Final

REGULATION IMPACT STATEMENT

For Decision

Assessment of options for residential smoke alarm provisions in the National Construction Code

October 2012

This Regulation Impact Statement (RIS) 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 proposals to revise the requirements for smoke alarms.

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 mission is to oversee issues relating to health, safety, amenity and sustainability in building. The ABCB promotes efficiency in the design, construction and performance of buildings through the National Construction Code, 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 www.abcb.gov.au

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Summary

This Regulatory Impact Statement (RIS) provides an analysis and evaluation of the current smoke alarm provisions contained in the National Construction Code (NCC) against a number of options to improve occupant notification and response times in the event of fire.

Following direction from the Australian Building Codes Board (ABCB), Victoria University (VU) was commissioned to provide a report on the efficacy of the current smoke alarm provisions for Class 1a buildings (houses).

The report concluded that the current minimum requirements for smoke alarms do not provide complete coverage for notification of fire in residential dwellings and that smoke alarms in every room in every dwelling in Australia would result in 17% to 30% fewer fatalities. This could be increased to 50% fewer fatalities if all alarms were interconnected.

The nature of the problem is that occupants may not be sufficiently notified of a fire in residential dwellings in Class 1, 2, 3 and Class 4 parts of buildings to enable, as required, emergency egress. The extent of the problem which may be attributed to new construction, and therefore the NCC, was observed to be approximately 1.5 fatalities and 8.4 injuries annually due to residential fires.

It was observed that other factors (behavioural and social), such as social economic status, higher risks associated with vulnerable individuals (young, elderly, impaired), disconnection of alarms, impaired by drugs or alcohol, maintenance of property, and non-compliance also reduced the efficacy of smoke alarms. This in part would be expected to continue and may be directly responsible for a proportion of current fatalities and injuries. Hence strengthened regulations only form part of the solution.

Extensive educational and information campaigns run by State and Territory fire authorities provide an excellent tool to minimize these 'other factors'; these were considered part of the status quo.

A range of options were considered to address the problem. All proposals were considered with and without interconnection of alarms. Proposals include;

- Status Quo: smoke alarms installed in accordance with the current NCC requirements;
- Option 1: Smoke alarms as per the status quo and installed in all bedrooms;
- Option 2: Smoke alarms installed in every room excluding the kitchens, bathrooms, toilets and laundries; and
- Option 3: Smoke alarms installed in every room of the dwelling.

The cost benefit analysis has been amended since the Consultation RIS in response to stakeholder advice on the occurrence of fatalities and cost of installation of smoke alarms. The revised analysis indicates that all options present a significant net cost with low cost benefit ratios not dissimilar to the findings of the Consultation RIS.

Stakeholders in their submissions in relation to these findings suggested that there are grounds for regulatory change regardless of economic implications.

"Government has an ethical responsibility to set minimum requirements based on community expectations for safety, such as those referenced in the current Objectives relating to automatic warning of the detection of smoke. The cost benefit analysis approach

would appear to be redundant if the outcome is to establish or retain requirements that have been demonstrated not to achieve their objective."

Contrary to this statement, stakeholders from the building industry and the majority of State and Territory governments believe that the economic implications on industry are too great to support any regulatory change.

The costs and benefits associated with each proposal were as follows:

Proposed amendments	Benefits ($)	Cost ($)	BCR	NPV ($)
Option 1a	$105,982,200	$446,275,732	0.24	(-) $340,293,503
Option 1b	$249,369,844	$ 554,592,775	0.45	(-) $305,222,931
Option 2a	$155,381,219	$846,377,366	0.18	(-) $690,996,147
Option 2b	$280,541,088	$1,037,955,667	0.27	(-) $757,414,579
Option 3a	$187,027,412	$1,429,790,325	0.13	(-) $1,242,762,913
Option 3b	$311,712,353	$1,723,102,324	0.18	(-) $1,411,389,971

*a) Options without interconnection

*b) Options with interconnection

The benefits quantified in the final RIS are higher than calculated from the Consultation RIS. This is a result of the effectiveness rates of each option being revised to align with the findings of the VU report and stakeholder submissions.

