Fire safety in new Class 2 and Class 3 residential buildings

Regulation Impact Statement for decision

2018

Regulation Impact Statement for Final Decision

Fire safety in new Class 2 and Class 3 residential buildings

November 2018

The Australian Building Codes Board has developed this Final Decision Regulation Impact Statement, which accords with the requirements of *Best Practice Regulation: A Guide for Ministerial Councils and National Standard Setting Bodies*, as endorsed by the Council of Australian Governments in 2007. Its purpose is to inform interested parties and to assist the Australian Building Codes Board in its decision making on proposed amendments to the National Construction Code.

The Australian Building Codes Board

The Australian Building Codes Board (ABCB) is a joint initiative of all levels of government in Australia, together with the building industry. Its objective is to oversee issues relating to safety, health, amenity, accessibility and sustainability in building. The ABCB promotes efficiency in the design, construction and performance and liveability of buildings through the National Construction Code (NCC), and the development of effective regulatory and non-regulatory approaches. The Board aims to establish effective and proportional codes, standards and regulatory systems that are consistent between States and Territories. For more information see the ABCB website (www.abcb.gov.au).

Disclaimer

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Glossary

Term	Meaning
Class 2 building	A building containing 2 or more sole-occupancy units each being a separate dwelling.
Class 3 building	A residential building, other than a building of Class 1 or 2, which is a common place of long term or transient living for a number of unrelated persons, including– (a) a boarding house, guest house, hostel, lodging house or backpackers accommodation; or (b) a residential part of a hotel or motel; or (c) a residential part of a school; or (d) accommodation for the aged, children or people with disabilities[1] (e) a residential part of a health care building which accommodates members of staff; or (f) a residential part of a detention centre.
Deemed-to-Satisfy Provisions	Means provisions which are deemed to satisfy the Performance Requirements.
Deemed-to-Satisfy Solution	Means a method of satisfying the Deemed-to-Satisfy Provisions
Fire-isolated stair	Means a stairway within a fire resisting shaft and includes the floor and roof or top enclosing structure.
Performance Requirement	Means a requirement which states the level of performance which a Performance Solution or Deemed-to-Satisfy Solution must meet.
Performance Solution	Means a method of complying with the Performance Requirements other than by a Deemed-to-Satisfy Solution
Sole-occupancy unit	Means a room or other part of a building for occupation by one or joint owner, lessee, tenant, or other occupier to the exclusion of any other owner, lessee, tenant, or other occupier and includes— (a) a dwelling; or (b) a room or suite of rooms in a Class 3 building which includes sleeping facilities; or (c) a room or suite of associated rooms in a Class 5, 6, 7, 8 or 9 building; or (d) A room or suite of associated rooms in a Class 9c building, which includes sleeping facilities and any area for the exclusive use of a resident.

Abbreviations

Abbreviation	Full name
ABCB	Australian Building Codes Board
BCA	Building Code of Australia (Volumes One and Two of the NCC)
COAG	Council of Australian Governments
DtS	Deemed-to-Satisfy
IGA	Inter-Governmental Agreement
NCC	National Construction Code
OBPR	Office of Best Practice Regulation
RIS	Regulation Impact Statement

[1] Class 3 residential care buildings accommodating the aged, children or people with disability are required to have automatic fire sprinklers as a consequence of amendments to the DtS Provisions of NCC 2019 and are therefore not within the scope of this analysis.

Introduction

Following the death and life changing injuries sustained by two occupants in an apartment fire in 2015, the NSW Deputy Coroner requested that the Australian Building Codes Board (ABCB) consider extending the current Deemed-to-Satisfy (DtS) Provisions for sprinkler protection to medium or 'mid–rise' multi-storey residential buildings. This work was supported by the Board and Building Ministers, and resulted in the ABCB commencing Stage 1 of the holistic review of fire safety measures for Class 2 and 3 buildings.

Concurrent with the work of the ABCB, advocates of fire safety, including Fire and Rescue New South Wales (FRNSW), the Australasian Fire and Emergency Services Authorities Council (AFAC) and the Fire Protection Association of Australia (FPAA), commenced developing their own proposal for change to the NCC. As justification for the proposal, the proponents suggested that the expansion of the fire sprinkler requirements to new Class 2 and 3 buildings constructed above three storeys and less than 25 metres in effective height would in-turn allow the removal of a number of passive fire safety features currently required under the DtS Provisions, leading to an overall saving in construction costs as well as an increase in life safety in these buildings.

An existing Victorian variation to the NCC (VIC H103.1) provides a number of concessions for active and passive fire safety systems where fire sprinklers are installed. In 2014, the ABCB conducted a survey of all NCC users, which found that some stakeholders felt these concessions better reflected minimum necessary regulation and had the potential to deliver higher economic and life safety benefits.

Fire sprinklers have proven highly effective both domestically and internationally as a means of suppressing fire in its early stages. In recent times, changes in construction methods such as timber mid-rise construction has also seen their inclusion in buildings less than 25 m in effective height.

Under the current DtS Provisions a fire sprinkler system is required in all new Class 2 and 3 buildings greater than 25 metres in effective height and in buildings accommodating the aged, children or people with disabilities[2].

This Final RIS assesses the costs and benefits of requiring fire sprinklers in the DtS Provisions, under alternative sprinkler specifications, in new multi-storey Class 2 and 3 residential buildings between four and eight storeys in height. It is informed by findings of a fire risk analysis by EFT Consulting and material provided by AFAC, FRNSW and FPAA, and information received at public consultation. The scope of this analysis is limited to new buildings as the solutions will not apply retrospectively.

The following sprinkler specifications on which this Final RIS relies:

- AS 2118.1 Automatic fire Sprinkler Systems – General Systems; and,
- FPAA 101D Automatic Fire Sprinkler System Design and Installation – Domestic Water Supply, 18 March 2018; and,
- FPAA 101H Automatic Fire Sprinkler System Design and Installation – Hydrant Water Supply, 18 March 2018.

[2] Class 3 residential care buildings accommodating the aged, children or people with disability are required to have automatic fire sprinklers as a consequence of amendments to the DtS Provisions of NCC 2019 and are therefore not within the scope of this analysis.

Problem

A core goal of the NCC is the efficient achievement of minimum necessary standards for the safety of building occupants from fire. Currently, this is achieved using a number of active and passive fire safety systems that work together as one system to provide an adequate level of life safety from the effects of fire.[3]

The type and number of fire safety systems required by the NCC increases proportional to risks due to the height of the building, the presence of sleeping occupants, larger populations of unrelated occupants and longer travel distances. Currently, the NCC DtS Provisions require a sprinkler system be installed in Class 2 and 3 residential buildings where any part of the building has an effective height that exceeds 25 metres. In Class 2 and 3 buildings of more than four storeys and less than 25 metres, the NCC does not recognise the option to sprinkler protect as a DtS solution. This is largely due to historically, no cost-effective domestic sprinkler systems being available.

Recently, following the death and life changing injuries sustained by two occupants of a building fire in 2015, both the NSW Deputy Coroner and proponents of fire safety including FRNSW, AFAC and FPAA proposed the ABCB consider extending the current DtS Provisions for sprinkler protection to mid-rise multi-storey Class 2 and 3 residential buildings. This is in recognition of the effectiveness of sprinklers and the likely benefits they bring in reducing an occupant's individual risk.

Nature of the Problem

The nature of the problem relates to the NCC's recognition through the DtS Provisions of appropriate strategies that are more cost effective in achieving the Goals of the NCC. New sprinkler specifications prepared by FPAA have been developed that use new technology to improve cost-effectiveness. Associated concessions are intended to provide higher life safety and property protection benefits when compared with the current mix of fire safety requirements specified under the DtS Provisions.

Performance-based building codes in Australia and internationally place the objective of occupant safety as a central goal of compliant design. Active and passive fire safety measures combine to achieve a building fire safety system, reducing exposure of building occupants to the products of fire including heat, smoke and toxic gases. Although not the only risk to building occupants, inhalation of smoke and/or toxic gases is the main cause of fatality from a fire.

The NCC Performance Requirements implicitly recognise that fire may have both a localised effect and impacts beyond the compartment of fire origin. Consequently, a fire safety system is one or any combination of the methods used in a building to—

- warn people of an emergency;
- provide for safe evacuation;
- restrict the spread of fire;
- control a fire,

and includes both active and passive systems.

Examples of active and passive fire safety systems include the following:

[3] Fire Centre Reform Council. Project 1 Restructure BCA Fire Provisions Part 1. Pg.13.

- **Passive systems**
    - Fire-isolated stairways, ramps and passageways
    - Fire walls
    - Other fire-resisting building elements.
- **Active systems**
    - Smoke alarms and intercom systems for emergency purposes
    - Emergency lighting
    - Exit signs
    - Sprinkler systems
    - Fire hydrant systems
    - Fire hose reel systems
    - Smoke and heat vents
    - Mechanical smoke-exhaust systems
    - Portable fire extinguishers.

Under the DtS Provisions, these active and passive systems combine to–

- alert people that an emergency exists and allow them to identify a path to a place of safety;
- provide people with an environment and evacuation routes which, during a fire, will minimise the risk of them suffering illness or injury;
- facilitate the role of emergency service personnel;
- assist in minimising the risk of fire spread; and
- not have a structural failure during a fire.

The problem this Final RIS considers is the degree that the current DtS Provisions in non-sprinkler protected medium-rise residential buildings address an occupant's individual risk from fire relative to the effectiveness and cost of other options.

The Current NCC Fire Safety Requirements

In the view of some stakeholders, the DtS Provisions do not reflect the most effective solution to meet the Goal of the NCC when considered from the perspective of individual risk and cost. The NCC's Performance Requirements establish the mandatory degree of performance buildings must meet. They reflect societal expectations and recognise that risks can vary with building use and occupancy. The requirements reflect a minimum necessary standard for all buildings. However, as the Productivity Commission noted in 2004, the BCA will, for some proportion of the population at least, fall short or exceed the expectations regardless of the level of regulation adopted. Therefore, in seeking to maximise the benefits to the economy and society along with community expectations, the costs and benefits of the level of performance adopted should be considered among other factors.

The DtS Provisions contained in Sections B – Structure, C – Fire Resistance, D – Access and Egress and E – Fire Fighting Equipment are commonly used solutions for buildings. They assist industry in interpreting the Performance Requirements in the absence of higher level quantification. Though performance-based codes allow alternative strategies and systems to be used to the degree necessary, including the use of sprinklers, the DtS pathway is considered the most common method of measuring or demonstrating compliance with the Performance Requirements, regardless of the compliance pathway adopted and hence are the focus of this Final RIS.

Section C – Fire Resistance

The DtS Provisions of Section C relate primarily to passive systems that impact fire resistance of a building structure and prescribe, inter alia, fire-resistance levels, maximum fire compartment sizes and the protection of openings. These elements are crucial in providing the necessary level of separation to prevent the spread of fire, contain its effects and in turn reduce an occupant's exposure, while maximising the time and opportunity for evacuation in an emergency.

Due to the high risks associated with sleeping occupants, the most stringent fire resisting construction applies to residential (Class 2 and Class 3) buildings of three or more storeys[4]. This is referred to as Type A construction. Buildings below this height have overall lower fire loads, occupancy and travel distances and Type B or C construction requirements apply. This graduated approach aligns the increase in fire safety with increased risk to efficiently achieve the Code's objectives.

Section D – Access and Egress

The DtS Provisions of Section D relate to means of egress from a building in an emergency including limiting the distance of travel to a place of safety, the number and dimensions of exits and their construction.

In residential buildings, an exit is required to be protected (fire-isolated) where it passes through or by more than three consecutive storeys in a Class 2 building and two consecutive storeys in a Class 3 building. These requirements serve to complement the maximum distance from a sole-occupancy unit to an exit in a residential building (generally 6 m or 20 m to a point where travel to different exits is available). This distance is less than that required in other classes in recognition of the increased time for sleeping occupants to become alert in the event of a fire.

