Fire Engineering Guidelines

Supplement to Health New Zealand | Te Whatu Ora Design Guidance Note: Fire Engineering Design for New Zealand Public Hospitals

In collaboration with Society of Fire Protection Engineers (SFPE)

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Document status

This document has been developed for use on a trial basis by Health NZ in conjunction with SFPE NZ. The purpose of this collaboration is for SFPE to seek industry feedback on the suitability of this document before feedback will be incorporated into the **DGN Fire Engineering Design for New Zealand Public Hospitals.**

Please send feedback to SFPE NZ (via comments@sfpe.org.nz).

Acknowledgements

This supplement has been developed by:

Health NZ Fire Engineering Project Panel

The panel wish to acknowledge the contribution of Prof. David Purser for his review of the chapter on Toxicity

Contents

References

The following are referenced in this document:

Legislation

- Building Act 2004
- The Building (Specified Systems, Change the Use, and Earthquake-prone Buildings) Regulations 2005

MBIE

- MBIE guidance on ANARP assessment
- MBIE guide "Requesting information for means of escape from fire for existing buildings",

Standards

- NZS 4121:2001 Design for access and mobility: Buildings and associated facilities
- ISO 13571:2012 Life-threatening components of fire

SFPE (Global)

- Purser and McAllister, 2016; SFPE Handbook of Fire Protection Engineering 5th Ed. Chapter 63
- Guide to Human Behaviour in Fire 2nd Edition (2019), Chapter 5 *Effects of Fire Effluent* and Chapter 7 *Calculation of Effects of Fire Effluent*. https://doi.org/10.1007/978-3-319-94697-9

1 Introduction

This Supplement contains further information to support the Design Guidance Note "Fire Engineering Design for New Zealand Public Hospitals", published by Health New Zealand | Te Whatu Ora (Health NZ). There are two main parts to this supplement.

The first part (Chapter 2) provides additional information to consider for performance criteria when undertaking the egress assessment. It is proposed to form a new section 13.3 in a future version of Part 3 of the Health NZ Design Guidance Note. More specifically, this part provides background information on population susceptibilities to toxicity resulting from fire.

The second part (Chapter 3) provides information to assist with application of the Design Guidance Note to existing hospital buildings. This information is intended to inform design decisions relating to fire safety and assessment of risk, to appropriately prioritise fire safety improvements on an ANARP basis (as near as is reasonably practicable) while also recognising the competing objective of allocating finite resources for healthcare services.

2 Toxicity and linkage to current Building Code requirements

2.1 Background

This chapter provides information on population susceptibilities to toxicity resulting from fire. It should be read with Section 11 to 13 (Part 3) of the Health New Zealand Design Guidance Note: Fire Engineering Design for New Zealand Public Hospitals (the DGN).

A suggested modification to DGN Paragraph 11.3.13 is as follows:
(suggested changes are marked in red):

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. A more in-depth discussion of toxicological considerations for public hospital buildings is given in Section 2.2 of this Supplement.

Changes and additions to DGN Section 13.1: (Suggested changes are marked in red**):**

This Section provides guidance to the engineer undertaking performance-based fire engineering design. The Engineer carrying out the ASET analysis is expected to use engineering judgement in selecting the relevant inputs, and performance criteria (PCs). The inputs/criteria selected and the basis for their selection are expected to be justified and supported through the FEB process.

2.2 Toxicity considerations

(This Chapter 2.2 is proposed to become Section 13.3 in a future version of the DGN.)

As stated at Paragraph 11.3.13, it is important to consider the inherent sensitivities of the population when choosing Performance Criteria (PCs) for public hospital buildings. In this section, some of the main considerations that should be taken in relation to the characteristics of the population are discussed, as well as the links between the fuel and choice of PCs. The content of this chapter is based on Chapter 63 of the 5th edition of the SFPE Handbook of Fire Protection Engineering (Purser and McAllister, 2016) and the standard ISO13571:2012 Life-threatening components of fire.

The designer often uses the default PCs for design stated in C/VM2 - Verification Method: Framework for Fire Safety Design in the fire safety design of public hospital buildings. The PCs stated in C/VM2 are:

- FED(CO) < 0.3
- FED(thermal) < 0.3
- Radiation < 10 kW/m2
- Visibility > 5 m in the room or fire origin

- Visibility > 10 m in other rooms (away from the room of fire origin)

In terms of the risk analysis approach (see Paragraph 11.3.10), C/VM2 is most similar to an absolute deterministic analysis, and special care must therefore be taken if the PCs above are to be used for any other type of risk analysis approach. It should also be mentioned that C/VM2 assumes mostly self-evacuation of occupants, which means that the PCs are tolerability limits for evacuation. If these limits are exceeded in the design, it is reasonable to expect that occupants might have difficulty evacuating of their own accord, which is a failure of the design. For some wards in public hospital buildings, patients will be assisted during evacuation. The designer might, in these cases, consider separate PCs for patients being evacuated and staff assisting evacuation, to reflect the different levels of susceptibility to hypoxic and irritant species.

Patients who are lying down while being evacuated may be less susceptible, due to lower respiration rates. However, this implies that the design can predict with reasonable confidence different staff and patients' respiration rates associated with the level of assistance provided or received.

Because C/VM2 focuses on self-evacuation, the PCs above are related to the loss of ability to evacuate, commonly called incapacitation. According to ISO13571:2012, incapacitation can occur when occupants are exposed to toxic chemical species, heat and radiation. Species are divided into asphyxiants, which influence the uptake and/or use of oxygen in the human body, and irritants, which cause painful irritation and potential inflammation and breakdown of lung tissue.

ISO13571:2012 considers carbon monoxide (CO), hydrogen cyanide (HCN) and low oxygen (low O_2) as the main asphyxiant gases from fires, with the uptake of asphyxiants being increased when high levels of carbon dioxide (CO_2) cause hyperventilation. However, low O_2 concentration is often not considered in design, as incapacitation is typically achieved much earlier for CO and HCN.

The concept of Fractional Effective Dose (FED) is often applied when considering the impact of CO and HCN. FED is a measure of the severity of the asphyxiant dose (concentration over time), as described by equations in ISO13571:2012. A FED value of 1.0 means that a person of average susceptibility is incapacitated. Lower values of FED can be used to introduce a level of conservatism in the design. For example, ISO13571:2012 states that FED < 0.3 means that approximately 11.4 % of people in society are incapacitated. FED is calculated by adding FED(CO) and FED(HCN) according to the equations in ISO13571:2012.

The dose relationship for CO follows Haber's law, which states that incapacitation occurs when the dose, which is the concentration multiplied by the exposure time cumulated over time, exceeds a specified value. A person of average susceptibility is incapacitated when a dose of 35000 ppm*min is achieved, which is called FED(CO) = 1. The PC stated in C/VM2 and Building Code C4.3, namely FED(CO) < 0.3, hence can be interpreted as 11.4 % of people in society becoming incapacitated if exposed only to CO.

The dose relationship for HCN does not follow Haber's law. A low concentration of HCN will not lead to incapacitation even for very long exposure times, but a high concentration can very quickly lead to incapacitation. In Chapter 63 of SFPE Handbook it is suggested that incapacitation will typically occur "after 20–30 min at 100 ppm HCN and after 2 min at 200 ppm, death occurring rapidly at concentrations exceeding approximately 300 ppm" (Purser and McAllister, 2016).

HCN is generated when materials containing nitrogen are combusted, e.g., polyurethane foams, melamine, polyamide, acrylics and wool. It is therefore recommended to consider HCN for public hospital buildings if there is reason to suspect that the chosen design fire will generate HCN exposure concentrations close to or exceeding 100 ppm. An example would be if mattresses made from nitrogen-containing foam is the main fuel source. Similar to what was described for CO, FED(HCN) = 1 is the incapacitation of a person of average susceptibility and FED(HCN) < 0.3 can be interpreted as 11.4 % of people in society becoming incapacitated if exposed only to HCN.