The authors of the VU report estimate that installation of smoke alarms in every room, in every dwelling would result in 17-30% fewer fatalities and that interconnected smoke alarms in every room in every dwelling would lead to about 50% fewer fatalities. The VU concludes that the great majority of this benefit would be obtained if interconnected smoke alarms were placed in bedrooms lounge rooms and kitchens.

Applying the same logic, each option has been proportionally weighted up to an effectiveness rate of 50%.

Due to the low number of fatalities and injuries attributed to new construction, the benefits of the proposals were also low. It was therefore observed that all options would provide a large net cost to the community, even with a sensitivity analysis applied to the major variables.

Despite the net cost identified in the Consultation RIS stakeholders were evenly divided in their preference of retaining the status quo and option 1b. Two stakeholders were highly critical in the methodology of the calculating benefits in the Consultation RIS; see AFAC and FPA sections in the Consultation Chapter for stakeholder comments and ABCB responses, Of the options proposed, Option 1b presents the lowest net cost to industry however the costs associated with this option is still considered to be an excessive burden on the construction industry and therefore retaining the status quo is preferred.

Recommendation

It is recommended that the Board retain the status quo.

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Glossary

ABCB	Australian Building Codes Board
ABS	Australian Bureau of Statistics
AFAC	Australian Fire and Emergency Services Authorities Council
ARC	Australian Research Council
AS	Australian standard
AS/NZ	Australian / New Zealand standard
BAC	Blood Alcohol Content
BCA	Building Code of Australia
BCC	Building Codes Committee
BCR	Benefit Cost Ratio
BMF	Building Ministers Forum
BS	British Standard
CCD	CESARE Coronial Database
Class ( )	Classification of building as defined in the NCC
COAG	Council of Australian Governments
CPSC	Consumer Product Safety Commission
dB	A measure of sound level
dB(A)	Sound levels in the human auditory frequency range
DtS	Deemed-to-satisfy provisions in the NCC
HIA	Housing Industry Association
Hz	Hertz – a measure of frequency
NCC	National Construction Code
NTS	National Technical Summit

Introduction

The adequacy of the provisions for smoke alarms, in residential dwellings has been raised on several occasions. Following the recommendations from the National Technical Summit in 2007 and 2008, the Building Codes Committee (BCC) recommended the ABCB add a review of the current smoke alarm provisions to the ABCB 2008/09 Work Plan.

The Board responded to these concerns by directing the ABCB Office to research the observed problem, prepare possible solution\s and to rigorously test the rationale of all options to address the problem through a Regulation Impact Statement (RIS). This was subsequently considered and approved by the Building Ministers' Forum (BMF).

Following the direction from the Board in June 2008, the ABCB, with the Australian Research Council (ARC) commissioned Victoria University (VU) to prepare an investigative study into the efficacy of smoke alarms and their ability to provide early detection and notification of a fire hazard.

The findings of the VU report formed the basis for proposed options that would increase notification to occupants in the event of fire and a Consultation Regulation Impact Statement (RIS) was prepared and made publicly available for comment in July 2012.

The purpose of this final RIS is to analyse and evaluate the current smoke alarm provisions contained in the National Construction Code (NCC) against a number of options that improve occupant notification and response times from the event of fire and provide a basis for decision-making on these options by the ABCB Board.

This RIS also presents a summary of the stakeholder responses in chapter seven and incorporates pertinent responses into the regulatory analysis. The ABCB expresses its appreciation to these stakeholders for their contributions.

Scope

In reviewing the current regulatory arrangement, smoke alarms are required in all residential buildings, however the number of smoke alarms and whether alarms are required in bedrooms depends on a buildings classification. A house (Class 1a), apartment (Class 2), hotel / motel rooms (Class 3) or caretaker flats (Class 4) only require smoke alarms between the main living areas and bedrooms, often located in a corridor. However, in a Class 1b (hostels, boarding houses), Class 9a (health care facilities), or Class 9c (aged care facilities) bedrooms must also have a smoke alarm installed as they represent a higher risk. In addition to this there are increased requirements for common areas of Class 2 and 3 buildings.