Section E – Services and Equipment

The DtS Provisions of Section E relate to active fire safety systems including fire sprinklers, firefighting equipment, smoke hazard management systems, smoke detection and alarms, emergency lifts, emergency lighting and exit signs.

Fixed Fire Suppression Systems

NCC Performance Requirement EP1.4 requires an automatic suppression system be installed 'to the degree necessary' to control the development and spread of fire appropriate to–

a) the size of the fire compartment; and
b) the function and use of the building; and
c) the fire hazard; and
d) the height of the building.

'To the degree necessary' is a term used in the NCC Performance Requirements and recognises the application of a particular requirement can differ depending on the specifics of a building[5]. This extends to not requiring an item to be installed, where this is appropriate. Guidance clarifies that its use in EP1.4 recognises that not all buildings require automatic fire suppression systems. When

[4] National Construction Code Volume One (2016) Part C1.1. p.109.
[5] Guide to the National Construction Code Volume One (2016) p. 17.

implementing a required sprinkler system, judgements relative to a number of criteria may be required. These would include the level of occupancy, the degree of passive protection available, the availability of a reliable water supply and the location. Similarly, DP1.3 uses 'to the degree necessary' to describe the extent fire isolation of exits required, in recognition that travel time increases with building height.

The key consideration of this analysis is the appropriate threshold required by the DtS Provisions for fire safety systems. Currently, the trigger for requirement for installation of fire sprinklers in residential buildings (other than accommodation for the aged, children or people with disabilities) above 25 metres (assumed to be a building greater than eight storeys for the purpose of this analysis). The 25 metre trigger for fire sprinkler systems has existed since August 1980, when the previous Australian Model Uniform Building Code (AMUBC), was amended to reduce the trigger height from 42 metres.[6]

In November 2017, the ABCB's Building Codes Committee considered a proposal suggesting cost effective sprinkler protection could be achieved through associated offsets to other fire safety requirements. At its meeting in December 2017, the Board agreed to further analysis, including through this Final RIS, of mandatory sprinkler protection for mid-rise Class 2 and 3 buildings above three storeys and with associated offsets.

Extent of the Problem

The extent of the problem is influenced by the rate of fire incidents, their location and the rate of injury and fatality in non-sprinkler protected Class 2 and 3 buildings constructed between four and eight storeys in height.

Risk to Life Safety

The fire safety provisions in the NCC have been developed over time to address two types of risk; individual risk, that is the risk of fatality or injury to a person or persons within the room of fire origin, and societal risk, that is the risk of fatality or injury to other occupants who may have little or no control over the activities or circumstances that lead to fire, but are exposed to its effects. When considering changes to the fire safety provisions it is necessary to consider how both types of risk will be impacted.

A fire safety engineering analysis was undertaken by EFT Consulting to compare the difference in individual risk associated with each proposed solution when compared to a building complying with the current DtS Provisions. The results of this analysis are shown in Table 1.

[6] The 25 metre trigger was chosen primarily due to cost effectiveness considerations and the known satisfactory performance of fire sprinklers, rather than in response to an unacceptable level of risk.

Table 1: Comparative individual risk levels per solution

Solution	Risk Level	Fatalities per 1,000 Fire Starts	Reduction in Risk Level (Percentage)
Current DtS Provisions	3.9×10^{-6}	3.9	-
FPAA 101D Sprinkler System Design and Installation – Domestic Water Supply	1.3×10^{-6}	1.3	67%
FPAA 101H Sprinkler System Design and Installation – Hydrant Water Supply	1.1×10^{-6}	1.1	72%
AS 2118.1 Sprinkler System Design and Installation	1.1×10^{-6}	1.1	72%

Source: EFT Consulting (2016).

The current risk to life is estimated to be 3.9 fatalities per 1,000 fire starts. As demonstrated by the fire safety engineering analysis, the effectiveness of fire sprinklers in reducing individual risk is estimated to range from 67% and 72% depending on the adopted system. In this regard, fire sprinklers demonstrate a high degree of effectiveness in reducing individual risk when compared with the current DtS Provisions.

Societal risk is less examinable, due to the rarity of multi-fatality events, however it has been established through engineering analysis using boundaries defined in land use planning criteria as within tolerable bounds[7]. The unintended consequences section of this Final RIS further discusses the impacts of the proposed solutions on societal risk.

Rate of Fire in Residential Apartment Buildings

The rate of fire in residential buildings is known with some certainty. The Report on Government Services shows approximately 0.9 fires per 1,000 households[8]. A more detailed analysis undertaken by EFT Consulting suggests apartment fires represent 2.6 fires per 1,000 households[9]. Noting there has been a downward trend in fire starts in recent years, a mid-point of 1.75 apartment fires per 1,000 sole occupancy units per annum is assumed.

[7] See EFT Consulting 2575-1, (2017) p.18.

[8] Report on Government Services (2017) shows the 5 year average 2011-12 to 2016-17 89.9 fires per 100,000 households, Table 9A.15. http://www.pc.gov.au/research/ongoing/report-on-government-services/2017/emergency-management/fire-services.

[9] Australian Bureau of Statistics (2004) Housing Choices Report No 3240.1.

The rate of fire in other multi-storey residential buildings (Class 3 buildings) is slightly less at a frequency of 0.9 fire starts per 1,000 sole-occupancy units, based on an examination of statistics from the United States of 39,874 fires for the Fire Code Reform Centre.[10]

Current Fatality Rate from Fire

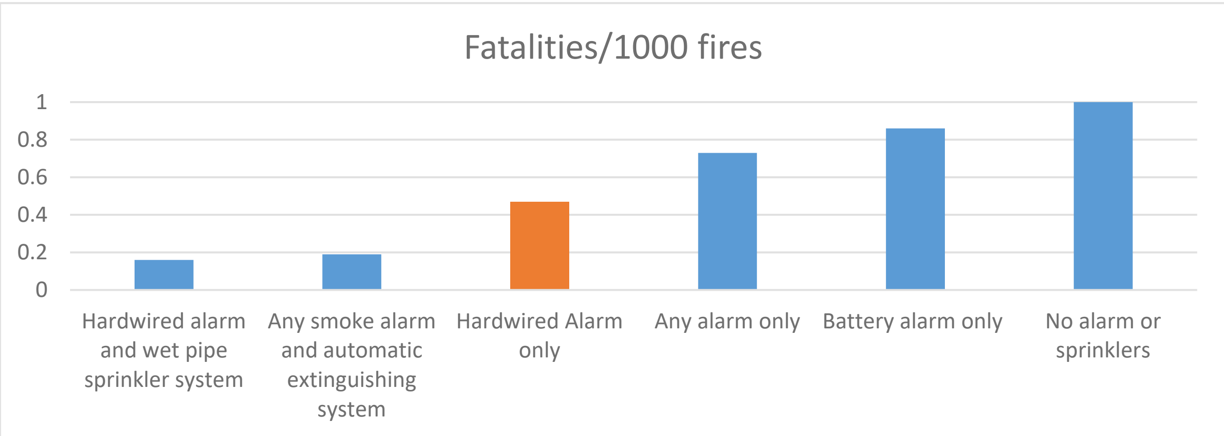
The extent of the problem is also influenced by the current rate of fatality in new Class 2 and 3 buildings. This analysis uses the best available information on the incidence of fatality from a report prepared by the National Coronial Information System (NCIS). A copy of this report can be found on the ABCB website.

Between 2000 and 2015, 46 fatalities were recorded in all multi-storey residential buildings as a result of fire. This equates to an average of 3 (2.9) deaths per year. Of these fatalities, it is known that 26 deaths (57%) occurred in buildings of three storeys or less with 2 deaths (4.3%) reported to have occurred within the four to eight storey height range. Of the remaining unknown fatalities, the estimated number to have occurred within the four to eight storey height range is calculated to be 1.3 assuming the same rate of occurrence as the known fatalities. Hence the total number of fatalities in all multi-storey residential buildings in the four to eight storey height range between 2000 and 2015 is 3.3 or an average fatality rate of 0.21.[11]

Contributing Factors of Fire Fatalities

The rate of fatality from fire is known to be influenced by a building's fire safety features. Chart 1 reflects the difference in fatality within sole-occupancy units in the presence of different fire safety systems. Hardwired alarms reflect the current requirement for Class 2 and 3 buildings less than 25 metres in height.

Chart 1: Fatalities per 1,000 fires under alternative fire safety systems expressed as a ratio



Source: Adapted from Ahrens analysis of fatality rates per 1000 fires (2003-2006)

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[10] Drawn from a detailed analysis of US fire statistics between 1983 and 1995 undertaken for the Fire Code Reform Centre, Project 4.

[11] The four to eight storey cohort is 7.6% of all fatalities and the remainder from the 'unknown' category are proportionately distributed.

Hall (2013) established fatality rates in the US of 7.4 fatalities per 1,000 fires in apartment buildings (Class 2 buildings) and 7.3 per 1,000 fires in hotel/motel buildings (Class 3 buildings) without automatic extinguishing equipment[12]. An examination of a variety of fire safety systems by Ahrens derived estimates for buildings with hardwired alarms (equivalent to the current NCC requirement) of 3.9 fatalities per 1,000 fires.

The influence of the proximity of an occupant to a fire is relevant to the issue of individual and societal risk. Fire statistics reflect the rate of fires, their origin and spread. NSW fire brigade data from 2003 to 2007 suggests up to 80% of fires in Class 2 buildings begin within the sole-occupancy unit. Victorian and US statistics indicate the rate could be closer to 63%.

The individual risk to life for occupants in a sole-occupancy unit of fire origin (in a non-sprinkler protected building) can be estimated as the product of the:

- frequency of reported fire (1.6 for Class 2 buildings and 0.9 for Class 3 buildings);
- fatality rate / fire for non-sprinkler protected buildings;
- proportion of fatalities from fires commencing within the sole-occupancy unit; and
- reduction ratio from the provision of fire sprinklers and / or smoke detection/alarm systems.

Based on US fire statistics, Table 2 shows the risk of fatality per annum from fire in Class 2 and 3 buildings.

Table 2: Annual risk of fatality from fire in an SOU of fire origin in Class 2 and 3 buildings

Description	Frequency of Fire Starts per 1,000 SOUs	Fatality Rate per 1,000 SOUs	Proportion of Fatal Fires within SOU	Reduction Factor for Fire Safety System	Fatalities per Annum per SOU x 10^{-6}
Class 2	1.60	7.40	0.66	0.44	3.44
Class 3	0.9	7.3	0.84	0.44	2.43

Source: EFT Consulting (2016).

The relative individual risk is calculated by dividing the number of fatalities per annum per SOU by the number of occupants within the SOU (assumed to be 2.5).

Table 3: Individual risk to occupants of an SOU

Building Description	Individual Risk of Fatality within the SOU of Fire Origin per Annum x 10^{-6}
Class 2	1.38
Class 3	0.93

Source: EFT Consulting (2016).

[12] Hall J.R. (2013) US Experience with Sprinklers National Fire Protection Association.

From the above statistics, it can be seen that the individual risk of fatality from fire in non-sprinkler protected buildings differs across building types, the risk level is higher in Class 2 buildings, though overall very low.

Injury Rate from Fire

The cost of fire-related injuries impacts on occupants and the wider community in the form of medical expenses, lost productivity and a reduction in overall health and welfare.

It is difficult to quantify the number of fire related injuries occurring in Class 2 and 3 buildings between four and eight storeys in height. FRNSW research identified that on average 134 fire-related injuries have occurred in Class 2 and 3 buildings in NSW between 1 July 2011 and 25 March 2015.

The Report on Government Services (RoGS) gives a breakdown on the proportion of fire-related injuries in Australia and is shown in Table 4.