Some wards of public hospital buildings may have patients that are more susceptible to asphyxiants than the general populations, e.g., many patients of a ward can belong to the 11.4% of the populations that would be incapacitated at FED < 0.3. Chapter 63 of the SFPE Handbook mentions patients with heart conditions, e.g., patients suffering from angina, as well as asthma patients as being more susceptible to hypoxic species. Children are also known to be more susceptible to hypoxic effects. It is suggested in ISO 13571 that FEDs of 0.1 or 0.2 might be used to accommodate more sensitive groups, and in Chapter 63 of SFPE Handbook it is suggested that FED of 0.1 can be used “for particularly sensitive groups (such as for those in health-care premises)” (Purser and McAllister, 2016). However, it is also acknowledged in the chapter that the value of FED can grow rapidly from 0.1 to 0.3, particularly for fast growing flaming fires in small volume spaces, which means there might be only a short difference in the time when FED reaches 0.1 and 0.3.

Fractional Effective Concentration (FEC) is often applied when considering the impact of irritants, e.g., halogen acids, SO_2, NO_2 and organic irritants. FEC is a measure of the severity of exposure of irritant species, as described by equations in ISO13571:2012. A FEC value of 1.0 means that a person of average susceptibility is incapacitated, and FEC < 0.3 can be interpreted as approximately 11.4 % of people in society becoming incapacitated. FEC is calculated by adding FEC for the different irritants according to equations in ISO13571:2012.

As can be seen above, irritancy is not expressed in terms of an FEC value in C/VM2. However, the visibility criteria, particularly the 5 m visibility, are arguably linked to levels of severity of irritancy of typical fire gases. As stated in Chapter 63 of the SFPE Handbook, researchers have attempted to determine an optical density threshold that can be used as a proxy for irritant species concentration, which has resulted in a suggested tenability limit of 0.08 to 0.2 OD/m (or approximately 5 to 10 meters of visibility). The link between visibility and irritancy means that the visibility should be evaluated as a point measure, e.g., visibility at the location of an occupant, and not viewed as the distance that an occupant can see through smoke in the direction of travel.

Some hospital populations are known to be more impacted by irritant species. Chapter 63 of the SFPE Handbook states that “Asthmatics and sufferers of other lung conditions, such as chronic bronchitis and reactive airways dysfunction syndrome, are particularly susceptible to bronchoconstriction on even brief exposure to very low concentrations of irritants, with distress, severely reduced aerobic work capacity, collapse, and death resulting, depending on the sensitivity of the individual and the severity of the exposure.” (Purser and McAllister, 2016)

The effect on the human body from hypoxic and irritant species can be both physiological and pathological. Physiological effects develop rapidly, i.e., seconds to minutes, and affect immediate vital functions, e.g., vision, respiration, circulation, movement ability, and consciousness, and can cause severe pain. FED and FEC are tools to quantify physiological effects, as these effects impact people’s ability to self-evacuate. Pathological effects are slower to develop, i.e., hours, days, or years, and affect longer term functions of organ systems, which can lead to adverse health effects or death.

Pathological effects are seldom considered in fire engineering design but may be relevant to consider for some wards in public hospital buildings. For example, a common consequence of exposure to fire gases is post-exposure lung inflammation. As mentioned in Chapter 63 of the SFPE Handbook "elderly subjects in particular have been found to be vulnerable to the development of fatal pneumonia from lung infection." (Purser and McAllister, 2016) For patients who may not survive these types of pathological effects, e.g., elderly or neonatal patients, it is considered important to take account of possible long term effects of smoke exposure. Chapter 63 of the SFPE Handbook (p. 2345) describes equations that can be used to explore post-exposure lung inflammation and survival rates. The severity of post-exposure effects of inhaled irritant gases and smoke particulates is dose related, and those with lung conditions are more susceptible (Purser and McAllister, 2016).

For most wards in public hospital buildings, it is considered appropriate to use the PCs from C/VM2 for deterministic risk analyses. However, it is important that visibility criteria (usually the most cautious of the PCs) are used as proxies of irritancy as described above. A slightly lower value of FED(CO) < 0.1 is only likely to be relevant when it is necessary to considering slow growing fires or smouldering combustion in spaces where occupants are sleeping, staff surveillance is limited and where photoelectric smoke detectors are not present. The reason for this is that the time difference between reaching FED =0.3 and FED = 0.1 is expected to be very small for fast-growing flaming fires.

It is important to carefully consider if additional specific PCs are needed for wards containing occupants with increased sensitivity to the hypoxic or irritant species in smoke. Some of the most relevant sensitivities are mentioned above (e.g. as discussed in Chapter 63 of the SFPE Handbook). The designer should consider (as part of the FEB process) to what extent these sensitivities exist and if/how they should influence the choice of PCs in the design.

Additional information on the effects of fire on occupants while escaping from fire is also included in the SFPE Guide to Human Behavior in Fire, Chapters 5 and 7.

2.3 Summary

On the basis of the study described above, and in the absence of contrary advice (from Te Whatu Ora Health NZ, or MBIE), this guidance recommends the use of FED_{CO} = 0.3 as a realistically cautious acceptance criteria for all occupants in hospital buildings except those listed as follows.

An acceptance criteria of FED_{CO} = 0.1 is suggested for occupants who are:

- patients who are asthmatics or suffering from adverse lung conditions such as chronic bronchitis and reactive airways dysfunction syndrome, or
- patients more susceptible than the general population to asphyxiants or irritant species or hypoxic species, or
- patients suffering from heart conditions e.g. angina, or
- children

Consideration should be given to reducing the risk of exposure to HCN by reducing the likelihood of involving in fire those materials which produce nitrogen when combusted, e.g. polyurethane foams, melamine, polyamide, acrylics, wool and mattresses made from nitrogen-containing foam.

3 Application to existing buildings:

3.1 Background

This chapter provides further information on prioritisation and ANARP principles for alterations to existing buildings. It should be read in conjunction with Section 1.9 of the Health New Zealand Design Guidance Note: Fire Engineering Design for New Zealand Public Hospitals (the DGN).

3.2 Fire Safety Compliance and Societal Expectations in Healthcare

Assessing the fire safety compliance of an existing hospital needs a holistic risk assessment which considers the key factors which influence fire safety. These key factors include the:

- emergency evacuation features, policies and procedures, which include the layout and design of escape routes
- 'active' fire safety systems (eg sprinklers, fire alarm and hydrants)
- 'passive' fire safety systems (eg fire separations, smoke separations)

The final fire safety strategy for the hospital will be based upon how each of these factors are incorporated into the building in a complementary and coordinated way around the expectations of the Building Act.

The Building Act places responsibility on the building owner to actively manage fire safety through the life of the building. The Act assumes that the building was suitably designed, documented and constructed in a compliant way, is maintained accordingly, and is strategically improved when reasonable to do so throughout its life. As recognised by the MBIE guide "Requesting information for means of escape from fire for existing buildings", it is recognised that the adequacy of the fire safety strategy may decrease with time and that the buildings fire safety strategy should be periodically revisited. Examples of this change include operational changes to the way the building is used or managed, normal degradation of the building fabric and systems, or due to our changing legislative expectations. This same document supports the approach to assess old buildings, where their design and construction may reflect a past building regulatory regime, and/or the building information may be poor. Ultimately, a fire safety strategy which suitably reflects the current state of the building is an important and fundamental document to permit the ongoing maintenance of the building and a design-basis for any future alterations within the building.

The concept of ”As Nearly As is Reasonably Practicable” (ANARP) is a fundamental principle and legal requirement of the Building Act. ANARP is to be addressed in an appropriate way when:

a) an existing building is ‘altered’ which triggers a Building Consent (ref: Section 112 of the Building Act)
b) an existing building is subject to a ‘change of use’ which triggers a Building Consent (ref: Section 115 of the Building Act)

Additionally, it may also be reasonable/suitable to apply ANARP in existing buildings even when no Building Consent is required for an alteration, say when voluntary minor life safety improvements are to occur.

