rehabilitation Outpatient Unit	2	3	1	3	4	3	4
Imaging: CT MRI PET Nuclear	3	4	3	2	4	3	4
Imaging: X ray Ultrasound	3	4	3	2	4	3	4
Ambulatory Care	2	4	1	3	3	3	4
Diagnostic/Labs	3	5	0	0	0	0	
Mortuary Whanau	3	5	0	0	0	0	
Administration Unit	3	5	0	0	0	0	
Health Information Unit	3	5	0	0	0	0	
Sterile Services Unit	3	5	0	0	0	0	
Kitchen Laundry	3	5	0	0	0	0	
Loading Rubbish Bulk Storage	3	5	0	0	0	0	

Figure G.1: Categories of occupant dependency and level of assistance needed for fire evacuation

Appendix H – Evacuation scheme (informative)

When Health NZ building design and operational use are being developed, best practice is achieved through including *Fire Evacuation Scheme* requirements and the related evacuation hardware that may need to be part of the integrated building design. The emergency evacuation plans form an essential part of building usage. Engaging a project Evacuation Consultant at the early design stage will therefore increase building efficiency and safety.

Evacuation Consultant advice is informed by research, literature related to best practice and professional experience which, together with evacuation scheme guidelines and the individual building design and usage, inform emergency evacuation plans and processes.

Including suitably skilled Fire Evacuation Consultants at the building design and operational use development stage will thus support both enhanced building design as well as operational use, including emergency evacuation plans and processes.

For the same reasons, a Fire Evacuation Consultants should also be included in the early design phase of buildings with a staged handover and/or alterations with a Certificate of Public Use (CPU) element. Particularly where alarm systems and cause and effect matrices are updated.

Effective evacuation planning includes (but is not limited to) the provision/storage/access to:

- Evacuation aides such as chairs and sledges.
  - Sledges considered at a rate of 1:1 in theatres and intensive care environments
  - Chairs considered at one per patient facing stairwell per floor
  - Recessed? Interruption of continuous handrail requirements? Risers?
- Installation of hand operated firefighting equipment (HOFFE)
  - Patient facing areas?
  - Locked cabinets?
  - Recessed?
- Hazardous chemicals list (Required for Fire Safety Evacuation Scheme application)
- Alarm tones and VAD – appropriate use and installation
  - Cause and affect matrix
- Engagement with Fire Risk team at FEB stage
- They are already involved and will also be part of other design elements.
- Elements outside the Building Code
  - MCP type (locked
  - Locked doors
  - Bariatric beds
  - Other needs.

- Ongoing scheme maintenance – training / fire drills
    - Frequency of exercises to capture all staff
    - Drills to ensure all evacuation elements are considered
- Bariatric beds and other needs

Appendix I – Passive fire system design and installation (informative)

A key feature of the fire engineering design is the provision of passive fire systems. The design and installation of passive fire systems, together with their ongoing inspection and maintenance, collectively play an important role in determining how the building will perform in the event of a fire. These systems help to restrict the spread of fire and smoke or maintain the structural adequacy of the building and play a critical role in ensuring that buildings are fire safe.

Like fire engineering design, passive fire design and installation is considered to be a specialised service so that the right product is specified and installed in the right situation. This necessitates the need for suitably qualified and experienced persons to be involved at every stage of specification, approval, installation, inspection and maintenance of passive fire safety systems throughout the buildings life.

Passive fire systems can be split into two main categories.

- The first relates to building services element penetrations through fire and smoke compartmentation, detailing how to protect the penetration so that the performance of the fire and smoke compartmentation is maintained.
- The second relates to detailing construction of fire and smoke compartmentation themselves, including junctions, wall head details, substrate terminations and structural intersections.

The nature of the project will define how passive fire design and installation is to occur. Figure I.1 show two possible project pathways for specification and approval for passive fire systems. Pathway 1 is expected for most hospital projects, given their size and complexity. With this pathway, the details of the passive fire safety systems are included within the Building Consent (and Tender) documentation. Where the hospital project requires only minor/basic passive fire works, pathway 2 may be appropriate. With either pathway, it is recommended that passive fire systems selection and design maintains an element of being a 'live' detail so that any changes throughout the build phase can be documented for compliance. This possible 'construction phase design' element may be the result of discovering construction details which were only uncovered once construction started.

Table I.1 provides clarity about the various roles and responsibilities for passive fire system design. Noting the number of designers are involved in this work, early consideration and coordination is key to the projects outcome. Passive fire system design requires adequate time to research the correct product or combination of products before specifying. In some situations, time is required to fire test innovative solutions at a registered test laboratory or to consider alternative ways of designing the building.