Table 4: Proportion of fire-related injuries in Australia

Total Fire Injury Admissions	NSW	VIC	QLD	WA	SA	TAS	ACT	NT	AUST
2014-15	29.5%	18.5%	21.8%	13.2%	8.6%	2.6%	0.8%	5.0%	100.0%
2013-14	28.1%	17.4%	22.5%	12.3%	12.0%	2.0%	0.9%	4.8%	100.0%
2012-13	28.2%	15.5%	24.6%	13.4%	10.0%	2.0%	0.9%	5.3%	100.0%
2011-12	27.5%	19.5%	23.7%	12.0%	9.4%	2.0%	0.8%	4.9%	100.0%
2010-11	24.9%	20.9%	24.3%	12.2%	9.5%	2.3%	0.5%	5.4%	100.0%
5 Year Average	27.6%	18.4%	23.4%	12.6%	9.9%	2.2%	0.8%	5.1%	100.0%

Source: Report on Government Services (2016).

Extrapolating the NSW data with the RoGs data, the estimated number of fire-related injuries occurring each year in Class 2 and 3 buildings is 485. The number of injuries occurring within the four and eight storey height range is unknown, however, is conservatively estimated to be 137. This equates to 30% of all fire-related injuries in Class 2 and 3 buildings. [13] Given the uncertainty of the number of injuries occurring nationally, this parameter is also tested through sensitivity and reports the findings of a high (20%) and very high (40%) increase in the annual rate.

The Australian Institute of Health and Welfare[14] reports that in 2013-14, the average length of hospital stay for all burn cases was 7 days. About 16% of hospitalised burn cases were considered high threat to life (HTTL) where the average length of stay increased to 17 days. This suggests that when injuries

[13] This estimate is based on the proportion of new Class 2 and Class 3 buildings constructed in the four and eight storey height range.
[14] Australian Institute of Health and Welfare (2016) "Hospitalised burn injuries Australia" Flinders University.

do occur due to the effects of fire, they are often severe and require on-going treatment and rehabilitation.

The Consultation RIS asked stakeholders whether they agreed with the extent of the problem and whether there were any other characteristics of the problem not identified by the RIS.

A total of 15 unique submissions were received in response to the Consultation RIS, encompassing 18 stakeholders. Of the responses received, the majority felt that the nature and extent of the problem had been adequately described.

Three respondents suggested that the problem was not demonstrated. Two held the view the proposal was a reaction to a specific event while two, including the HIA also believed that the analysis was an exercise in determining the cost-effectiveness of different options which in itself did not demonstrate an unacceptable level of societal risk under the status quo. These stakeholders believed that societal risk should inform further quantification. This view is understood to be driven by a concern that in the absence of objective quantification, a change to the DtS Provisions would unjustifiably lower the risk benchmark.

Advocates of fire protection suggested the problem included a number of additional characteristics including that modern furnishings combined with higher density living increased both the number of incidents and time taken by fire services to respond. These stakeholders also believed that the current research justified the extension of the proposal to all new Class 2 and 3 buildings less than 25 metres in height citing that 92% of historical fatalities occurred in multi-storey residential buildings 3 storeys or less.

The primary purpose of this analysis is to determine whether the current rate of injury and fatality can be reduced using a more cost-effect solution when compared with the current DtS Provisions. The analysis acknowledges that the problem in terms of life safety is very small and therefore any proposed changes should be considered in terms of their cost-effectiveness in providing for an acceptable level of life safety.

The potential for a greater number of fire incidents to occur in the future is noted and sensitivity analysis tests the outcomes of this risk on the expected benefits of the options. However, it should be acknowledged that the historical fatality rate in apartment buildings is currently observed to be small and decreasing over-time. This Final RIS incorporates more data on the extent of the problem to support this finding.

Calls for the scope to be increased to include buildings under four storeys in height would require separate consideration and consultation as the proposed offsets, fire safety features, costs of sprinkler protection would differ by number and degree. Hence, the increase in scope would require separate consideration of the overall impact and likely require different concessions identified for buildings within this height range.

Objective

The primary objective of the NCC is to address safety and health in the design, construction and performance of buildings. The objective of the analysis in this Final RIS is to ensure that the DtS Provisions relating to fire safety for new Class 2 and 3 buildings constructed between four and eight storeys in height are proportional, the minimum necessary to achieve their objectives and the most efficient of the available alternatives. [15] This objective aligns with the Board's and Code's objectives to cost effectively:

- protect the lives of building occupants;
- facilitate fire brigade intervention in the event of an emergency; and
- protect adjacent property from the spread of fire and physical damage in the event of structural failure. [16]

Options

There are two options presented to decision-makers for consideration in addition to the option of retaining the status quo. In the Consultation RIS, the term mandatory was used to describe Option 1. However, as the RIS only considers the DtS pathway as a means of compliance, the Options are described in terms of DtS compliance using sprinkler protection only (Option One) and DtS sprinkler protection as an alternative (Option 2) for clarity.

Status Quo

The status quo is the default choice for decision-makers in considering alternatives to achieve the objectives. Where the incremental impacts of other options would result in more costs than benefits, or would be ineffective in addressing the problem or achieving the objectives, this Final RIS will conclude in favour of the status quo.

The status quo will be regarded as a baseline, as a basis to determine the incremental impacts of the other options. The current DtS Provisions relevant to this Final RIS are described under the status quo in Table 5.

[15] The ABCB's Inter-governmental agreement (IGA) requires that in determining the area and level of the requirements there is a rigorously tested rationale, the regulations are effective and proportional and there is no regulatory or non-regulatory option that would generate a higher net benefit.https://abcb.gov.au/Resources/Publications/Corporate/Inter-Governmental-Agreement.

[16] Relevant Performance Requirements National Construction Code (2016) Volume One Section C, D and E.

Table 5: NCC DtS Provisions under the status quo and proposed offsets under Option 1

NCC DtS Subject Matter	Status Quo	Option 1
Fire sprinkler system	(E1.5) Not required	In accordance with FPAA Specifications 101D*, 101H* or AS 2118.1*
Non-loadbearing walls around fire-isolated stairs	-/90/90	-/60/60
Penetrations in non-loadbearing walls around fire-isolated stairways and internal bounding construction (Specification C1.1 Table 3 and Part C3)	-/60/30	-/60/15
Protect window openings in bounding construction separating a path of travel to an exit along open balcony and landing (C3.11(g)(v))	Wall wetting sprinklers; or -/60/- fire windows; or -/60/- fire shutters	Not required
Distance of travel from SOU door to exit or choice of exits (D1.4(a)(i)(A))	6 m	12 m
Distance of travel to single exit serving the storey at the level of egress to a road or open space (D1.4(a)(i)(B))	20 m	30 m
Maximum distance of travel between alternative exits (D1.5(c)(i))	45 m	60 m
Internal fire hydrants (E1.3)	Where the total floor area exceeds 500 m^2	External hydrant or dry fire main required. Street hydrants used as 'feed' hydrants for suction of water to boost the dry hydrant system need only meet the flow requirement of AS 2419.1 and not the pressure requirement. Note - no concession for the FPAA 101H system feed fire hydrants used for boosting are intended to provide the necessary flow rate to the fire brigade pumping appliance.

NCC DtS Subject Matter	Status Quo	Option 1
Spandrels (C2.6)	A 900 mm spandrel or horizontal construction (both non-combustible and FRL of 60/60/60) is required if a window in an external wall is above another window in the storey below	No requirement

* Scope and Limitations of the FPAA 101D and FPAA101H specifications:

1. Class 3 residential care facilities are excluded.
2. Buildings required to have sprinkler protection to satisfy the proposed verification method CV3 are excluded.
3. Other classifications (e.g. Class 5 or 6) may be situated below a Class 2 or 3 building utilising a FPAA 101H system subject to:
   (i) the sprinkler system being hydraulically designed in accordance with the relevant hazard class as specified in AS 2118.1; and
   (ii) being fire separated in accordance with the NCC fire safety provisions.
4. Other classifications (e.g. Class 5 or 6) may be situated below or above a Class 2 or 3 building utilising a FPAA 101D system subject to the other classifications:
   (i) not exceeding 25 percent of the total floor area of the building; and
   (ii) being fire separated in accordance with the NCC fire safety provisions; and
   (iii) not being located above the fourth storey; and
   (iv) being sprinkler protected in accordance with the concessions currently permitted in Clause 4.3.4 of AS 2118.4; and
   (v) being provided with end of line sprinkler monitoring also providing water supply to toilets serving these ancillary parts of the building.

Option 1 – DtS Compliance using Sprinkler Protection only

This option will amend the DtS Provisions to require fire sprinklers in new Class 2 and 3 buildings having a rise in storeys of four or more and less than 25 metres in height - and allow proportional concessions (Table 5) for other fire safety measures.

Other classifications that occupy storeys in an otherwise Class 2 or 3 building would also require sprinkler protection, due to the heavy reliance on fire sprinklers to maintain exit pathways that pass through or pass by these other classifications.[17]

Compliance with the DtS Provisions (described below) attract similar fire safety concessions. These options are intended to be introduced as a package that encompass a range of alternative sprinkler specifications. They are provided in recognition of the limitations of the domestic system[18] and the potential for buildings of mixed classification or unique configurations require alternative options be provided. This analysis considers all options individually, before examining the aggregate impact based on the assumed uptake of the alternative specifications below.

[17] Analysis recognises the potential for other uses, such as car parking, office space or retail (Class 7, Class 5 or Class 6 buildings) in an otherwise Class 2 or 3 building. It concludes that due to the heavy reliance on fire sprinklers to maintain exit pathways that pass through or pass by these uses, it is critical these areas are also sprinkler protected. EFT Consulting (2017) 2575-1 p. 25.

[18] For uses that occupy more than 25% of the building's total floor area on other levels (below) Class 2 or 3 buildings, or when located above the fourth storey, an FPAA 101D system must not be used.

AS 2118.1: Automatic Fire Sprinkler Systems General Requirements Amendment 1: 1999

This specification provides for the installation of an AS 2118.1 fire sprinkler system in new Class 2 and 3 buildings having a rise in storeys of four or more and less than 25 metres in effective height. Subject to the inclusion of fire sprinklers to this specification, the nominated concessions to other DtS Provisions listed in Table 5 above would also apply.

FPAA 101D Sprinkler System Design and Installation - Domestic Water Supply

This specification provides for the installation of a FPAA 101D fire sprinkler system in new Class 2 and 3 buildings having a rise in storeys of four or more and less than 25 metres in effective height, subject to the limitations listed under Table 5. In addition, subject to the inclusion of fire sprinklers to this specification, the nominated concessions to other DtS Provisions listed in Table 5 above would also apply.

FPAA 101H Sprinkler System Design and Installation - Hydrant Water Supply

This specification provides for the installation of a FPAA 101H fire sprinkler system in new Class 2 and 3 buildings having a rise in storeys of four or more and less than 25 m in effective height. Subject to the inclusion of fire sprinklers to this specification, the nominated concessions to other DtS Provisions listed in Table 5 above would also apply.

Option 2 – DtS Compliance Using Sprinkler Protection as an Alternative

This option would amend the current DtS Provisions to include as a new (alternative DtS), the option to fire sprinkler protect Class 2 and 3 buildings below 25 m in effective height to AS 2118.1, FPAA 101D and FPAA 101H, with proportional concessions to other fire safety features (offsets) in accordance with the specifications and any conditions described in Table 5.

Under this option, the current DtS Provisions (no sprinkler protection) would be retained as an option to meet the NCC Performance Requirements relating to fire safety.

The Consultation RIS asked stakeholders whether they believed there were any other feasible options.

Three stakeholders advocated for referencing AS 2118 Parts 4 and 6 as alternatives to the FPAA fire sprinkler specifications. These Australian Standards pertain to fire sprinkler protection for accommodation buildings not exceeding four storeys in height (AS 2118.4-2012) and combined fire sprinkler and hydrant systems in multi-storey buildings (AS 2118.6-2012).