A hospital "means of escape from fire" assessment focuses on the three key factors noted above, with compliance being on ANARP grounds. ANARP will be dependent on multiple factors, including:

- the sacrifice of undertaking any 'work'
- the life safety benefit that this 'work' may provide, and
- the consequence that not undertaking 'work' might have

ANARP is a subjective construct based around the management of life safety risk. Life safety as a result of fire is a sub-set of ‘societal safety’. When managing fire safety risks within buildings, consideration also should be given to the societal expectation for good healthcare delivery and outcomes. A balance will always need to be found between the level of investment provided to buildings and those provided to the delivery of healthcare services. This balancing may occur using formal or informal cost-benefit analyses. An obvious outcome is that priorities will likely need to be set based around the short, medium, and long-term needs of both the building and healthcare provisions. Having accurate information about the fire safety within the building (as per the MBIE Guide above) is expected to provide the building owner with information suitable to make decisions about these multiple expectations.

ANARP is to be considered in a systematic review against the collective expectations of Building Code clauses C1-C6, (ie. not just a compliance discussion about a single feature of a building, say a fire collar on a pipe). Fire engineers are expected to be best placed to undertake this holistic C1-C6 assessment.

Good practise when considering ANARP is to seek life safety improvements during every consent. There would typically be something, no matter how small or large, which could be done to improve safety. ANARP is ultimately “a negotiation” with the building owner as to how much risk they consider is reasonable and justifiable to have within their building.

The parties involved in this negotiation are typically:

- The Building Owner / Operator: who is ultimately responsible under the Building Act (and other legislation) for the ongoing use of the building and the safety it provides for those within and around the building. They decide on what options are to be presented by the design team to the BCA for their review and NZBA approval.
- The Fire Engineer: who alone or with assistance from others, will assess the fire compliance of the entire existing building against today's NZBC requirements. They will highlight the life safety risks resulting from existing non-compliant building features to the building owner (and design team if relevant). They will present options for improvement, which may be prioritised on a ‘sacrifice vs benefit’ arrangement to facilitate the building owners decision.
- The Building Consent Authority (or TA): who is ultimately responsible for checking that the Building Act is complied with. They may agree or disagree with the building owner on what is ANARP compliant (eg. and grant a building consent, or not).

It is recommended to discuss how existing building fire compliance is to be addressed for any building work as early as possible during the project planning or design stage. These discussions may include a pre-lodgment meeting between the building owner, fire engineer and Building Consent Authority.

3.3 Categorising hospital building and occupancy risk

3.3.1 Aligning fire system effectiveness with hospital performance requirements

Regardless of whether designing a new building, or altering an existing building, creating a design solution using a prescriptive compliance document or an engineered solution based on performance objectives and compliance verification, all hospital fire engineering designs need to balance the requirements for fire safety with the fundamental aim of providing healthcare services. Usually, this balancing process is implicit rather than explicit. New buildings usually have fewer design constraints than making alterations to existing buildings, especially when new healthcare services are introduced into an existing building that was not originally designed for that purpose. When faced with physical or financial constraints for a new building, or when comparing cost, benefit and safety for alterations to an existing building it is helpful to be able to establish fire safety features priorities.

One way of doing this is to consider the performance requirements that are specific to a hospital building and rank the various design process, design solutions and fire safety features that can be specified in terms of how well they contribute to meeting both fire safety and healthcare needs. Approaching any hospital design project in this way helps to clarify which fire safety systems deliver best value in meeting the project needs.

This concept design process is also useful to identify those fire safety features which may be fundamentally necessary to address fire risks as they relate to the type of health planning unit and associated occupant vulnerability that the building needs to accommodate.

Section 2 of the DGN describes the fire safety design principles that apply to hospital buildings. Together with a list of high level, hospital-specific fire risk factors, these principles have been used as the basis for a list of performance requirements for hospital fire safety design. Chapter 3 of this DGN describes the four categories used to classify the level of occupant dependency for assistance with evacuation in a fire emergency. The different occupant categories require different levels of assistance and staff resources. A risk matrix approach is described in the following section in this supplement to assist with ranking and prioritising design process, solutions and fire safety features in terms of their effectiveness in meeting various overall hospital performance requirements. However, the availability of assistance and staff resources is not directly included in this matrix, even though this has a significant influence. This influence should be considered on a project specific basis as part of the process of comparing cost, benefit and importance of design features.

> The number of vulnerable occupants and number of staff available to assist with evacuation will influence and be influenced by the size of the building, the simplicity or complexity of evacuation procedures and the need or not for a range of fire safety features and systems such as extent of firecell compartmentation, sophistication of detection systems and means for communicating with staff assisting.

3.3.2 Principal hospital fire risk factors

The fire risk factors for hospitals can be described in general terms as follows:

- Immediate and total evacuation of a hospital is a challenging exercise and not desirable from a patient and staff safety perspective

- Hospital patients may be more susceptible to the effects of exposure to smoke
- Hospital fire risk can be broadly categorised by occupant vulnerability (occupant dependency category from DGN Section 3) and the corresponding relationship with health planning units.

The ability to assist, evacuate or rescue occupants is related to the number of people in each occupant category and their escape height in the building. A combination of these factors can be used to classify a building or part of a building in terms of overall hospital fire risk: e.g. low, medium, high, or very high.

3.3.3 Hospital Building Risk matrix

A relative risk ranking can be applied on a building-wide basis when evaluating fire risk of an existing building for hospital use. This Hospital Building risk is assessed on the basis of:

- occupant category as defined in the DGN (and location in the building)
- number of occupants in various occupant categories
- building escape height

The building risk increases from low, to medium, to high (or very high) as the building escape height increases and/or occupants are present who need staff assistance to evacuate to a place of safety, as illustrated in Figure 3.1 below.

A low risk and medium risk classification applies only if all building occupants evacuate to a place of safety outside the building (i.e. no occupants evacuate to an internal place of safety).

Where the number of occupants is small and none of the occupants are Category P1 or P2 those hospital buildings can be classified as (relatively) low risk (in other words, none of the occupants are strongly dependent on assistance for means of escape from fire), or where the building escape height is not tall. For hospital buildings containing only Category P3 (or P4) occupants, the evacuation procedures may not require these occupants to evacuate to an internal place of safety.

Occupant vulnerability: escape & rescue		Escape height for the occupants		
		Single level	Up to 10m	> 10m
Total number of Cat P3 occupants in the building	up to 50 people			
Total number of Cat P3 occupants in the building	> 50 people			
Total number of Cat P2 occupants in the building	up to 8 people			
Total number of Cat P2 occupants in the building	> 8 people			
Total number of Cat P1 occupants in the building	1 person			
Total number of Cat P1 occupants in the building	> 1 person			

	Low Risk (provided no occupants evacuate to an internal place of safety)
	Medium Risk (provided no occupants evacuate to an internal place of safety)
	High Risk: (sprinkler system needed)
	Very High Risk: (sprinkler system needed)

Figure 3.1 Hospital Building Risk matrix
(function of occupant vulnerability and escape height)

3.3.4 Hospital fire performance requirements

To address the risk factors and risk ranking described in the previous sections, hospitals need to meet a range of general design requirements, written in performance terms. The performance requirements are listed in Table 3.1, ranked loosely in order of decreasing importance (the most important at the top of the list). The fire performance requirements that would normally be expected to be provided for each Hospital Building Risk ranking are also indicated in Fig.3.2 Existing buildings: Prioritisation matrix.

Depending on the particular building and health planning units provided, some or all of these may be needed, as well as additional requirements, depending on specific project constraints.