Within the parameters of what was agreed upon by the ABCB, the scope of the RIS is to review the current arrangement for fire detection in sole-occupancy units for Class 1, 2, 3 and Class 4 parts of buildings in the NCC. Examples of the classifications affected include houses (Class 1), apartments (Class 2), hotel or motel rooms (Class 3), and caretaker flats (Class 4). Note only sole occupancy units are affected i.e. only the actual apartment not any common areas associated with an apartment building.

This RIS specifically evaluates options that address the effectiveness of smoke alarms in relation to their placement (locations) and the scope of this project relates only to new construction which accounts for 1.93% of the Australian housing stock.

Background

The National Construction Code

The National Construction Code (NCC) is a performance based document that contains the technical provisions for the design and construction of buildings and other structures, covering such matters as structure, fire resistance, access and egress, services and equipment, and energy efficiency as well as certain aspects of health and amenity. The NCC is given the status of building / plumbing regulations by all States and Territories.

The primary goal of the NCC is to promote the health and safety of building occupants, and safety from fire is a critical element in achieving this goal.

The NCC specifies 'Objectives' which are considered to reflect community expectations for the built environment. It also defines mandatory 'Performance Requirements', which state the level of performance a 'Building Solution' must meet to achieve the related NCC Objectives.

The NCC allows compliance with the Performance Requirements through the adoption of acceptable Building Solutions by:

- implementing Deemed-to-Satisfy (DtS) provisions, which are technical provisions contained either in the NCC or in NCC referenced documents or a technical standard in the NCC; and / or
- formulating an Alternative Solution that can be shown to be at least equivalent to the DtS provisions or which can be demonstrated as complying with the Performance Requirements.

The Victorian University Report

The Victorian University report was commissioned by the ABCB to determine the most appropriate locations for smoke alarms in residential dwellings, considering both detection and occupant notification.

The project experimentally determined the loudness of smoke alarms in five existing residential houses (Class 1a); for each room; with doors open and closed. The houses used were intended to represent typical Australian residential dwellings. The report also reviewed fire fatalities that occurred in Victoria between 1998 and 2006 from the CESARE Coronial Database (CCD).

The findings concluded that the existing minimum requirements for smoke alarms are deficient in providing complete coverage for early detection and notification of fire. This can only be achieved with interconnected smoke alarms in every room in every house in Australia.

A key observation contained in the report is that of those occupants who died in a single fatality fire, 79% of the detailed 89, were known to have responded to the fire emergency via fire cues and/or a smoke alarm signal. The authors advise that the changes proposed in the report, at best, would be expected to improve the time to arouse an occupant, rather than increase the ability for an occupant to respond (Thomas & Bruck 2010).

The main factors identified in the VU Report to enable a smoke alarm to effectively alert building occupants to a fire hazard include;

- The loudness of the smoke alarm signal;

- The proximity of the smoke alarm to the occupant at time of alarm;
- Occupant activity (awake or asleep);
- The ability for the occupant to perceive and be aroused by the signal (including impairment by drugs and alcohol or a physical disability)

It was estimated by the authors that smoke alarms in every room in every dwelling in Australia would result in 17% to 30% fewer fatalities. This could be increased to 50% fewer fatalities if all alarms were interconnected, with the authors estimating approximately 50 lives per year could be saved (Thomas & Bruck 2010).

Current regulatory arrangements

It is important to detail the current regulatory arrangement for smoke alarms in residential buildings contained in the NCC.

The NCC is a performance based document and allows compliance with the Performance Requirements by adopting two broad types of building solutions:

- Complying with the Deemed-to-Satisfy (DtS) provisions which are specific design or construction requirements that are either contained in the NCC or in NCC referenced documents such as Australian Standards (AS).
- Formulating an alternative solution that can be shown to be at least equivalent to the DtS provisions or which can be demonstrated as complying with the Performance Requirements.

Performance Requirements for smoke alarms are an integral component of both Volumes of the NCC.

Volume One Performance Requirement EP2.1 states – "In a building providing sleeping accommodation, occupants must be provided with automatic warning on the detection of smoke so they may evacuate in the event of fire to a safe place". This Performance requirement only applies to residential classes of buildings.