Two fire safety engineers separately suggested intervention relating to increased early warning and evacuation measures could be implemented. This would place greater emphasis on fire detection and fire brigade monitoring. It was also proposed that this could be combined with emergency evacuation and training requirements for occupants of Class 2 and 3 buildings.

Referencing AS 2118 Part 4 is not possible due to its limited application to residential buildings of up to four storeys in height. This limitation would prevent its use in the majority of Class 2 and 3 buildings within scope of this proposal.

The proposed referencing of AS 2118 Part 6 does not acknowledge the evidence in the Consultation RIS that AS 2118 Part 1 is cost prohibitive to install and routinely service for buildings less than 25 metres in height. The costs of requiring fire sprinklers in accordance with AS 2118.6 are driven to a large extent by the reliance on steel pipe. Therefore, although this option has not been explicitly examined by this Final RIS, it is likely to be comparable to the costs associated with the AS 2118 Part 1 system.

The alternative option to include greater early warning and evacuation measures is likely to demonstrate fewer benefits than the options tested and therefore have also not been examined by this RIS.

Impact Analysis

This section provides an assessment of the incremental costs and benefits associated with each option when compared with the status quo baseline.

Groups Impacted by the Options

The Final RIS identifies the following impacted stakeholder groups–

- Individuals, e.g. owners and occupiers of sole-occupancy units in new Class 2 and 3 buildings constructed between four and eight storeys in height;
- businesses, e.g. developers, builders, building practitioners and the fire safety industry; and
- government, e.g. State and Territory building authorities and fire authorities.

Assumptions and Parameters

The following assumptions and parameters have been used in preparation of this impact analysis:

1. The annual number of Class 2 and 3 buildings approved is not collected nationally. Victoria collects data on the number of approvals issued each year. It is known through ABS comparisons that Victoria accounts for approximately 25% of all building activity occurring annually.

   This has been verified in the following ways:

   - Value of non-residential work completed 2003 – 2013: Victoria accounted for 24.7% of all activity (Catalogue 8752.0 Tables 71 and 72).
   - The number of other residential units completed 2003 – 2013: Victoria accounted for 25.9% of all activity (ABS Catalogue 8752.0 Tables 37 and 39).

   The estimated national number of Class 2 and 3 buildings constructed between four and eight storeys in height approved annually is shown in Table 6.

Table 6: Number of new Class 2 and 3 buildings approved annually more than four storeys and less than 25m in effective height

Building Class	Number
Class 2[19]	897
Class 3[20]	9

2. Based on an analysis of VBA approval data, two representative building sizes were identified; a multi-storey residential building with an average floor plate of 900 m^2 per storey and assumed to contain a single fire-isolated stair, and a larger multi-storey

[19] Based on Victorian data which shows the average number of Class 2 buildings constructed between four to eight storeys to be 224 (2012-2016).

[20] Preliminary analysis by the ABCB suggests the majority of new Class 3 buildings are being constructed outside of the four and eight storey height range.

residential building with an average floor plate of 1200 m^2 and assumed to contain more than one fire-isolated stair.

3. Data received from Phillip Chun Building Compliance during the consultation period revealed:
   - the proportion of single fire-isolated stair buildings is 37% of all buildings constructed within the four to eight storey height range, while the proportion of buildings with two or more fire-isolated stairs represent 63%.
   - the proportion of buildings using the DtS Provisions for travel distance is taken to be 47% of all approvals issued (i.e. 53% of new approvals use Performance Solutions relating to egress in multi-story residential buildings).

4. The analysis by EFT Consulting determined that where a Class 2 or 3 building is located above another class of building there is a need to sprinkler protect these other classes. Quantity surveying by Donald Cant Watts Corke (DCWC) suggests the practice of locating retail (Class 6 buildings) and offices (Class 5 buildings) below Class 2 or 3 buildings is not representative of average buildings within the concerned height range.

5. Consultation with FPAA and AFAC revealed that the Consultation RIS did not consider costs of pumps and associated maintenance for hydrants under the status quo. DCWC were asked to consider the impact of these components as part of the baseline. This analysis has assumed 20% of all new buildings will avoid the need to install and maintain a pump through a concession where FPAA 101D or AS 2118.1 sprinkler specifications are used. [21]

6. Ongoing maintenance and replacement costs were investigated as part of this analysis. Australian Standard AS 1851: 2012 – *'Routine service of fire protection systems and equipment'* establishes the frequency intervals for carrying out regular servicing of fire protection systems and equipment. As maintenance is a state and territory function, this Standard is not referenced in the NCC, and not uniformly adopted by States and Territories in maintenance legislation. This analysis assumes that the frequency intervals similar to those outlined in the Standard are either obligations or applied voluntarily. For all systems with the exception of FPAA 101D, based on advice from FPAA, the analysis assumes an annual visual inspection.

The Consultation RIS asked stakeholders whether they agreed with the assumptions used in the analysis.

One submitter raised a number of technical concerns relating to the effectiveness of the proposed fire sprinkler specifications, namely:

- The robustness of FPAA 101D and FPAA 101H in assuring flows and absolute pressures, which appear to be based on opinion within the EFT report.

[21] A proposed concession under the NCC allow for a dry hydrant riser to be provided in lieu of a 'charged' riser for the FPAA 101D and AS 2118.1 specifications. DCWC excluded these costs in consultation costings on the basis that only a small number of buildings would benefit from their removal.

- The use of toilet systems in monitoring the reliability of supply. It is understood this concern is based on the view that some occupants may not realise there is a problem with their toilet re-filling.
- The consequences of simultaneous flow (i.e. where multiple fires within the building occur).
- The impact of the hydrant system on the fire brigades ability to control and direct water flows to fire-fighter activities.
- The reliability of control valve assemblies in the FPAA 101H system and its impact on reliability.

The same submitter considers the analysis and findings by EFT Consulting baseless; however, the respondent does not provide any alternative evidence to substantiate these claims.

A building certification company also added the following methodological considerations for the Final RIS:

- In their experience, a significant number of potential buildings in scope are currently subject to fire engineering that may result in fewer overall impacts than presented in the Consultation RIS.
- Savings associated with penetrations and linings are unlikely to be realised as selection will be governed by the NCC's acoustic requirements.
- The largest offset (the removal of a fire-isolated stair), will not be realised in many buildings resulting in Option 1 imposing a net cost in the majority of cases.

In response to the methodological concerns raised by the building certification company, the Final RIS has been updated where supported by data to reflect these observations.

AFAC and FPAA were asked to review these technical concerns and concluded that the FPAA 101D and FPPAA 101H system delivers the required level of safety for occupants of Class 2 and 3 buildings citing evidence from 13 full-scale tests by CSIRO and the EFT Consulting Report. AFAC and FPAA consider that the reliability of both FPAA specifications are comparable to or better than existing systems and note the following comparative advantages:

- a reduced number of components within the FPAA systems that reduces points of failure; and,
- failure of a component will result in the loss of domestic water supply, which will be observed by the occupants and result in immediate rectification.

AFAC and FPAA also contend that the development of both FPAA 101D and FPAA 101H followed a rigorous development process citing that FRNSW took a proactive approach in response to the Bankstown Coronial inquest and commissioned research and testing that helped inform the development of the Standards.

The results of the FRNSW research and testing by CSIRO found that the tested systems improved life safety by 67% and 72%. The results of these tests were then used as evidence in the development of FPAA 101D and FPAA 101H fire sprinkler systems and verified by an independent fire safety engineer.

Option 1

This section considers the impacts of removing the current DtS Provisions from the NCC in favour of three new DtS specifications and associated offsets reliant on fire sprinklers for new Class 2 and 3 buildings more than four and less than 25 in in effective height:

- AS 2118.1 Automatic fire sprinkler systems: General Requirements Amendment 1: 1999
- FPAA 101D Sprinkler System Design and Installation – Domestic Water Supply
- FPAA 101H Sprinkler System Design and Installation – Hydrant Water Supply

The costs and benefits of this option are categorised by building size, then by technology. The range of solutions being considered are intended to provide industry with options in meeting the new obligations and is also in recognition of the variations in building stock and technical limitations of FPAA 101D specification.

Costs

The costs of each solution are informed by two reports:

- Final Report on the Cost Implications of Fire Sprinklers in Class 2 and 3 Buildings – DCWC (2018).
- Cost Effective Automatic Fire Sprinkler Protection for Class 2 and 3 Buildings – EFT Consulting (2016).

Revisions to the DCWC estimates for materials have been made in response to the updated FPAA specifications, which are reflected in this Final RIS. Costs below are incremental, measured from the status quo baseline.

Representative Buildings

The Consultation RIS considered four representative Class 2 and 3 buildings:

- A Class 2 building with an average floor plate area of 900 m^2 of six storeys with a basement carpark and designed and constructed under the current DtS Provisions. It was assumed to contain 48 two bedroom SOUs and a carpark containing over 40 car spaces.
- A Class 2 building with an average floor plate area of 1200 m^2 of six storeys with a basement carpark and designed and constructed under the current DtS Provisions. It was assumed to contain 72 two bedroom SOUs and a carpark containing over 40 car spaces.
- A Class 3 building with an average floor plate area of 900 m^2 of six storeys with a basement carpark and designed and constructed under the current DtS Provisions. It was assumed to contain 96 one bedroom SOUs.
- A Class 3 building with an average floor plate area of 1200 m^2 of six storeys with a basement carpark and designed and constructed under the current DtS Provisions. It was assumed to contain 144 one bedroom SOUs.

Since the Consultation RIS, information has been received that highlights that a proportion of Class 2 and 3 buildings are unlikely to contain more than one fire-isolated stair. As such, the impacts are now considered separately based on whether the building has one or more than one fire-isolated stair. The assumed floor plate sizes considered by the Consultation RIS have been retained for this Final RIS.

Buildings containing a single fire-isolated stair

It is assumed that buildings impacted by Option 1 that contain a single fire-isolated stair do not receive the benefits of off-setting the costs of fire sprinklers through the removal of a fire-isolated stair. The following tables show the cost implications of Option 1 in new Class 2 and 3 buildings with an average floor plate of 900m^2.

Table 7: Class 2 building – Single fire-isolated stair

Class 2 – Single Stair	Present Value Construction Costs	Present Value Maintenance	Total Cost
AS 2118.1	$307,971,860	$102,325,643	$410,297,503
FPAA 101D	$138,501,174	($4,565,272)	$133,935,902
FPAA 101H	$272,015,433	$51,171,183	$323,186,616

Notes:

1. Present Value construction costs have been calculated using a 7% discount rate over 10 years.
2. Present Value maintenance costs have been calculated using a 7% discount rate over 40 years.
3. Bracketed values represent cost savings.

Table 8: Class 3 building – Single fire-isolated stair

Class 3 - Single Stair	Present Value Construction Costs	Present Value Maintenance	Total Cost
AS 2118.1	$3,090,019	$1,076,343	$4,166,362
FPAA 101D	$1,389,644	($18,289)	$1,371,355
FPAA 101H	$2,729,252	$548,088	$3,267,340

Notes:

1. Present Value construction costs have been calculated using a 7% discount rate over 10 years.
2. Present Value maintenance costs have been calculated using a 7% discount rate over 40 years.
3. Bracketed values represent cost savings.

Table 9: Total Class 2 and 3 buildings – Single fire-isolated stair

Total Buildings - Single Stair	Present Value Construction Costs	Present Value Maintenance	Total Cost
AS 2118.1	$311,061,879	$103,401,986	$414,463,865
FPAA 101D	$139,890,818	($4,583,561)	$135,307,257
FPAA 101H	$274,744,685	$51,709,271	$326,453,956

Notes:

1. Present Value construction costs have been calculated using a 7% discount rate over 10 years.
2. Present Value maintenance costs have been calculated using a 7% discount rate over 40 years.
3. Bracketed values represent cost savings.