Table 3.1 Hospital building fire performance requirements (outcomes)

1. Hospital buildings that accommodate occupants who cannot/should not be evacuated directly to a safe place (outside) need to be subdivided to provide internal places of safety.
2. Limit the number of patients that must be evacuated in the initial phase of evacuation
3. Control spread of smoke into internal places of safety
4. Control spread of fire (conductive and radiant heat) into internal places of safety
5. Fire and evacuation strategy provides Category P1 to P3 occupants (with no or limited mobility) with escape routes to internal places of safety on the same level, regardless of fire location.
6. Fire and evacuation strategy provides Category P1 to P3 occupants with more than one phase of progressive horizontal evacuation.
7. Design escape routes so all occupants can always move away from a fire, or from an internal place of safety to a place of safety on a level below and to an external place of safety regardless of fire location.
8. Occupants can be safely evacuated within a reasonable upper limit time period (consistent with minimum limit agreed on number of staff who can assist).
9. Building fire systems support implementation of the RACE procedure.
10. Fire systems allow staff to alert other staff to the presence, location and nature of the fire emergency.
11. The evacuation strategy and associated fire safety systems acknowledge that vertical evacuation of occupants who need assistance is only carried out if a fire cannot be controlled.
12. In hospitals with vulnerable occupants on upper floors, lifts can be used to assist with evacuation of occupants requiring a high level of assistance.

3.3.5 Fire safety systems and design strategies

Various fire design strategies can be applied and fire safety features provided to mitigate risk and contribute to the performance requirements listed in Table 3.1. These are listed in Table 3.2.

Table 3.2 Risk mitigation fire safety systems and strategies for existing buildings

S1	Integrate/coordinate fire design & evacuation strategy with the hospital building design and expected staff/patient ratios
S2	Provide internal firecell subdivision for internal places of safety using an arrangement of separate evacuation zones, firecells, smokecells
S3	Design rooms and ancillary spaces adjacent to patient areas so that smoke from a fire can be 'contained' (by simply closing the door) for sufficient time to move patients away from the threat
S4	Provide at least two escape routes so all occupants can always move away from a fire, either to a safe place, or to a place of safety inside the building on the same level and alternate escape routes are provided from internal places of safety that lead to a safe place, regardless of fire location
S5	Provide fire separations and smoke separations and escape routes of adequate minimum width to accommodate the necessary equipment and staff assistance
S6	Provide fire separations and smoke separations and control on maximum escape route distance to adjacent places of safety/evacuation zones
S7	Provide a minimum of two fire-protected stairways, located so that if means of escape to one stairway is obstructed, occupants have an alternative egress route to another stairway
S8	Provide at least two evacuation zones on the same level for Category P1 to P3 occupants
S9	Provide at least three evacuation zones on the same level for Category P1 to P3 occupants
S10	Provide separation walls and floors to control spread of smoke and fire between evacuation zones
S11	Provide separation walls to control spread of smoke within evacuation zones
S12	Install/verify fire stopping of building services penetrations with appropriate quality assurance for evacuation zone boundary fire separations and safe path stairs
S13	Install/verify fire stopping of building services penetrations with appropriate quality assurance for other escape route and firecell fire separations
S14	Install/verify fire stopping of building services penetrations for fire separations within evacuation zones
S15	Control fire spread properties of internal surface finishes
S16	Control fire spread properties of external wall finishes
S17	Provide automatic fire suppression (sprinklers)

S18	Provide early detection and warning of fire to allow staff time to respond and evacuate occupants to a place of safety: automatic smoke detection
S19	Provide detection and warning of fire to allow staff time to respond and evacuate occupants to a place of safety: automatic heat detection
S20	Provide automatic detection of the specific location of smoke
S21	Provide staff intercommunication system
S22	Provide mechanical pressurisation (differential air pressure) systems to control spread of smoke
S23	Provide hydrant systems to assist firefighters to control a fire that has not been controlled by sprinklers nor occupants
S24	Provide elevator controlled by staff or firefighters for evacuating occupants who cannot use stairs
S25	Fire separate different clinical and non-clinical HPUs
S26	Fire separate areas of higher fuel load or fire risk from patient sleeping areas
S27	Reduce risk by limiting the residency time (ie the design life) of those HPUs which are vulnerable to high fire risk.

Notes for Table 3.2:

1. Coordinate the design with hospital management so enough staff can attend at the fire location to move all occupants to an adjacent evacuation zone within 5 minutes (or less) of fire notification. This is not suggesting an acceptance level for safe evacuation. Instead it is suggesting that staff who cannot arrive and assist at the fire location within the proposed time limit would not be counted in the number of staff usefully available.
2. Includes smoke stopping to control spread of ‘warm’ smoke (e.g. from a smouldering fire).
3. Safety of lift evacuation is influenced by size of floorplate, number of evacuation zones on floor plate, number of lifts and their separation distance, staffing arrangement.

> Table 3.2 is not an exhaustive list of fire safety features that could be specified. Depending on the design of the existing building, some of these fire safety features may be more or less effective than in other cases.

Depending on the type of HPU proposed for an existing building, some of these features may not be important. This building-specific influence will affect the effectiveness (benefit) of some fire safety features when compared to others. The effectiveness with which a fire safety feature contributes to achieving one or more of the design performance requirements determines the value of providing that fire safety feature. This ‘value ranking’ varies depending on the specific building and the types of HPU provided in that building. The cost of providing the fire safety feature also varies according to specific circumstances – in particular, whether the building is a new construction or involves an alteration to an existing building.

For alteration of existing buildings (and for new construction) it can be helpful to rank the fire safety features in terms of effectiveness (benefit). The fire safety features and systems which provide highest value are those which provide greatest benefit by contributing to many of the most important performance requirements and at ‘acceptable cost’. The ‘acceptable cost’ should consider not only the cost of providing the fire safety system but also the sacrifice of not being able to provide the relevant healthcare service that would be enabled by the design.

For new construction, the cost of providing a specific fire safety feature can be estimated with reasonable precision and confidence. For alteration of an existing building, estimating the cost will depend on the particular building (building location, minor or major alteration scope, project time frame, etc.).

One example of how fire safety features might be ranked in terms of effectiveness in meeting the hospital performance requirements is shown in Fig. 3.2, Prioritisation matrix. In this matrix the Hospital Performance Requirements are listed in the left-hand column, ranked more or less in order of decreasing importance.

The range of fire systems and strategies that could be used are listed along the top row. Note that the list of fire systems and strategies are not listed in any particular ranking order. The applicability of some systems is also dependent on the HPU relevant to the existing building design.

A tick mark in the matrix indicates that this fire system is likely to contribute in a meaningful way to achieving the hospital performance requirement (this is a subjective judgement – there is no requirement for verification or proof). The fire systems and strategies that provide the most tick marks, and importantly contribute to the performance requirements (outcomes) near the top of this matrix, represent the highest contribution to improving fire safety in the existing building. These should be valued accordingly in any compliance or project feasibility review carried out on an ANARP basis.

Not all of these requirements will apply to all existing buildings (e.g. some buildings will not have more than one level; some buildings will not contain Category P1, P2 or P3 occupants).

Note that at feasibility assessment or concept design the relative beneficial influence of a particular fire system (e.g. sprinklers) may not be known because the project specific circumstances are not fully defined (e.g. ANARP considerations around condition of existing building, water supply constraints, type of HPU that might be proposed for an existing building, etc).

Figure 3.2 Existing buildings: Prioritisation matrix for fire safety systems and strategies for life safety

✓ Indicates that the fire safety system or strategy is likely to make a meaningful contribution towards achieving the performance outcome listed in the left-hand column (the actual value for each system will be project specific). Refer to Figure 3 for key to colours.