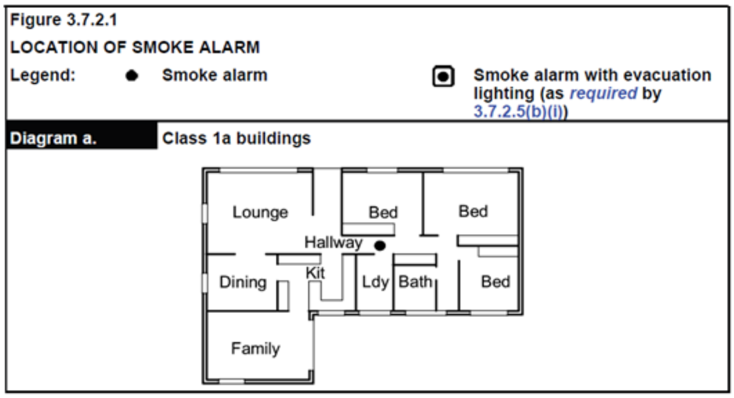
Volume Two Performance Requirement P2.3.2 states – "In a Class 1 building, occupants must be provided with automatic warning on the detection of smoke so they may evacuate in the event of fire to a place of safety".

The Deemed-to-Satisfy Provisions to meet the Performance Requirements for smoke alarms are contained in NCC Volume One Part E2 'Smoke Hazard Management' and NCC Volume Two Part 3.7.2 'Smoke Alarms'. These broadly consist of the following:

- Volume Two; Class 1 (houses) and class 1b (hostels and boarding houses)

Smoke alarms in a Class 1a building (House) are to be located on any storey containing a bedroom, see figure below.

Figure 1: Location of Smoke Alarms for a Class 1a as per NCC Volume Two

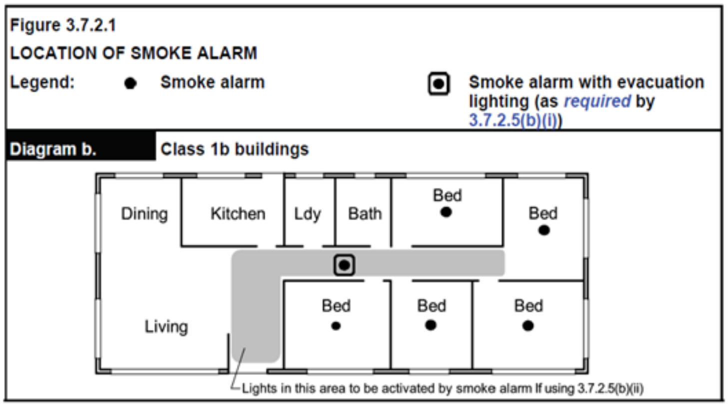


**Extract from NCC Volume Two*

Depending on the layout, a typical single storey Class 1a dwelling could have 1 or more smoke alarms and two storey Class 1a dwellings could have 2 or more smoke alarms.

In a Class 1b building (Hostel, boarding house) smoke alarms are required in every bedroom and in every hallway or corridor associated with a bedroom for every storey, see figure below.

Figure 2: Location of Smoke Alarms for a Class 1b as per NCC Volume Two



**Extract from NCC Volume Two*

- Volume One; Class 2, 3, and Class 4 parts of buildings (Apartments, Hotels/Motels, Caretaker flats)

In terms of smoke detection in residential accommodation such as apartments, motels or hotels, sole-occupancy units and common areas are treated separately in the NCC.

There are more stringent smoke alarm provisions for common areas, public corridors and other internal public spaces, as these areas may be used by a range of occupants but are maintained by the building owner. Where a fire sprinkler system is not installed these areas must have a smoke detection system in accordance with AS 1670.1 and be connected to a building occupant warning system.

Smoke alarm provisions for a sole-occupancy unit within a Class 2, 3 and Class 4 parts of buildings are similar to those contained in Volume Two. Where at least one smoke alarm is required in every sole occupancy unit, where this sole-occupancy unit consists of multiple storeys (such as a two storey penthouse), then a smoke alarm is required on every storey containing a bedroom. The location of the smoke alarm is to be between each part of the dwelling containing bedrooms and the reminder of the dwelling. Depending on the layout an apartment or hotel room will contain 1 or more smoke alarms.