Due to the absence of an additional fire-isolated stair, no specification demonstrates cost savings when compared with the status quo baseline for smaller Class 2 and 3 buildings within four and eight storeys in height. Increases in construction and maintenance costs range from $135 million for the FPAA 101D specification to $414 million for the AS 2118.1 specification in Present Value terms.

These costs will be considered against the life safety benefits and other benefits described below.

Buildings containing more than one fire-isolated stair

As a result of the data received at consultation, a smaller proportion of Class 2 and 3 buildings are now assumed to include an additional fire isolated-stair as a component of the status quo. The proportion greater than 1200 m^2 are assumed to qualify for a stair's removal under the proposal. [22] The cost of each specification in terms of construction and maintenance is shown in the following tables.

Table 10: Total Class 2 Building – More than one fire-isolated stair

Class 2	Present Value Construction Cost	Present Value Maintenance	Total Cost
AS 2118.1	$201,202,693	$166,570,742	$367,773,435
FPAA 101D	($141,320,939)	($18,821,070)	($160,142,009)
FPAA 101H	$143,716,209	$75,227,334	$218,943,543

Notes:

1. Bracketed figures for the FPAA 101D system represent construction cost savings.
2. Present Value construction costs have been calculated using a 7% discount rate over 10 years.
3. Present Value maintenance costs have been calculated using a 7% discount rate over 40 years.

Table 11: Total Class 3 Building – More than one fire-fire isolated stair

Class 3	Present Value Construction Costs	Present Value Maintenance	Total Cost
AS 2118.1	$2,307,150	$1,755,556	$4,062,706
FPAA 101D	($985,345)	$169,128	($1,154,473)
FPAA 101H	$1,153,575	$797,071	$1,950,646

Notes:

1. Bracketed figures for the FPAA 101D system represent construction cost savings.
2. Present Value construction costs have been calculated using a 7% discount rate over 10 years.
3. Present Value maintenance costs have been calculated using a 7% discount rate over 40 years.

[22] Phillip Chun's analysis suggests a proportion of these buildings would not qualify for removal under the proposal.

Table 12: Total Class 2 and 3 buildings – More than one fire-fire isolated stair

Class 2 and 3	Present Value Construction Costs	Present Value Maintenance	Total Cost
AS 2118.1	$203,509,843	$168,326,299	$371,836,141
FPAA 101D	($142,306,284)	($18,890,198)	($161,296,482)
FPAA 101H	$144,869,784	$76,024,405	$220,894,189

Notes:

1. Bracketed represent cost savings.
2. Present Value construction costs have been calculated using a 7% discount rate over 10 years.
3. Present Value maintenance costs have been calculated using a 7% discount rate over 40 years.

Two of the three options demonstrate a net cost when compared with the status quo baseline, ranging from $220 million for the FPA 101H option to $371 million for the AS 2118.1 option. FPAA 101D is more cost effective when compared with the status quo, demonstrating a cost saving of $161 million in Present Value terms.

Total Impacts - Construction Cost and Maintenance

The total construction cost and maintenance implications of Option 1 are shown in Table 13. The below cost outcomes are reported on the basis of full uptake and should therefore be interpreted as a comparative cost analysis of each specification.

Table 13: Comparison of total construction cost and maintenance impacts

Option	Class 2	Class 3	Total
AS 2118	$778,070,938	$8,229,068	$786,300,006
FPAA 101D	($26,206,108)	$216,882	($25,989,226)
FPA 101H	$542,130,159	$5,217,986	$547,348,144

Note: Bracketed values represent cost savings.

Overall, two of the three specifications demonstrate net combined construction and maintenance cost when compared with the status quo ranging from $547 million for the FPAA 101H option to $786 million for the AS 2118.1 option. FPAA 101D demonstrates small net savings of $26 million in Present Value terms. These costs will be compared with the expected uptake of each option and the benefits gained from sprinkler protection.

Stakeholders were asked whether they agreed with the information on costs used in the Consultation RIS and whether they had any other information that would help inform the Final RIS.

The majority of respondents supported the costs prepared by DCWC, however, felt that some minor concessions would be unlikely to materialise where products were not on the market. One stakeholder also questioned whether consideration was needed to compensate for the removal of a fire-isolated stair in terms of structural robustness (bracing). Where relevant, these costs have been revised by the quantity surveyor.

A plumbing stakeholder suggested that the backflow prevention requirements should be raised from low to medium where metal piping is used in an SOU, acknowledging that this would increase the cost of the proposed solutions.

FPAA 101D has the same backflow prevention requirements as other sprinkler specifications; that is, there is a backflow prevention device that separates the sprinkler system (non-drinking water supply) from domestic water supply (drinking water). No cross connection is permitted by the specification either. This addresses the low risk of contamination to the drinking water supply. Pipework for the FPAA 101D system must also be either copper or PE-X pipe, both of which are currently permitted for use in AS 3500.1 – 2015 *'Potable Water Supply Systems'*. As such, no change has been deemed necessary to the specified backflow prevention requirements as the risk from stagnant water is considered equivalent to existing systems.

Benefits

There are two primary sources of benefits arising from Option 1.

These are:

- Avoided fatalities - although already infrequent, the number of fatalities from multi-storey residential fires is expected to fall.
- Avoided injuries – the number of injuries is also expected to fall at the same rate of fatalities.

In addition to these primary benefits there is the potential for significant secondary benefits to arise.

These are:

- Avoided property damage – the cost of property damage as a result of fire will reduce given the effectiveness of sprinkler systems to control fire in its early stages.
- The ability to capitalise space arising from removal of a fire-isolated stair.

Avoided Fatalities

The number of avoided fatalities that can be attributed to Option 1 is influenced by the current rate of fatality in new Class 2 and 3 buildings and the rate at which fatalities can decline with the presence of sprinkler systems.

Risk Reduction

A fire safety engineering analysis was undertaken by EFT Consulting on behalf of FRNSW that compares the risk levels associated with each specification when compared to an NCC DtS building and the results are shown in Table 14. It should be acknowledged that the small difference in risk between options is a result of the degree of system coverage.

Table 14: Comparative risk levels per specification

Specification	Risk Level	Fatalities per 1,000 Fire Starts	Reduction in Risk Level (Percentage)
Current DtS Provisions	3.9×10^{-6}	3.9	-
FPAA 101D Sprinkler System Design and Installation – Domestic Water Supply	1.3×10^{-6}	1.3	67%
FPAA 101H Sprinkler System Design and Installation – Hydrant Water Supply	1.1×10^{-6}	1.1	72%
AS 2118.1 Sprinkler System Design and Installation	1.1×10^{-6}	1.1	72%

As demonstrated by the fire engineering analysis, the effectiveness of fire sprinklers in reducing fatalities within SOUs is estimated to range from 67% and 72% depending on the adopted system. In this regard, all options demonstrate a high degree of effectiveness in reducing the current rate of fatality when compared with the current DtS Provisions.

Estimated Benefits

The National Coronial Information System (NCIS) identify an average of 2.9 deaths per year between 2000 and 2015 totalling 46 fatalities, where the deceased died as a result of a fire in a multi-storey residential building. The number of fatalities by building height is shown in Table 15.

Table 15: Fire-related fatalities (2000-2015) in multi-storey buildings by number of storeys

Number of Storeys	Fatalities
2	23
3	3
7	2
Unknown*	18
Total	46

Note: The incidence of "Unknown" indicates that a clear reference to the building having multiple storeys was made in the coronial reports, however, the exact number of storeys was not able to be identified.

The number of fatalities occurring in Class 2 and 3 buildings between four and eight storeys in height is estimated to be 3.3 fatalities over 16 years, or an annual average fatality rate of 0.21.[23] The estimated benefits associated with reducing fire fatalities as a result of requiring fire sprinklers is shown in Table 16.

Table 16: Benefits from avoidable fatalities

Factor	Total
Total fatalities 2000 - 2015	46
Total fatalities occurring in 4 – 8 storey height range	3.3
Annual fatality rate occurring in 4 – 8 storey height range	0.21
Annual fatality rate occurring in 4 – 8 storey height range under DtS Provisions (47%)	0.10
Effectiveness of fire sprinklers on the rate of fatality (72%)	0.07
Annual rate of avoidable fatalities through changes to the NCC (2%)	0.001
Value of Statistical Life[24]	$4.2 million
Total Annual Benefit	$5,863
Present Value Benefits	$628,515

Notes Present Values have been calculated using a 7% discount rate over 40 years.

The total benefits resulting from a reduction in fatalities is estimated to be $628,515 in Present Value terms using the FPAA 101H and AS 2118.1 systems and $584,868 in Present Value terms using the FPAA 101D system.

Stakeholders where asked in the Consultation RIS whether they had any other information on fatalities.

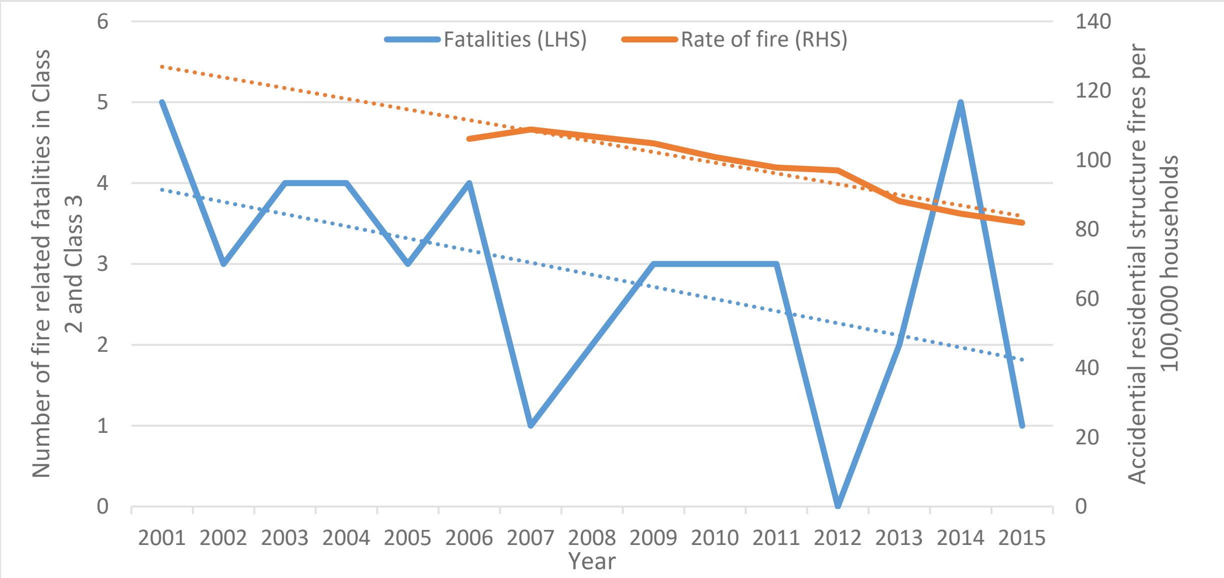
One stakeholder questioned the use of historical data to inform the benefits and suggested the benefits are sensitive to changes in fire events. To emphasize this point they believed that fire events would likely increase based on high density living and the risks associated with modern flammable furnishings and argued this should be reflected by the analysis.

Chart 2 reflects the rate of fire and fatality in multi-storey residential buildings over the recent past based on available data.

[23] The four and eight storey cohort is 7.6% of all fatalities and the remainder from the 'unknown' category are proportionately distributed.

[24] OBPR (2014) Best Practice Regulation Guidance Note – Value of statistical life. Department of Prime Minister and Cabinet.

Chart 2: Number of fire related deaths in Class 2 and 3 buildings (2001 – 2015) and number of accidental residential structure fires per 100,000 households



Sources: NCIS (2018), RoGS (2017).