Fire safety systems and strategies (contribute to achieving performance outcomes)		S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20	S21	S22	S23	S24	S25	S26	S27
Hospital performance requirements (outcomes)																												
1. Hospital buildings that accommodate occupants who cannot/should not be evacuated directly to a safe place (outside) need to be subdivided to provide internal places of safety.	Yellow, Red, Purple	✓	✓	✓	✓	✓	✓		✓		✓		✓					✓	✓		✓	✓				✓		
2. Limit the number of patients that must be evacuated in the initial phase of evacuation	Green, Yellow, Red, Purple	✓	✓	✓	✓			✓	✓		✓	✓	✓			✓	✓	✓			✓	✓				✓	✓	✓
3. Control spread of smoke into internal places of safety	Yellow, Red, Purple	✓	✓	✓					✓		✓	✓	✓			✓		✓					✓			✓	✓	
4. Control spread of fire (conductive and radiant heat) into internal places of safety	Yellow, Red, Purple	✓	✓						✓		✓		✓					✓						✓		✓	✓	
5. Fire and evacuation strategy provides Category P1 to P3 occupants (with no or limited mobility) with escape routes to internal places of safety on the same level, regardless of fire location.	Yellow, Red, Purple	✓	✓		✓	✓	✓		✓		✓		✓					✓								✓		
6. Fire and evacuation strategy provides Category P1 to P3 occupants with more than one phase of progressive horizontal evacuation.	Yellow, Red, Purple	✓	✓		✓	✓	✓	✓		✓	✓			✓				✓				✓	✓					
7. Design escape routes so all occupants can always move away from a fire, or from an internal place of safety, to a place of safety on a level below and/or to an external place of safety regardless of fire location.	Green, Yellow, Red, Purple	✓	✓	✓	✓	✓	✓	✓	✓		✓		✓								✓							
8. Occupants can be safely evacuated within a reasonable upper limit time period (consistent with minimum limit agreed on number of staff who can assist).	Green, Yellow, Red, Purple	✓	✓	✓	✓	✓	✓		✓		✓	✓	✓			✓		✓	✓	✓		✓				✓		
9. Building fire systems support implementation of the RACE procedure.	Yellow, Red, Purple	✓	✓	✓	✓	✓	✓		✓		✓	✓			✓	✓			✓	✓		✓						
10. Fire systems allow staff to alert other staff to the presence, location and nature of the fire emergency.	Green, Yellow, Red, Purple	✓																✓	✓	✓	✓	✓						
11. The evacuation strategy and associated fire safety systems acknowledge that vertical evacuation of occupants who need assistance is only carried out if a fire cannot be controlled		✓	✓		✓	✓	✓			✓	✓						✓	✓					✓	✓		✓	✓	
12. In hospitals with vulnerable occupants on upper floors, lifts can be used to assist with evacuation of occupants requiring a high level of assistance.		✓																✓				✓			✓			

3.4 Building assessment and fire design process

3.4.1 Introduction

Alterations of existing Hospital buildings are relatively common as needs change due to new technology, changing population demographics, specific health related events, or assets nearing their viable end of life and requiring refurbishment or revitalisation. It is important therefore for Health NZ, building design professionals and building consent authorities to understand the requirements for altering an existing hospital building.

Altering an existing building can trigger requirements such as:

- complying 'as nearly as is reasonably practicable' (ANARP) with current Building Code requirements for:
  - means of escape from fire (referred to here as 'fire')
  - access and facilities for persons with disabilities (referred to here as 'accessibility')
- ensuring the building continues to comply with the Building Code to at least the same extent as before the alteration, and
- undertaking seismic work so that the building is no longer earthquake prone (for a substantial alteration (defined in regulations) to an earthquake-prone building).

This section of the Supplement helps determine the requirements for proposed alterations to existing hospital buildings, whether earthquake-prone or not, and how these can be met. This information does not replace the decision-making responsibilities of BCAs in relation to alterations to existing buildings.

New building work associated with an alteration must comply with the Building Code. This advice does not apply to establishing compliance of new building work with the Building Code.

3.4.2 Managing hospital building alterations

The regulations for managing hospital building alterations are primarily contained in sections 112 and S115 of the Building Act, and section 133AT of the Building Act for earthquake-prone buildings.

Under the Building Act 2004:

- Section 112 sets out the requirements for altering an existing building that is not earthquake-prone.
- Section 115 sets out the requirements for changing the use of an existing building that is not earthquake-prone
- Section 133AT sets out the requirements for altering an existing building that is earthquake-prone, issued with an earthquake-prone building notice (EPB notice). This must be used instead of section 112.
- Schedule 2 and Section 118 set out the types of buildings to which the requirement to upgrade access and facilities for persons with disabilities applies. Section 7 defines a person with a disability. Sections 117, 119 and 120 are also relevant for applying the accessibility requirements.

- Section 7 defines means of escape from fire. The upgrade requirements for means of escape from fire apply to all existing buildings undergoing an alteration.
- NZS 4121:2001 is an Acceptable Solution to the Building Code for accessibility requirements.

Regulations:

- The Building (Specified Systems, Change the Use, and Earthquake-prone Buildings) Regulations 2005 define the term ‘substantial alterations’ for earthquake-prone buildings subject to section 133AT of the Building Act.

Certain clauses in the Building Code relate to building alterations:

- means of escape from fire – clauses C3.4, C4, C6, D1, F6, F7, F8.
- access and facilities for persons with disabilities – clauses D1, D2, F7, F8, G1, G2, G3, G5, G9, G12.

3.4.3 Requirements of sections 112 and 133AT of the Building Act

Sections 112 and 133AT require:

1. The building's overall compliance with the Building Code (including other applicable clauses in addition to fire and accessibility, such as structure) must not be less than what it was prior to the alteration taking place.
2. The whole building needs to be upgraded so that it complies as nearly as is reasonably practicable with the current Building Code clauses for fire and accessibility (if applicable under section 118 of the Building Act).

   The applicable Building Code clauses for Means of escape from fire are:

   - C3.4 Fire affecting areas beyond the fire source
   - C4 Movement to place of safety
   - C6 Structural stability
   - D1 Access routes
   - F6 Visibility in escape routes
   - F7 Warning systems
   - F8 Signs
3. If the building being altered is earthquake-prone and the alteration is a substantial alteration, section 133AT of the Building Act also requires the alteration to include the necessary seismic work so the building is no longer earthquake-prone.

If buildings do not meet requirements 1 and 2, territorial authorities do have discretion to grant a building consent for a proposed alteration that does not comply. The criteria that must be met to apply this discretion are different for section 112 and section 133AT for earthquake-prone buildings.

Other provisions include:

- the requirements for alterations to buildings with an intended life of less than 50 years, set out in section 113 of the Building Act
- the resource consent requirements for heritage buildings and forwarding the relevant building consent application to Heritage New Zealand
- the requirement to notify Fire and Emergency New Zealand of any alteration that affects a building's fire safety systems
- the additional detail required in building consent applications for buildings being altered that contain specified systems subject to a compliance schedule
- the requirements for alterations that also involve a change of use, set out in section 115 of the Building Act
- whether a certificate for public use is required when the public are still required to use the building while it is being altered, until a code compliance certificate is issued
- whether the building consent is subject to a waiver or modification of the Building Code.

3.4.4 Alterations requirements apply to the whole building

The requirements above apply to the whole hospital building undergoing an alteration, not only the HPU or space undergoing the alteration work. Where there is a group of buildings, e.g. a hospital campus, these requirements only apply to the building that is undergoing the alteration.

3.5 Demonstrating and assessing compliance for hospital buildings undergoing alterations

If a hospital building is undergoing an alteration, then Health NZ (as the building consent applicant), with input from their team of design professionals, needs to demonstrate it complies with the requirements of the Building Act.

A building undergoing an alteration may be granted a building consent by demonstrating:

- that the proposed alterations (ie the new building work) will comply fully with applicable clauses of the Building Code, and
- that the building as a whole will continue to comply with all other relevant Building Code clauses (eg structure) to at least the same extent as before the alteration,
- that the building as a whole will comply ‘as nearly as is reasonably practicable’ (ANARP) with applicable Building Code clauses for fire and accessibility after the alteration takes place.

Note that sub-paragraph 2 of Section 112 offers a number of relaxations to the level of compliance required providing the proposed works fall into a set of specific limitations. Refer to the Building Act and MBIE guidance for more information about these allowances.

Building Code compliance can be demonstrated using Acceptable Solutions, Verification Methods or Alternative Solutions.

This five-step process explains how to meet the requirements and the information that needs to be provided:

Step 1: Check what approvals, consents, and extent of documentation is required for the proposed alteration.

Step 2: Consider current and proposed Building Code compliance for the whole building (compliance 'gap assessment')

Step 3: Assess ANARP for outstanding fire and accessibility Building Code clauses and requirements (the 'gaps')

Step 4: Present design and ANARP assessment documentation to BCA for review and approval.