However where a Class 3 (hotel or motel) has a room (sole-occupancy unit) located higher than 2 storeys above ground floor or the building accommodates greater than 20 residents as accommodation for aged, children or people with disabilities the more stringent provisions of AS 1670.1 apply.

- Volume One; Class 9a (Healthcare facilities) and 9c (Aged care facilities)

At minimum in a healthcare or aged care facility, where there are less than 6 beds, a smoke alarm must be installed in every room, public corridor and other internal public spaces. These alarms must be interconnected to provide a common alarm.

Where there are 6 or more beds more stringent provisions apply and smoke alarms must be installed as per AS 1670.1 and consist of a smoke detection system compared to a smoke alarm system. The main difference between the two systems is a smoke detection system must activate a building occupant warning system.

Further smoke alarm requirements

It may not always be practical to place an alarm in the area mention above, particularly where there is a risk of spurious signals being generated (nuisance alarms), such as from a smoke alarm located near a laundry being activated by steam. Therefore flexibility is provided through the mandatory performance requirements, which allows an approval authority to accept other suitable locations, provided these heed the intent of the performance requirement.

Additional DtS provisions for smoke alarms may have the following requirements, depending on the circumstance:

- Must be connected to the consumer mains power; and
- Must comply with AS 3786-1993 Smoke Alarms.
- One of the key measurements identified in AS 3786, is the effectiveness of the smoke alarm. Complying alarms must be able to sound an alarm at not less than 85 dB(A) for 1 minute continuously and at not less than 82 dB(A) after 4 minutes, measured 3 metres from the device.

Types of alarms

There are three main types of smoke alarms available in Australia; ‘photoelectric’, ‘ionisation’ and a dual detectors (a combination of ‘photoelectric and ionisation’).

A photoelectric alarm detects visible smoke, when a light beam is disrupted by smoke particles in the air. This type of alarm is particularly good for smouldering fires or dense smoke.

An ionisation alarm uses a small amount of radioactive material in an ionisation chamber. The radiation in the chamber charges the air and allows a small current to cross the chamber. Smoke is detected when the passage of this current is distorted. Ionisation alarms are effective in detecting smoke that has little visibility or burnt combustion particles (CSIRO, n.d).

The third type of alarm contains both an ionisation chamber and a photoelectric detector; these are called dual detector alarms.

State and Territory requirements

New South Wales, South Australia, Queensland, Victoria and Western Australia require all residential houses (existing and new) to have at least one smoke alarm. Tasmania and the Australian Capital Territory require smoke alarms only in new homes (or where substantially renovated) built after 1997, however it is noted ACT have had this requirement since 1994. Northern Territory during the time of writing this RIS has aligned with NSW, SA, Qld, Vic and WA to ensure all residences have a smoke alarm installed, however they go a step further mandating the use of photo-electric alarms with existing ionisation alarms to be replaced after they cease to work or run out of warranty (NT Government, 2011).

Education Campaigns

Information and education campaigns regarding fire safety in homes are run by all State and Territory fire authorities across Australia. They aim to reduce the incidence of house fire fatalities and injuries and improve fire safety in homes by raising community awareness.

One notable education campaign is the ‘Be alarmed! Change you smoke alarm battery’ which is often tied to daylight savings.[1] A snapshot of existing awareness campaigns and educational material provided by the local fire authorities is shown below, these have been loosely grouped in columns.