In response to suggestions these risks are present and increasing, they are yet to be reflected in both the rate of accidental fire and fatalities in the buildings of interest. However, in recognition of the view an increase in future fire events and fatalities may arise, the analysis tests the robustness of the options against a high (20%) and very high (40%) increase in injuries and fatalities over the next 40 years. Based on the information available for this analysis, further investigation of increased fatality and injury is unnecessary as the analysis is insensitive to changes in fatality rate.

Injuries

Table 17 shows the estimated total annual cost of fire-related injuries occurring in Class 2 and 3 buildings between four and eight storeys in height. As described in the problem section, where fire injuries occur, they are moderate to severe injuries and often require on-going treatment and rehabilitation. The costs in Table 17 are based on the Australian estimates for Quality Adjusted Life Years (QALY) and take into account productivity, welfare and medical costs of fire-related injuries.

Table 17: Total cost of fire-related injuries each year

Incidence Avoided	Length of Hospitalisation (days)	Disability Weight	Health Cost per Case	Medical Cost per Case	Total Cost per Case	Total Incidence	Total Cost
Moderate	7	0.172	$32,212	$13,300	$45,512	115	$5,233,898
Severe	17	0.172	$644,243	$32,300	$676,543	22	$14,883,950
Total Cost	-	-	-	-	-	137	$20,117,849

Notes:

1. Length of hospitalisation: AIHW (2016) found that the mean length of stay (MLOS) was 7 days for all hospitalised burn cases in 2013 – 2014. The MLOS was much higher for high threat to life cases at 17 days which accounted for 16% of all burns.[25]
2. Disability Weight: The disability weight index provides weight according to the severity of the injury. C. Mathers, T. Vos, C. Stevenson "The Burden of Disease and Injury in Australia (1999) AIHW Canberra. For fire-related burns the disability weight is reported as 0.172.
3. Health cost per injury: Measures the amount the community is willing to pay to avoid an adverse health outcome. It is derived from the Quality of Adjusted Life Year (QALY) in Australia which is $151,000 (Abelson, 2007). Adjusted for 2016 prices, this amounts to $187,280. Divided by the number of days in a year, a QALD is $513. Hence the cost of a moderate fire-related injury in terms of health costs is $513 x 365 days x 0.172 = $32,212. This analysis assumes that on-going health care is required for one year for moderate injuries and reoccurring for 20 years for severe injuries. There is little published evidence of the need for ongoing care for minor and moderate burn injuries. Surveys of burns on patients' physical and psychosocial life suggest the impact is slight even with respect to severe injuries,[26] however, this assumption recognises there is a greater risk of poor outcomes and longer term rehabilitation at increased severity.[27]
4. Medical cost per injury: Medical costs have been estimated using the National Hospital Cost Data Collection Report (2016) prepared by the Independent Hospital Pricing Authority (IHPA). The average cost per night was $1,900 in the 2014-2015 year. This cost has been multiplied by the length of stay based on the severity of the burn, e.g. the medical cost associated with a moderate burn is estimated to be $1,900 x 7 days = $13,300. In line with the estimated impact of the NCC on all building stock, the change would impact an estimated 2% of buildings. Assuming the same rate of effectiveness in reducing injuries as that of fatalities, the total avoided injury cost is calculated to be $14,596,674 for the AS 2118.1 and FPAA 101H systems and $13,583,016 for the FPAA 101D system in Present Value terms under Option 1.[28] That is

[25] AIHW: Pointer S & Tovell A. (2016) *"Hospitalised burn injuries, Australia 2013 – 2014"* Pg. 20-22.
[26] Health status after recovery from burn injury, Kimmo, Tanttula et al.,Burns , Volume 24 , Issue 4 , 293 - 298
[27] Finlay, Vidya et al. Burns , Volume 35, Issue 8, 1086 - 1091
[28] The Present Value saving of avoiding injuries has been calculated using a 7% discount rate over 40 years.

72% and 67% (respective effectiveness) of 47% (percentage of DtS solutions) of 2% (impact of new buildings) of $20,117,849 (total cost of injuries) each year.

The Consultation RIS asked stakeholders whether they had any other information on injuries.

There was broad support for the information relied upon by the Consultation RIS from those who responded to this question.

Avoided Property Loss

There are some difficulties associated with quantifying property damage arising from fire-related incidents. Fires may not be reported and homes may not be insured, in which case the property damage is not recorded for statistical purposes. Smoke and fire-related damage can also result in loss of personal possessions, essential documents and valuables that resist complete quantification.

The Consultation RIS asked stakeholders whether they agreed with the information on property loss and whether they agreed that the effectiveness of fire sprinklers in reducing damage would be the same as the rate in reducing injuries and fatalities.

Two stakeholders suggested that the options would not be as effective at reducing property loss, citing that fire sprinklers were not loss prevention features. One further stakeholder added that any additional costs in construction should be aimed at reducing fatalities and injuries, and not protecting property. It is acknowledged that there may be a proportion of fires where fire sprinklers do not mitigate damage (e.g. smouldering fires) and some damage can be associated with a sprinkler's activation, again noting that property protection is not the primary objective of this exercise.

In 2017, a contemporary analysis by the U.S National Fire Protection Association (NFPA) into the effects of fire sprinklers reducing property loss revealed that of 356,000 fires that occurred between 2010 and 2014, average losses reduced from $19,301 per fire to $8,100 where fire sprinklers were present[29].

This equates to a 58% reduction in property loss where fire sprinklers were installed. As these figures include single dwellings with less fire resistance than that of apartments, damage under the non-sprinkler protected scenario has the potential to be a non-conservative estimate. Another study into the impacts of the Fire Code Reform Centre in 2001 published analysis of U.S statistics on the cost of property loss arising from fire where a sprinkler system was present in residential apartments (Class 2) and hotels/motels (Class 3).[30] This study found that property loss from fires in apartments and hotels/motels was on average reduced by 47% and 62% respectively.

This Final RIS uses a 58% reduction of property loss as a central case acknowledging this would be an upper bound estimate of the likely benefits. The expected annual avoidable costs from installing fire sprinklers is shown in Table 18.

[29] M. Ahrens, U.S Experience with Sprinklers, July 2017. NFPA, p.11.
[30] FCRC Project 4, Fire safety System Design Solutions, Part 1, Centre for Environmental Safety and Risk Engineering, June 2001, Appendix F.

Table 18: Total cost of fire-related property damage each year

State	Percentage of Fires	Cost of Fire	Avoidable Costs	Present Value
NSW	36%	$17,245,285	$47,011	$3,173,216
VIC	30%	$14,741,857	$40,186	$2,644,347
QLD	14%	$6,691,427	$18,241	$1,234,028
WA	7%	$3,354,346	$9,144	$617,014
SA	8%	$3,637,986	$9,917	$705,159
TAS	3%	$1,556,318	$4,243	$264,435
ACT	1%	$589,477	$1,607	$88,145
NT	1%	$337,901	$921	$88,145
AUS	100%	$48,154,596	$131,269	$8,814,489

Notes:

1. Information has been sourced from unpublished AFAC data and extrapolated using a Report on Government Services.[31]
2. Present Values have been calculated using a 7% discount rate over 40 years.
3. The avoidable costs are based on the proportion of new construction compared with the existing stock (2%).

The RIS acknowledges that the benefits of protecting property are secondary effects of the proposed regulatory change and should be considered incidental to the primary goal of providing an adequate level of health and safety.

Additional Saleable Space

The Consultation RIS identified, but did not quantify, the potential gain from increasing the saleable/lettable space as a result of the reduction in the number of fire-isolated stairs required under both options.

The Consultation RIS asked:

- Do you have any information that could inform the extent an increase in saleable/lettable space will be achieved in practice?
- Do you have any information that would assist in quantifying the impacts of increasing the saleable/lettable space of new Class 2 and 3 buildings?
- In the absence of information, what is a reasonable estimate of the value of saleable/lettable space in a new Class 2 and 3 building on a per square meter basis?

In response to these questions, AFAC commissioned KPMG to quantify the contribution of saleable space to the total benefits of fire sprinklers in Class 2 and 3 buildings. The estimate based on Victorian market analysis of median sale prices of 1, 2 and 3 bedroom apartments over 12 months to December

[31] Report on Government Services, Part D, Chapter 5 “Emergency Services for fir and other events” Productivity Commission.

2017 suggested a premium of $2,878 per square metre is available for 2 bedroom apartments – equivalent to the size used in the DCWC assumptions.

It should be acknowledged that these estimates are based on short-term trends and may be sensitive to time and location chosen. Victorian data is likely to over-estimate prices nationally, as Melbourne is second only to Sydney in medial quarterly dwelling prices over the past 10 years. Apartment development outside of capital cities is less than 10 percent of all approvals concentrated to inner and middle suburbs.

The KPMG's adjusted benefit estimates were not able to be used as part of the Final RIS as these values did not include the costs associated with capitalising a space otherwise occupied by a fire-isolated stair. However, the impacts of Option 1 on increasing saleable space has been quantified for the Final RIS using adjusted costs that include those associated with capitalisation of the space. Table 19 shows the total premium for saleable space under Option 1 which has been adjusted based on updated quantity surveying.

Table 19: Total premium for saleable space arising from Option 1

Number of buildings	Number of Storeys	Premium	Total	Present Value
266	6	$43,170	$68,796,152	$517,019,063

Notes:

1. Based on the modelled proportion of buildings assumed to contain a second stair.
2. Assumes allotment sizes constrain building size and saleable space only arises from the ability to capitalise space inside the building envelope.

The total industry-wide benefit of capitalising the space in a building otherwise occupied by a fire-isolated stair (for those with more than a single stair) is $517,019,063 in Present Value terms.

Comparative Impacts of Each Specification Under Option 1

The total net impacts resulting from each specification under Option 1 are presented in Table 20.

Table 20: Total savings under alternative specifications

Present Values	AS 2118.1	FPAA 101D	FPA 101H
Construction & Maintenance	($1,178,227,087)	($359,047,236)	($939,275,225)
Saleable Space	$517,019,063	$517,019,063	$517,019,063
Injuries	$14,596,674	$13,583,016	$14,596,674
Fatalities	$628,515	$584,868	$628,515
Property	$8,814,489	$8,814,489	$8,814,489
Total	($637,168,346)	$180,954,200	($398,216,484)

Note:

1. Bracketed values represent negative savings (costs).

The individual impacts of each specification differ significantly and range from a net cost of $637 million for the AS 2118.1 option to a saving of $181 million for the FPAA 101D option in Present Value terms. Due to the large variation in outcomes depending on which specification is used, these results need to be considered in conjunction with the expected uptake of each specification which is discussed below.

Uptake of Alternative Sprinkler Specifications

As only the FPAA 101D system generates a net benefit in its own right, and acknowledging that this specification cannot be used in all circumstances, the aggregate impact of both options will be dependent on the rate at which all specifications are adopted.

The degree to which each specification will be selected in practice is not known with certainty. A central case has been constructed based on the following information:

1. Designers apply a top down approach to system design – selecting a system on its ability to serve the proposed design, based on the limitations of the specification. These limitations may depend on the:
   - availability of materials and skilled labour;
   - familiarity and recognition of a system; and
   - building characteristics including floor area, compartment sizes, water supply and inclusion of other classifications and their location within a building. [32]

2. Individual specification costs suggest there would be a strong preference for the FPAA 101D domestic specification where the limitations of the system are not exceeded and the configuration provides the opportunity to reduce the number of fire-isolated stairs.

   The FPAA 101D system cannot be used where–
   - other classifications (e.g. Class 5 or 6 part of building) are situated above or below the Class 2 or 3 part of building; and
   - where another Class of building exceeds 25 percent of the total floor area of the building; and
   - Recycled water used to supply the toilet fixtures would prevent end of line monitoring as grey water is not a permitted water supply for fire sprinkler systems[33].