Step 5: Implement alteration works, and document final design such that areas which comply only on an ANARP basis are clearly recorded and understood.

3.5.1 Step 1 – Check approvals, consents and documentation requirements

Health NZ (as the applicant) should initially check what their proposed alteration requires in terms of building consent, whether the works might be exempt from consent, and what documentation is required to demonstrate compliance.

MBIE describe a process for working through this step on their web site:

Step 1: Applicants check what is required for the proposed alteration | Building Performance

If alterations' requirements apply, then the information or documentation required by the BCA for the existing Hospital Building should be determined. The process outlined by MBIE in their "Requesting information about means of escape from fire for existing buildings" can be used as guidance – which is summarised here. For further detail refer to the MBIE website guidance and discuss with the BCA:

Means of escape | Building Performance

Consider the key factors

We recommend focussing on these key factors in assessing the existing hospital building:

- likelihood of the existing building complying
  - building age
  - information held by the BCA or TA
- extent of the proposed building work
  - minor
  - moderate
  - significant
- potential consequences of the building not complying
  - building importance level (which is often IL4 for more complex hospital buildings).
  - presence of sleeping facilities (which is almost certainly the case in hospital buildings).

Health NZ should not rely on BCAs retaining all design records, fire reports, and previous building assessments. This Design Guidance Note recommends all Health NZ hospitals and entities retain all fire safety design reports, assessments, advice, product warranties and certificates relating to all fire safety design items and equipment in their own records so they can be readily referenced and used for alteration works on existing buildings.

MBIE guidance on "Requesting information about means of escape from fire for existing buildings" assesses the building using a score sheet to determine the extent of review required. When this MBIE score sheet is completed, this supplement suggests any gap assessment or full assessment uses the prescriptive requirements contained in Section 2 of the DGN as the basis of comparison. Where the existing building's features, geometry and systems deviates from this prescriptive guidance, then this should be identified as a compliance 'gap' and assessed for compliance on an ANARP basis as described further below.

3.5.2 Step 2: Consider current and proposed Building Code compliance for the whole building (compliance 'gap assessment')

Health NZ, as the building consent applicant, with the assistance of their design team and fire engineer, needs to consider Building Code compliance for the whole building to check it continues to comply to the same extent as before the alteration – and to identify which fire and accessibility clauses need to be looked at further.

For buildings subject to section 112 of the Building Act, building consent applicants need to consider and demonstrate the following in their application:

1. That the building as whole (not only the part being altered) will continue to comply with all clauses of the Building Code to the same extent as before the alteration.
2. Whether the building as a whole will comply fully with any of the fire and accessibility Building Code clauses after the proposed alteration. An assessment of 'as nearly as is reasonably practicable' (ANARP) (Step 3) will apply to any Building Code clauses that the building does not comply with.

BCAs will check this information.

When demonstrating compliance <u>to the same extent</u> with all Building Code clauses

Building consent applicants should provide adequate evidence including plans, drawings and previous compliance documentation to demonstrate that the building's overall compliance with the Building Code will not be reduced by the alteration. In most cases this will be a straightforward test.

- If the building complies with provisions of the Building Code before the alteration, it must continue to do so. If the building exceeded the requirements of the Building Code before the alteration, the Building Act does not prevent the alterations resulting in a lesser level of performance, as long as the building continues to comply with the provisions of the Building Code.
- If the building did not comply fully with the Building Code before the alteration, it needs to comply to the same extent that it did before the alteration.

Consider, for example, a hospital alteration involved refurbishment and redesign of an entry foyer area, cafeteria and reception space, with a reduced number of toilets proposed, and whether this will comply with the Building Code to the extent required.

If the building complied with the Clause G1 of the Building Code before the alteration then the number of accessible toilets may be reduced, so long as the building still complies with this aspect of the Building Code after the alteration.

If the building did not comply before the alteration, then the number of accessible toilets must not be reduced by the alteration.

Replanning of a ward area involves the relocation of a subdividing firewall. While the impact of this change on means of escape from fire is assessed with respect to its compliance on an ANARP basis, its effect on external spread of fire to adjacent buildings is required to comply to a different extent:

- If the provisions for external fire spread from the ward firecell complied before the alteration, then the new configuration must also comply.
- If these provisions did not comply before the alteration then the new configuration should not reduce this level of compliance – which could be assessed with regards to the received thermal radiation on and 1m over the relevant boundary.

An alteration may require an existing building element to perform better in order to meet this requirement.

For example, if a proposed alteration includes new building work to an existing building element (i.e. new cladding over an existing frame) the new work would require fixings to the existing frame. If the existing frame is not compliant, eg it has rot, those fixings will not comply (as new building work) if they are into rotten wood. In this scenario, the frame needs to be remedied in order for the new cladding to comply.

When demonstrating compliance with fire and accessibility Building Code clauses on an ANARP basis

As noted above, the “Design Guidance Note: Fire Engineering Design for New Zealand Public Hospitals” suggests using the prescriptive design requirements contained in Section 2 of the DGN for assessing how and where the existing hospital building complies with the means of escape from fire clauses of the NZ Building Code.

For existing hospital buildings, the process outlined in Figure 3.3 below should be used for determining:

- which aspects of the building need to be more closely examined during inspections and investigations of the existing building – based on the classification of building risk.
- where compliance ‘gaps’ exist by assessing the exiting building against the prescriptive requirements of Section 2 of the DGN.
- whether some features identified as a compliance ‘gap’ require further site investigation or inspection to ascertain the full extent of non-compliance.
- what features or issues with the building are required (by Health NZ) to be remediated or fixed, without the need for further ANARP assessment – again driven by the classification of building risk.
- ANARP compliance of any compliance ‘gaps’ identified, and working through a range of possible remediation solutions to achieve a threshold of compliance on an ANARP basis.

Note that in some cases, the requirements of Section 2 in the DGN may exceed the minimum requirements of the Building Code. This may be relevant if it is important to distinguish work that is needed for compliance ANARP with S112 of the Act compared with work that is needed for compliance ANARP with Section 2 in the DGN.