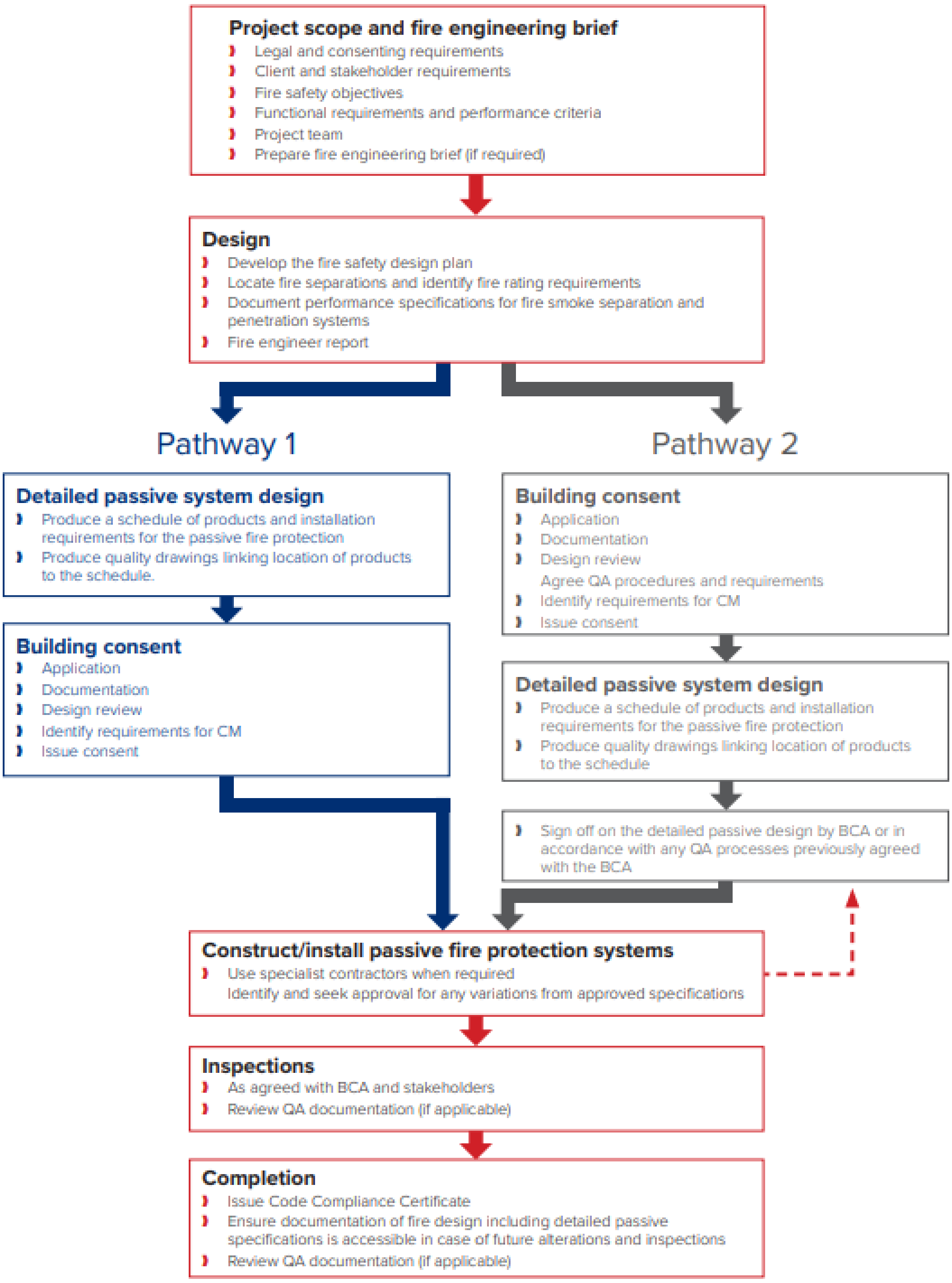


Figure I.1: Typical project process for passive fire protection, showing two paths for specification and approval.
(from FPANZ Passive Fire Fundamentals PFPS-01, and BRANZ Guide to Passive Fire Protection in Building)