3. The assumed uptake between sprinkler systems remains unchanged from the Consultation RIS. The Final RIS assumes 60% of future approvals will use the FPAA 101D system (assumed to be used in all circumstances where limitations do not restrict installation), 30% of all future approvals will use the FPAA 101H system (the majority of approvals which cannot utilise the FPAA 101D system) and 10% will use AS 2118.1 (a small proportion of industry which are assumed to use familiar but not cost-effective solutions).

[32] Discussed in EFT Consulting 2575 -1 pg.25 and 52.
[33] Understood to be a requirement of local government sustainability requirements in some metropolitan areas.

Stakeholders were asked if the building types used in the Consultation RIS were representative of common Class 2 and 3 buildings within the affected range and if data could be provided to inform these assumptions?

Philp Chun Building Compliance, a national building surveying firm, noted a number of factors that would influence the uptake of fire sprinklers. They submitted that more than half of Class 2 and 3 buildings were subject to Performance Solutions with the aim of achieving extended travel distances.

Methodologically this has several implications. Firstly, optimisation of design, if pursued to achieve the same outcome at a lower up-front cost, would continue under either option. The proportion subject to Performance Solutions should therefore be excluded. More significantly, as cost effectiveness is in large part driven by the savings associated with the ability to remove a fire-isolated stair, any proportion with one fire-isolated stair under Option 1 using the DtS Provisions would incur a net increase in construction cost, notwithstanding the increase in life safety benefit. The ABCB approached other building certification stakeholders seeking views on the likely proportions and no uniformity of view could be found. As no data of this type is collected nationally, Phillip Chun Building Compliance were approached to provide additional information supported by data.

An interrogation of Phillip Chun's national database identified 77 buildings at various stages of design construction and occupancy for which they had been engaged between 1 January 2013 and 16 July 2018. These included Class 2 and 3 projects within the four storey to eight storey height range from Victoria (11), New South Wales (27), Queensland (32) and Western Australia (7) offices. Table 21 reflects the diversity of configurations and compliance pathways.

Table 21: Building configurations and compliance pathway

Number of stairs	DtS	Performance Solution for egress	Total
Single fire-isolated stair	*13*	*23*	36 (47%)
Two or more fire-isolated stairs	*23*	*18*	41 (53%)
Total	36 (47%)	41 (53%)	77 (100%)

Importantly the data revealed the proportion of buildings utilising a single fire-isolated stair either via the DtS Provisions or a Performance Solution (53% of all approvals). For buildings that contained two or more fire-isolated stairs, a lesser proportion used Performance for this purpose. This Final RIS excludes 53% of all approvals nationally on the basis that they will be unaffected by the proposal and will continue to use the Performance Solution pathway.

Phillip Chun's analysis also identifies the number of buildings likely to utilise more than a single fire-isolated stair until a particular size building is reached. As the number of stairs are a function of travel distance, under the proposal, there may be opportunities for buildings with multiple fire-isolated stairs to gain efficiencies by reconfiguring.[34] Despite this, it is the proportion with a single fire-isolated stair that will incur an increase in capital cost from installing a sprinkler system. Therefore the proportions

[34] According to Chun's analysis, the number of projects currently designed/constructed with two or more stairs for which a single stair would be feasible was 7 (9% of the total projects within the target range).

identified by Chun's analysis as utilising a single stair under the DtS have been adopted for the number of single stair buildings (36%).

These configurations are suggestive of a different profile of market behaviour than that assumed by the Consultation RIS and have informed the analysis in the following way:

- The total proportion subject to influence is reduced by the percentage known to be using Performance Solutions for egress 53% from 897 to 422.
- Of the 422 buildings subject to Option 1, the proportion assumed to contain more than one fire-isolated stair is 269 (63%). Hence, the number of Class 2 and 3 buildings being approved with only a single fire-isolated stair is 153 (or 36%).

Total Impacts

As shown in Table 22, based on the information above, and assuming the same uptake of each specification as the Consultation RIS, Option 1 demonstrates a net cost of $74.5 million in Present Value terms.

Table 22: Total Net Present Value of Option 1 - Aggregate estimate

DtS Status Quo	AS 2118.1	FPAA 101D	FPAA 101H	Option 1
N/A	10%	60%	30%	-$74,609,260

Option 2

Option 2 would include, as an option, compliance with AS 2118.1, FPAA 101H and FPAA 101D while maintaining the current DtS provisions as an alternative option for compliance. This option has the potential to capture the benefits of Option 1, where industry identifies it as cost effective to do so, while minimising impacts on buildings and the industry in other circumstances, such as a result of the following:

- Unique building configurations, or mixed use classifications.
- Water supply or industry capability.[35]
- Existing infrastructure in mixed-use buildings.
- Overarching sustainability requirements which may not permit the use of the FPAA 101D system.

Option 2 assumes the uptake of the FPAA 101D specification is consistent with Option 1 (60%) in recognition of the opportunities to reduce construction cost and gain saleable space. Where FPAA 101D is unable to be used, this option assumes that building practitioners would not opt for higher cost, but rather continue using the current DtS Provisions to achieve compliance. Likewise, in circumstances where only a single fire-isolated stair is proposed, the most cost effective solution would be to continue to adopt the current DtS Provisions.

Hence, the costs and benefits under Option 2 reflect the assumption that industry will not adopt a higher cost specification voluntarily in circumstances where it is not cost effective to do so. This has

[35] AFAC/FPAA proposal notes that mandating the installation of sprinklers would lead to higher demand on experienced trades than could likely be met, particularly in regional areas.

the effect of reducing the primary benefits of life safety and those of property protection (secondary benefits) proportionally to the uptake of alternatives to FPAA 101D, and decreasing costs relative to the efficiency of the alternatives. The Net Present Value of Option 2 is shown in Table 23.

Table 23: Total Net Present Value of Option 2 – Aggregate Estimate

Option 2	Present Value
Construction and Maintenance	($134,243,988)
Saleable Space	$196,467,244
Injuries	$5,161,546
Fatalities	$222,250
Property	$3,349,506
Total	$70,956,558

Notes:

1. Construction and maintenance costs and benefits associated with saleable space calculated to be 60% of all large Class 2 and 3 buildings.
2. Avoidance of injuries, fatalities and property loss calculated to be 38% of Option 1 (that is 60% of 63%).

Option 2 demonstrates small net savings in the range of $71 million in Present Value terms.

Stakeholders were asked whether they had any comment on the ability of industry to meet the demand for sprinkler protection in four to eight storey Class 2 and Class 3 buildings.

Four stakeholders suggested that demand for fire sprinklers would be unserviceable by industry upon implementation on the basis that practitioners would need to re-train and manufacturers re-tool. These stakeholders also advised that the fire safety industry is currently facing a labour shortage and the industry had more positions vacant than could be filled.

Contrary to these views, the National Fire Industry Association indicated that the industry had a surplus of labour and apprentices in training. Similarly the AFAC and the FPAA submission indicated that a number of alternatives were available, including allowing the existing plumbing labour force to be permitted to install fire sprinklers. This is considered feasible under both options.

A plumbing business raised concern regarding the timely availability of purpose made products before implementation, suggesting this problem could be exacerbated if the requirements were to replace the existing DtS provisions.

The materials and components for both systems are currently available with the exception of:

- Sprinkler heads that conform with the WaterMark Certification Scheme; and
- “lugged” tees.

FPAA is currently working with industry partners of the Home Fire Sprinkler Coalition (i.e. sprinkler manufacturers/suppliers) to ensure their sprinkler heads obtain Watermark prior to NCC 2019 being adopted. However, this remains an unresolved supply constraint and may warrant consideration of a transitional arrangement should Option 1 be supported.

In regards to “lugged” tees, these are available internationally, but currently there is little demand to install these in Australia. With the introduction of the specifications, such demand will be supplied from international manufacturers whilst production lines may be established in Australia.

Sensitivity Analysis

This section examines the sensitivity of the quantitative analysis to variations in key assumptions underpinning the aggregate gross impact. The sensitivity analysis has been conducted on the following areas noting the following:

- A real discount rate of 7% has been used in the quantitative analysis, and sensitivity will be tested from a lower bound of 3% to an upper bound of 11%.
- Construction costs and maintenance may vary between States and Territories. The sensitivity analysis will test a variance of ±10%.
- The proportion of buildings constructed with two or more fire stairs could vary. The sensitivity analysis will test a ±10% variation.
- Not all buildings will be capable of meeting the requirements of the FPAA 101D option. As such, the analysis may be sensitive to the uptake of the option and the sensitivity analysis will test a ±20% variation.
- The rate of injury and fatality will also be tested and the analysis will apply a high (20% increase) and very high (40% increase) to the results.

Table 24 shows the outcomes of the sensitivity analysis of each varied parameter on the Present Value of the options.

Table 24: Sensitivity testing of NPV outcomes

Parameter	Option 1	Option 2
Discount Rate Low (3%)	($103,655,318)	$97,763,435
Discount Rate High (11%)	($66,457,910)	$50,781,898
Construction Costs Low (-10%)	($13,105,899)	$84,380,957
Construction Costs High (+10%)	($136,112,622)	$57,532,159
Proportion of buildings with two or more fire stairs - Low (53%/47%)	($151,257,905)	$63,544,690
Proportion of buildings with two or more fire stairs - High (73%/27%)	($23,386,853)	$78,368,426
Specification uptake FPAA 101D -Low (10% AS 2118.1, 40% FPAA 101D, 50% FPA 101H)	($190,443,397)	$45,504,367
Specification uptake FPAA 101D High (5% AS 2118.1, 80% FPAA 101D, 15% FPAA 101H)	$53,172,469	$91,008,734

Parameter	Option 1	Option 2
Rate of Injury and Fatality High (+20%)	($71,691,099)	$72,033,317
Rate of Injury and Fatality Very High (+40%)	($68,772,938)	$73,110,076

Option 1 demonstrates net costs under the majority of parameters tested through sensitivity analysis. Two scenarios demonstrate small net benefits under Option 1. Very high uptake of the domestic system was modelled to reflect FPAA expectations that AS 2118.1 would not be adopted into widespread use due to cost. While cost would prove a barrier to adoption under the status quo for some buildings, should Option 1 be implemented, there would be an absence of DtS alternatives. AS 2118.1 is proposed in recognition of the known limitations of the FPAA specification, and draws on significant industry capability and awareness. Given stakeholder feedback on the assumptions used in the Consultation RIS, the very high uptake scenario is considered unlikely.

The other sensitivity test that demonstrates small net benefit under Option 1 is the proportion of new buildings with two or more fire stairs, increasing from 63% to 73%. The central scenario of 63% is an upper bound and analysis by Phillip Chun Building Compliance suggests the potential for fewer buildings able to reduce fire-isolated stairs. As such, this scenario is also considered unlikely.

All parameters tested under the sensitivity analysis for Option 2 demonstrate small net benefits ranging from $46 million to $98 million. Each sensitivity test also revealed that in all cases Option 2 produced higher net benefits when compared with Option 1. It should also be noted that the results of each option are not sensitive to changes in life safety (injury or fatality) outcomes largely due to the low frequency of fatalities and injuries currently occurring in these buildings.

Unintended Consequences

A potential unintended consequence that could result from the inclusion of measures to decrease individual risk (within a SOU) is the potential impact on societal risk arising from providing concessions to the current DtS Provisions.

The fire engineering analysis concluded that for the buildings modelled, using the proposed sprinkler options, the societal risk was consistently lower than an equivalent building under the status quo with the same building population.

Other classifications were also acknowledged as being potential components of an otherwise Class 2 or 3 building. The risks associated with evacuation using an exit that passed through or by these parts were considered significant enough to require these ancillary uses to also be sprinkler protected, which is reflected in all specifications.