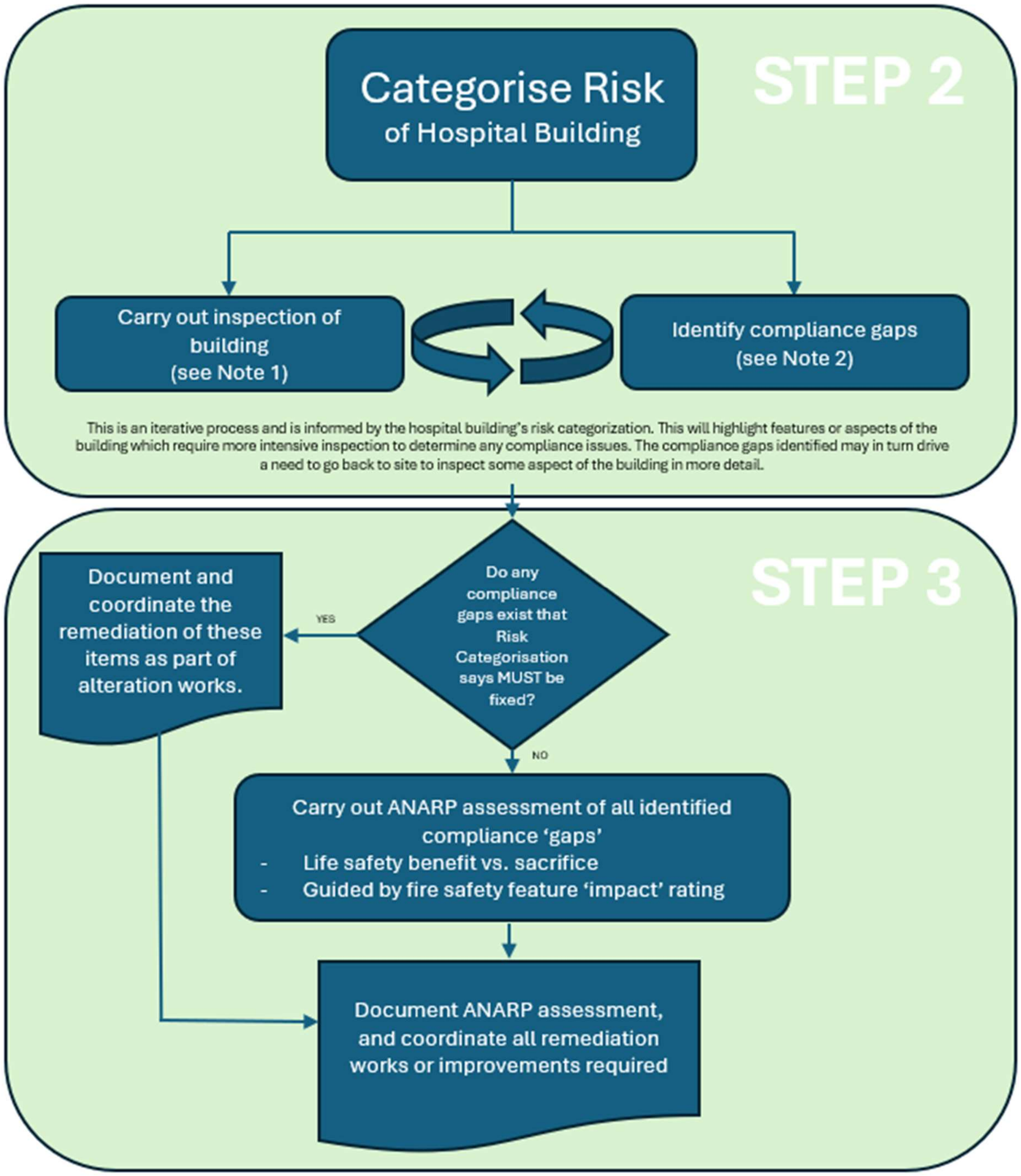

Figure 3.3: Process for assessing existing hospital buildings.

Notes for Figure 3.3:

1. A physical inspection of the existing building is considered a crucial element of its assessment. A desktop study only of design information which might be on record is not sufficient in gaining the necessary understanding of the building, its systems, and their condition.
2. Sometimes referred to as a 'gap assessment' this process could use Part 2 of the DGN as a basis for determining what a fully complying building might/should have, to determine the existence and extent of any compliance shortfalls (or 'gaps') needing further investigation.

3.5.3 Step 3: Assess ANARP for outstanding fire and accessibility Building Code clauses

The process of determining the compliance gaps that exist in the building is an iterative process. An initial inspection of the building will give the assessing engineer an understanding of and familiarity with the building layout, features, and general condition. From there, the building can be compared against the prescriptive requirements of Part 2 of the DGN to identify where any compliance gaps might exist.

Features requiring more in-depth inspection on site

While a broad, high-level inspection is typically warranted, the Section 3.3 on 'Categorising hospital building and occupancy risk' provides the assessing engineer with information pertaining to aspects of the building which warrant more thorough investigation, onsite assessment, and understanding of condition. These more in-depth inspection recommendations are summarised in Table 3.3 below.

Note that this does not imply the other features of the building should not be reviewed, they should be, but perhaps in just sample locations throughout the building. The features identified below should be more thoroughly inspected, in all locations, and documentation reviewed.

Example:

Health NZ propose to convert a vacant nurse accommodation building on a hospital site into emergency ward space to cater for pandemic events and seasonal spikes in demand, with 20 additional bed spaces. This single level building is sprinkler protected, although the system is old. The building is vacant and has not been inspected or maintained for some time.

Referring to Figure 3.1 in paragraph 3.3.2 above, this existing building is classified as 'high risk'. A review of fire design information on record and a broad investigation of the building on site might include:

- Discussing the building with the facilities management (FM) team to get an understanding of recent works, issues they might be having with some systems, outcomes of recent IQP inspections, functionality and useability of fire systems in the building(s) on site etc.
- If a broad investigation of the building in random sample locations identifies a possible repeated series of defects or issues with construction, then this is perhaps an indication of a wider systemic issue which would prompt a more thorough assessment of this construction or system throughout the building.

- Making sure systems ancillary to mean of escape from fire, like emergency lighting, egress signage, accessibility etc is investigated or inspected by appropriately competent parties like, for example, the electrical engineer or architect.
- Using reasonable endeavours to investigate areas of the building that might not be easily accessible (or perhaps not possible to inspect due to continuing operational demands – such as operating theatres) by thoroughly assessing as built documentation, design information, recent IQP inspection reports, and conversations with FM and clinical users.

In addition, referring to Table 3.3 below, special focus and consideration should also be given to:

- A thorough investigation of the proposed evacuation strategy for the building (including conversations with Evacuation Advisor/consultant), fire safety training material provided to clinical staff, and a detailed conversation with users on proposed staff to patient ratios at different times of the day (and overnight) and how/where patients will be evacuated.
- A sample check of fire compartmentation in the building, a more comprehensive investigation of wall construction enclosing proposed evacuation zone boundaries and safe path corridors should be carried out – including investigation of construction above ceilings in services spaces etc.
- A review of existing sprinkler system design information against the requirements of NZS4541. This should include review of recent IQP inspection documentation, BWOF documentation and 12A forms, and a condition assessment/survey of the sprinkler system itself (pipes, head locations, joints and connections, valve sets, and pumps etc).
- A similar review of the existing fire alarm system, and how it might be modified (or need to be upgraded) to facilitate the new design for the building.

Once the building has been assessed, and compliance gaps identified, each compliance gap should be the subject of a further assessment which determines how that compliance gap is to be remedied so the building is considered to comply on an ANARP basis.

Table 3.3: In depth investigation requirements of existing buildings

Fire safety feature/strategy	Comment				
S1 – Evacuation strategy and staff/patient numbers		X	X		
S2 – Fire separation of evacuation zones and internal places of safety		X	X		
S3 – Smoke separation of rooms within sleeping firecells					
S4, S5, S6 – Number, width/capacity, path length, and fire/smoke separation of means of escape from each firecell/evacuation zone					
S7 – At least two safe path stairs from upper floors.		X			
S8, S9 – Number and configuration of evacuation zones on each level		X			
S10, S12 – Fire separations and fire stopping separating evacuation zones, and around safe path stairs		X	X		
S11, S13, S14, S25, S26 - Fire separations and fire stopping within evacuation zones and other fire compartmentation					
S15 – Internal surface finishes					
S16 – External wall finishes and cladding materials					
S17 – Sprinkler system		X	X		
S18, S19, S20 – Fire alarm system installed, and addressability		X	X	X	
S21 – Staff intercommunication system					
S22 – Smoke control					
S23 – Hydrant system					
S24 – Fire service lift control and lifts used for evacuation					
S27 – Design life of HPU		X			

	Low Risk
	Medium Risk
	High Risk: (sprinkler system needed)
	Very High Risk: (sprinkler system needed)

Compliance improvement priorities in Health New Zealand buildings

As an interim step preceding this ANARP assessment, Health NZ have identified some compliance priorities that must be considered or undertaken in some buildings – depending on their risk categorisation – without a need to undertake an ANARP assessment.

Therefore, before commencing an ANARP assessment of the compliance gaps identified, the assessing engineer must specify the remediation or retrospective construction of the following key fire safety features, if they are identified as not being in the building already, or are present but are not fully compliant. All other compliance gaps are to be assessed for ANARP compliance as would be carried out for a typical existing building, and the improvements or features necessary to achieve a threshold of ANARP compliance designed and specified accordingly.