Table I.1: Passive Fire Design Roles and Responsibilities

Scope/Task	Architect	Structural Engineer	Services Engineers	Fire Engineer	Other Engineers / Designers	Passive Fire Designer
1 **Selection and Coordination of Floors, Walls, & Ceilings**	Responsible for the design, based on information from wider design team	Responsible for slab design, based on information from wider design team	Provide input into how design strategies impact services	Responsible for performance requirements, based on collaboration with stakeholders	Acoustic, Seismic, Client, providing inputs to design	Assist designers with selection and detailing
2 **Structural Protection**	Responsible for the design, based on information from wider design team	Responsible for identifying elements requiring protection, based on information from wider design team	Receive inputs on limitations to service runs	Responsible for performance requirements, based on collaboration with stakeholders	Manufacturer/s to provide design inputs and detailed specification to Lead Designer	Assist designers with system selections and documentation
3 **Structural Penetrations**	Responsible for the design, based on information from wider design team	Responsible for providing information on how the structural design impacts the rest of the design i.e. movement of structure	Receive inputs on limitations to service runs	Responsible for performance requirements, based on collaboration with stakeholders	Manufacturer/s to provide design inputs to Lead Designer	Assist designers with system selections and documentation
4 **Services Penetrations**	Provide accurate substrate build up and performance criteria	Provide accurate substrate build up and performance criteria	Responsible for the design, and providing accurate information on service types, sizes, & locations	Responsible for performance requirements specific to penetrations	Acoustic, Seismic, Manufacturer/s, providing inputs to design	Responsible for specifying & coordination of fire and smoke stopping solutions
5 **Movement Joints**	Responsible for the design, based on information from wider design team	Responsible for providing information on how the structural design moves	Provide information on flexibility in service runs	Responsible for performance requirements, based on collaboration with design team	Acoustic, Seismic, Client, Manufacturer/s, providing inputs to design	Assist designers with selection and detailing
6 **Curtain Wall / Façade Details**	Responsible for the design, based on information from wider design team		Collaborate with design team regarding services runs	Responsible for performance requirements, based on collaboration with design team	Façade Engineer, Manufacturer	Assist designers with selection and detailing

Appendix J – Active fire system descriptions (informative)

A key feature of the fire engineering design is the provision of active fire systems (eg fire alarm and sprinkler systems). Given the size of most hospitals and the inclusion of a staged evacuation strategy, these systems are typically complex in the way they are designed and operate. For these systems to work properly, full and clear details need to be provided. The fire report plays a key initial role to define the fundamental elements of these systems and how they are to interact with each other and with people within the building (in order to achieve the strategic level of safety defined by the fire engineering design). This role is identified in the System Integration Process flow chart within the FPANZ Code of Practice for Integration of Building Fire Safety Systems (see Figure J.1). The information within the fire report will help other as they develop full system details such as technical specifications and drawings, operation and maintenance manuals, detailed cause and effect matrices etc. it will also facilitate the system certifier at the end of construction as the certify the compliance of the systems. With reference to NZS 4512, this fire report information will help to support the details of the fire alarm ‘declared functional requirements’.

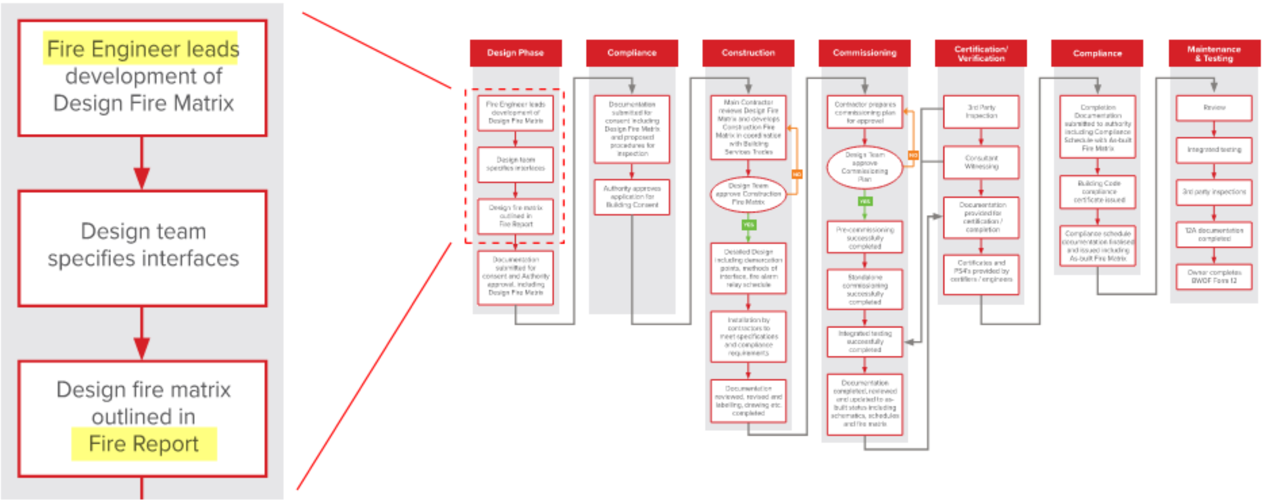


Figure J.1: Fire Engineer and Fire Report Inputs into the *Fire Systems Interface Matrix* (extract from FPANZ COP 04, Figure 1: System Integration Process flow chart)

Early engagement with both the fire systems designers, installers, maintenance contractors and certifiers is expected to be beneficial. This may start during the design stage; for example, the certifier can be used to approve design concepts and assist with interpretations of the relevant Standard, or the maintenance contractor can help clarify the operation of an existing fire system.