The resulting conclusions of the fire engineering analysis found that all options being considered by this Final RIS did not increase the societal risk of occupants in buildings and on balance reduced this risk.

Business Compliance Cost

Industry will incur a one-off education cost to become aware of the proposed DtS Provisions for fire sprinklers, and to reflect how to respond to them and their objectives. The ABCB seeks to effectively communicate changes to the NCC and hence minimise education costs, by holding seminars in each jurisdiction to explain the changes. The building industry takes time and effort to become familiar with the changes each year, including through strong participation in the ABCB seminars (about half a day). As an indication of the size of the one-off education costs, the incremental contribution of the sprinkler provisions would be a small part of this education exercise, around 10 minutes in a half-day seminar.

Stakeholders were asked in the Consultation RIS whether they felt there were any business compliance costs that should be considered by the Final RIS.

Concern was raised in regards to the current competency of practitioners and whether there was need for further training to be provided at a TAFE level.

FRNSW, FPAA and AFAC consider the current TAFE qualifications to be suitable and provides for the necessary skills to install these fire sprinkler systems. However, they do consider it necessary to provide dedicated training workshops for installers, designers, and building surveyors to inform them of the subtle differences from what they would know as typical historical type sprinkler systems. Should either option be adopted, training and awareness to the industry will be provided by FPAA.

It is understood that the FPAA and AFAC will also prepare appropriate training and information materials for use by practitioners upon the introduction of any new specifications.

Regulatory Burden

The Australian Government has introduced the 'Guide to Regulation', which discusses the importance of cutting red tape.

A key principle for Australian Government policy makers in the Guide to Regulation is that:

The cost burden of new regulation must be fully offset by reductions in existing regulatory burden.

All regulatory costs, whether arising from new regulations or changes to existing regulation, must be quantified using the Regulatory Burden Measurement framework. The framework must also be used for quantifying regulatory savings, where applicable.

As measured in accordance with the framework, the regulatory burden associated with each option is shown in Table 25.

Table 25: Regulatory Burden Measurement

Regulatory Burden Measurement	Option 1	Option 2
Substantive Costs		
Construction Costs	($23,404,763)	$11,361,428
Maintenance Costs	($1,361,683)	($261,026)
Training – Building Certifiers	($56,463)	($18,127)
Training – Plumbing Practitioners	($66,321)	($21,292)
Total	($24,889,230)	$11,060,983

Notes:

1. All costs are annualised and presented in real terms.
2. Construction and maintenance costs reflect capitalised square meter costs and relative uptake of each system under each option.
3. Training costs incurred for FPAA 101D and FPAA 101H systems only.
4. Training costs to Building Certifiers under Option 1 calculated as 18 x 0.12 x $68.79 x 380 (number of pages x time required x wage rate x number of times performed)
5. Training costs to sprinkler fitters/plumbing practitioners under Option 2 calculated as 18 x 0.12 x $80.80 x 122 (number of pages x time required x wage rate x number of times performed).
6. Training costs to Plumbing Practitioners follows same method as Building Certifiers with a wage rate of $80.80

Option 1 imposes a regulatory burden of $24,889,230 of which the Commonwealth's share is $2,765,537.

Option 2 generates a regulatory saving of $11,060,983 of which the Commonwealth's share is $1,228,998.

Governments of the States and Territories are not required under COAG policy to identify regulatory offsets. Some jurisdictions may have their own mechanisms regarding regulatory offsets, which would be a matter for those jurisdictions to consider.

Consultation

Consultation is the cornerstone of the ABCB's commitment to create a contemporary and relevant construction code that delivers good societal outcomes for health, safety, amenity and sustainability in the built environment. This must be achieved in the context of good regulatory practice that evaluates the costs and benefits to society, as per the objective of the ABCB's Inter-Government Agreement. The ABCB recognises the value of engaging constructively with the community and industry in order to achieve this.

There were 15 submissions to the Consultation RIS. Submissions were received from the following stakeholders:

1. Acceptable Public Domain
2. An Architect
3. Australasian Fire and Emergency Services Council (AFAC)
4. BGC Construction
5. BR Plumbing and Excavations Pty Ltd
6. Building Code Group
7. Fire Protection Association of Australia (FPAA)
8. FIRE Technical Services
9. Housing Industry Association (HIA)
10. Master Builders Australia
11. National Fire Industry Association
12. National Fire Industry Association Australia
13. Phillip Chun Compliance
14. Plumbing and Pipe Trade Employees Union
15. Plumbing Industry Climate Action Centre
16. Property Council of Australia
17. Stephen Grubits and Associates
18. UNSW Enabling Built Environment Program

In general respondents were supportive of the description of the problem, three respondents felt the proposed solution was not commensurate with the problem. Problems outside of the influence of the analysis raised by respondents included the proportion of buildings less than 4 storeys where fatalities occur, fire service capability and future risks from increased population density.

Valuable technical feedback was received and considered via the specification's development process by the proponent. This report reflects a revised standard including amendments to the proposal and in some cases costs following further research and consultation. No new feasible alternatives to the proposal were identified.

Five stakeholders raised concerns over industry capability to service the required demand under Option 1, an area acknowledged by the analysis as needing to be addressed directly via training. Data including market behaviour and performance solutions, building configurations, maintenance and saleable space was provided from FPAA, Phillip Chun Compliance and AFAC.

Responses to consultation questions have been included throughout this document.

Conclusion

The analysis reveals that of the options proposed, Option 2 produces a small net benefit relative to the status quo.

The proposed sprinkler specifications and associated offsets present a range of benefits for Class 2 and Class 3 buildings that include reductions in individual and societal risk, improved property protection, and where larger buildings are constructed, more flexibility in building design and configuration associated with the removal of other fire safety features.

Under Option 1, a range of costs would apply to specifications and be offset to differing extents primarily through increased travel distances allowing the ability to reduce the number of fire-isolated stairs and to a lesser extent through other offsets and associated maintenance. Primary benefits are small and savings are driven by those configurations with the potential to increased travel distance.

The FPAA 101D specification was found to be the most cost effective of all specifications under the assessed building configurations. It is assumed that where configurations allow, industry will use this specification, which also requires the lowest ongoing maintenance cost. The analysis recognises saleable/lettable space will be a significant incentive and encourage the uptake of FPAA 101D (under either Option), although savings are unlikely to extend to those buildings with only a single fire-isolated stair. As not all designs can utilise this configuration, the share of alternative specifications is found to be important. Taking these factors into consideration, Option 1 demonstrates a net cost of $74,609,260 in Present Value terms.

A number of key assumptions were varied to assess the robustness of this outcome that did not change the proportional standing of the options. The variance of market uptake of the most cost effective specification was found to be most sensitive to change. Raising the uptake of FPAA 101D had the effect of increasing benefits under both options and produced a small net benefit under Option 1. However, stakeholder feedback on the assumptions used in the Consultation RIS and the known and unknown limitations of the FPAA 101D system suggest higher uptake would be unlikely should Option 1 be implemented.

Conversely, Option 2 assumes industry will only opt for FPAA 101D at the same rate as Option 1 and in scenarios where it is unable to be used, revert to the current DtS Provisions. For Option 2, even under a lower than expected uptake, all scenarios demonstrate a net benefit. As Option 2 generates the highest net benefit of $70,956,558 in Net Present Value terms, this RIS recommends Option 2 sprinkler protection as an alternative option under the DtS for implementation in NCC 2019.

Implementation and Review

If approved, the measures are proposed for reference in the NCC and would apply alongside the current NCC DtS Provisions in NCC 2019.

As a matter of policy, proposed changes to the NCC are released in advance of implementation to allow time for familiarisation and education and for industry to modify its practices to accommodate the changes. It is anticipated that State and Territory building Administrations and industry organisations, in association with the ABCB, will conduct information and awareness raising practices. Further FPAA have indicated that training on the new measures will be available ahead of implementation.

A specific review of the preferred option is not planned following its implementation. The NCC is amended on a three yearly cycle and the ABCB maintains regular and extensive consultative relationships with a wide range of stakeholders. It relies on this process to identify emerging concerns, and through these relationships can evaluate the uptake of the alternative specifications proposed, which would serve as an indicator of acceptance and cost effectiveness.

Appendix A: International Comparison

Summary of International Approaches

The ABCB participates in an international Inter-jurisdictional Regulatory Collaboration Committee (IRCC) that includes 18 member countries and affiliates. A comparative study of international building regulations has been conducted to determine approaches to fire safety in other jurisdictions based on a survey of IRCC members.

A common rationale for the inclusion of fire sprinkler systems in buildings was reported as the practical realities faced by fire authorities when fighting fires above certain heights. Other counties such as Norway reported mandating fire sprinklers was done in recognition of the abilities of vulnerable occupants to identify and use escape paths.

Like Australia, Scotland, Sweden, Singapore and Japan include triggers beyond a nominated height or fire compartment size. Other jurisdiction's requirements vary according to the fire safety strategy adopted.

In Norway's case, the decision to mandate fire sprinklers is tied to the needs of vulnerable occupants and the directive to adopt mandatory sprinkler protection supports a 'protect in place' strategy. In Australia, such strategies are implicit in high care settings, such as hospitals and aged-care buildings. However, strategies for building evacuation management in residential buildings will be informed by the building's fire safety features such as the presence of an Emergency Warning and Intercommunications System (EWIS). In buildings less than 25 m in effective height, evacuation is therefore reliant on established building procedures and may include a range of responses including phased evacuation due to initial localised cues to evacuate, protect in place or full evacuation at the direction of an attending fire brigade.

The effect of fire sprinkler protection on evacuation and societal risk has been examined by EFT Consulting by undertaking risk analysis and is discussed in the unintended consequences section of this Final RIS.

Scotland

In Scotland new apartment buildings where the top floor is more than 18m above the ground require automatic fire suppression systems to be installed. Under the Technical Handbook 2017 – Non-Domestic, automatic fire suppression such as that which would be used in hotels is an option as part of a fire engineered solution or where the building is designed on the principle of phased evacuation and the top floor is more than 25m above ground. Where a design accommodates simultaneous evacuation of occupants automatic sprinkler protection is not required.

Research from 2015 provided a marginal case for installing fire sprinklers in halls of residence (student accommodation) based on the benefits associated with property protection.

Norway

In 2010 the Norwegian building regulations were amended to require an automatic fire extinguishing system in residential buildings greater than two storeys (where a lift is required). This change complemented the recognition of a 'protect in place' strategy for occupants with disabilities and coincided with a requirement for automatic sprinkler protection in hotels, hospitals, health care facilities, care homes or supported accommodation and housing specially designed and intended for persons with disabilities to ensure the fire safety of vulnerable occupants.

United States of America

The International Building Code is a model code published by the International Codes Council for adoption by jurisdictions both within and outside the United States. Since 2003, the model code has required all residential occupancies to be sprinkler protected throughout the entire building. This requirement is reported to be universally adopted for buildings other than single houses.

Sweden

Automatic sprinkler protection is only mandatory in hospitals and in some nursing homes. All buildings greater than 16 storeys (approximately 48 m) are subject to 'analytic design' and hotels are suggested to commonly install sprinkler systems to gain concessions to other fire safety requirements.

Singapore

Automatic sprinkler protection is required where the height of a building is greater than 24m or where minimum compartment sizes are exceeded. In a building of mixed use, where a residential component forms the upper storeys, this requirement applies to every storey of the non-residential portion only and any basement not used for residential purposes.

Japan

Residential buildings greater than 11 storeys (approximately 33 m) require automatic sprinkler protection. For hotels greater than 11 storeys, the trigger applies where the floor area exceeds 6,000m^2. For buildings of lesser height, floors from 4th to 10th with a floor area that exceeds 1,500 m^2 require sprinkler protection. In other residential type buildings such as hospitals and welfare facilities, a requirement to install fire sprinklers exists where a floor area trigger of greater than 275 m^2 is exceeded.