Example:

In the example given above, a compliance gap assessment against the prescriptive provisions in Section 2 of the DGN identifies the following compliance gaps:

- The sprinkler system has several defects, coverage shortfalls, and head location issues which do not comply with the sprinkler standard to which it was designed and is currently assessed.
- While location of manual call points and sounders complies with the fire alarm standard, smoke detection is installed in bedrooms only and not throughout (so just supplementary smoke detection installed).
- Fire stopping of services penetrations is generally of a poor quality, and there are many instances of services penetrations not being fire stopped at all.
- Exit signage is provided in the form of non-illuminated signs and 'stickers' in main corridors only, and does not offer particularly effective wayfinding.
- Table 3.4 below guides the assessing engineer on what should continue to be assessed for compliance on an ANARP basis, and what HNZ consider must be remediated given the risk categorisation of the building and proposed use (high risk). Therefore:
- The buildings sprinkler system must have all identified defects remediated so it complies with the sprinkler standard (to which it was originally designed or more recent). Whether this remediation is required should not be the subject of an ANARP assessment.
- Smoke detector coverage should be extended to cover the entire building to the extent required to comply with the fire alarm standard (to which it was originally designed or more recent), without the need for an ANARP assessment.
- Passive fire defects in fire separations between proposed evacuation zones, and to safe path corridors should be remediated. An ANARP assessment should be undertaken on al other passive fire defects (in other fire separations) to determine the extent of remediation required to meet a threshold of ANARP compliance.
- An ANARP assessment should be carried out to determine what remediation, if any, is required to the egress signage throughout the building.

Table 3.4: Fire safety features that MUST be remediated if not in existing building or fully compliant.

Hospital building risk categorisation
Very High Risk
S17 - Automatic suppression system (sprinklers)
S4 - Provide at least two escape routes so all occupants can always move away from a fire, either to a safe place, or to a place of safety inside the building on the same level; alternate escape routes are provided from internal places of safety that lead to a safe place, regardless of fire location
S7 - Provide a minimum of two fire-protected stairways, located so that if means of escape to one stairway is obstructed, occupants have an alternative egress route to another stairway
S2, S8 - Provide at least two evacuation zones on the same level for Category P1 to P3 occupants
S2, S10 - Provide separation walls and floors to control spread of smoke and fire between evacuation zones
S12 - Install/verify fire stopping of building services penetrations with appropriate quality assurance for evacuation zone boundary fire separations and safe path stairs
S18, S20 - Provide addressable early detection and warning of fire to allow staff time to respond and evacuate occupants to a place of safety: automatic smoke detection
S1 – Integrated/coordinated evacuation strategy and correct staff/patient ratios
High Risk
S17 - Automatic suppression system (sprinklers)
S4 - Provide at least two escape routes so all occupants can always move away from a fire, either to a safe place, or to a place of safety inside the building on the same level; alternate escape routes are provided from internal places of safety that lead to a safe place, regardless of fire location
S2, S10 - Provide separation walls and floors to control spread of smoke and fire between evacuation zones
S12 - Install/verify fire stopping of building services penetrations with appropriate quality assurance for evacuation zone boundary fire separations and safe path stairs
S18, S19 - Provide detection and warning of fire to allow staff time to respond and evacuate occupants to a place of safety: automatic smoke or heat detection
S1 – Integrated/coordinated evacuation strategy and correct staff/patient ratios

Medium Risk
S10 - Provide separation walls and floors to control spread of smoke and fire between evacuation zones **S12 - Install/verify fire stopping of building services penetrations with appropriate quality assurance for evacuation zone boundary fire separations and safe path stairs** **S18, S19 - Provide detection and warning of fire to allow staff time to respond and evacuate occupants to a place of safety: automatic smoke or heat detection** **S1 – Integrated/coordinated evacuation strategy and correct staff/patient ratios**
Low Risk
S1 – Integrated/coordinated evacuation strategy and correct staff/patient ratios

The above table seeks to identify compliance gaps and their respective impact on fire and life safety which might be identified in common New Zealand public hospital building stock. It is acknowledged that there **might** still be situations where a remediation absolute identified above is, by observation, unreasonably onerous and offers little in the way of life safety benefit (for example, a minor non-compliance in an otherwise complying sprinkler system installation). The design engineer should liaise with Health NZ directly in these cases, as they retain the prerogative to overturn the remediation instructions contained in Table 3.4, and instead require the design engineer to carry out an appropriately robust ANARP assessment instead.

ANARP assessment of remaining compliance gaps

For buildings subject to alteration under section 112 of the Building Act, the design engineer is required to assess the 'as nearly as is reasonably practicable' (ANARP) threshold for any outstanding NZBC compliance gaps identified above, and whether the proposed alteration meets this threshold.

To do this, MBIE recommends[1] that building consent applicants complete, and BCAs consider:

- a comparative analysis of the building's current, full and proposed compliance resulting from the alteration, and
- a weighting exercise to consider the sacrifices and life safety benefits of full or partial/proposed compliance.

The considerations made during the gap analysis and weighting exercise should be outlined by the applicant in the consent documentation as evidence that ANARP has been considered sufficiently. BCAs and/or territorial authorities will check this when determining whether or not to grant a building consent for the alteration.

[1] 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

The ANARP threshold will be different for each building and will vary with the type of HPU and category and number of occupants needing assistance to evacuate, and may be full Building Code compliance. A pre-application meeting is recommended involving the building consent applicant, building professionals (eg architects or designers) and the BCA to discuss the ANARP threshold and design intentions. Ongoing dialogue will be necessary and may result in applicants needing to revise the level of upgrade proposed.

The reader is directed to the MBIE guidance on ANARP assessment[1] for more information on how to carry out such an assessment. Key points to note are:

- For each compliance gap identified, the assessing engineer should explore a number of possible remediation options which ranges from partial improvement, through to a solution (or solutions) which will result in the building (or that feature) fully compliant with the Building Code. It is not appropriate to explore or assess just one possible improvement solution, and determine if that reaches a threshold of ANARP compliance on its own.
- Health NZ should be consulted a part of the assessment, as they are able to provide valuable information and input on the 'sacrifice' side of the assessment, as they understand the operational impact, cost, business continuity affects, and disruption the proposed solution might cause.

As noted in the MBIE guidance, the key questions that should be front of mind when carrying out an ANARP assessment and justifying the results/conclusion are:

- What is necessary to reach full compliance? At what sacrifice?
- What are the options to partly comply? What is the sacrifice vs benefit of partial compliance?
- What is the most reasonably practicable solution?
- Does that solution sufficiently improve the level of compliance given the scope of the proposed building work?

3.5.4 Step 4 and Step 5: Documentation of design and assessment, and retention of design information.

It is important that the design of the alteration works, and ANARP assessments for the existing building, are documented as clearly as possible to make the process of convention and approvals as smooth as possible. The information shall be kept on file by Health NZ so that it is useful to facilities management and any fire engineers required to work on the building in the future.

The fire engineer should consider:

- Clearly separating the design information from the gap assessment and ANARP assessment of the existing building.
- Making it clear what aspects or features of the building comply on an ANARP basis, and to what extent, so inspecting IQPs, Council inspectors, and fire engineers investigating the building in the future understand where full Building Code compliance is not achieved and how this is justified.
- Producing a clear set of fire engineering drawings or sketches that shows the location and extent of fire separations, their fire resistance rating (FRR), and level of compliance.

They should also clearly show; location of fire doors and their FRR, doors which do not require closers, location and extent of evacuation zones, location of designated safe path escape routes, location of egress signage, and designated places of safety within the building.

- Reviewing the existing Compliance Schedule and reporting to Health NZ if it is inaccurate or lacking adequate detail so that the territorial authority can be requested to issue a revision. The Compliance Schedule provides the fundamental basis and control for undertaking inspections of each of the specified systems.
- The assessment document should attempt to compile as much ‘current’ information on the building as possible so it can be readily referenced in the future. This can be achieved by either clearly referencing cited documents, inspection reports, and condition assessments, or else including them in the appendices of the report so they are all in one consolidated document.

Once consented and works completed, Health NZ facility management should ensure the fire engineering design, as built information, and completion documentation like final inspection records and Operations & Maintenance manuals and fire equipment warranties are kept securely on site (or on record) so they can be readily uplifted and referenced in the future.

It is not appropriate for reliance to be placed on Council or the fire engineer to retain or maintain this documentation for Health NZ.