[1] http://www.changeyourbattery.com.au/campaign-commercial.html

Table 1: Existing programs, campaigns and education material

Fire Authority	Programs, Campaigns, Educational Material						
ACT	Kitchen Fire Safety Fact sheets	Numerous Home Fire Safety Bulletins		Fire Education in Schools			
VIC	Seniors Fire Safety Program	Home Fire Safety Information		Fire Education in Schools			Community Safety Month
NSW	Fire Awareness Program for Parents	Home Fire Safety Campaigns/ Audits		School programs		Smoke Alarm Battery Youtube campaign	
SA	Smoke Alarm Retirement Program	Home Fire Safety Fact sheets	Home Fire Safety Presentation	Teacher Resources for Fire Education			
WA		Home Fire Safety Information		School Education Programs			
NT	Home Fire Safety Training Material	Smoke Alarm Fact Sheets	Building Fire Safety Report Service		Downloa d-able Fire Escape Plan		Community Fire Safety Fact sheets
QLD	Best Practice Smoke Alarm (Photo electric) Pamphlet	Home Fire Safety Information	Safe Home Visit Service	Fire Education in Schools	Safe home Education Centre in Petrie	Seniors Fire Education Booklet	Community Fire Presentation Service
TAS	Project Wakeup program for Smoke Alarms	Home Fire Safety Information		School Fire Education Programs		Smoke Alarm Battery Youtube campaign	

It is noted that not all education programs may have been identified and this table only represents a select sample.

Another example of non-regulatory options in Australia is States and Territories employing subsidy programs. This includes Victoria which covers the cost of visual & vibrating smoke alarms for persons who are above 18 years of age and profoundly deaf, for a $50 copayment. The pilot scheme was introduced in July 2011 and is expected to be expanded to include children between the ages of 13 to 18 living with a guardian.

Response to alarms

The response to alarms from occupants is an important consideration in determining how effective the current smoke alarm provisions are at notifying occupants of a fire hazard.

Currently the NCC through AS 3786 prescribes the minimum signal level in a sole-occupancy dwelling unit to be 85 dB(A) for one minute at a measure of 3 metres from the device and no less than 82 dB(A) for four minutes.

However AS 1670.1: Fire detection, warning, control and intercom systems states that where an “audible evacuation signal is intended to arouse sleeping occupants, the minimum of … 75 dB(A) at the bedhead, with all doors closed” is required. It further notes that 75 dB(A) may not be adequate to arouse all sleeping occupants. AS 1670.1 also prescribes a maximum sound level from a single alarm device of 95 dB(A). This standard is adopted in Volume One of the NCC as an alternative to AS3786 where smoke alarms are required outside of a ‘sole-occupancy unit’, ie communal or public rooms or pathways. It is important for an occupant warning system to ensure all occupants are notified that a fire hazard has been detected.

The VU report demonstrated that there are concerns with smoke alarms emitting the required sound level to arouse an occupant (at the bedhead) when doors are closed or rooms are distant from an alarm.

Tests suggest that when doors are closed the signal strength of an alarm is drastically reduced. An example is contained in the VU report (house 1); where an alarm is ~3100 Hz sounding at 85 dB(A) located in the rear hallway adjacent to bedrooms 2 and 3 (meeting current requirements) signal strength is measured. With all doors open, the signal received in the adjacent bedrooms was approximately 65 dB(A). With the bedroom doors closed the signal decreased further to approximately 51 dB(A). Note this is one example taken from the VU report and the results of the study varied across all examples, ranging from lower recorded signals to higher; this depended on the building design and layout.

The VU report contains a great deal of recorded data and this example does not attempt to ignore this fact. However the figures above may be taken as an indicator to the likely sound reduction caused by an alarm being installed in a hallway adjacent to a bedroom as currently required by the NCC. Therefore it may be expected that an alarm signal strength is reduced by 20 to 35 dB(A), which is lower than the recommended signal level intended to arouse sleeping occupants in AS 1670.1.

A study conducted by Bruck and Brennan, in 2001, sought to determine an ‘unimpaired’ persons response to a fire hazard whilst asleep. The study used natural sounds which may occur during an fire event, such as a ‘crackling’, representing the early stage of a timber fire and a ‘shuffling’ noise, representing moving occupants. These were played at a level of 42-48 dB(A) with the highest sound being 58 dB(A). The authors concluded that there was a high rate of occupant arousal with 91% responding to a ‘crackling’ sound and 83% responding to a ‘shuffling’ sound. At such a low level of sound, being below 58 dB(A), the authors observed that most people will arouse from sleep to a low level fire (auditory) cue (Bruck & Brennan 2001).

An earlier study tested the waking ability of 24 participants aged between 18 and 24 from a traditional smoke alarm sounded twice at ~60 dB(A) at the pillow. The authors observed that 65% of the young adults awoke within the first 30 seconds of the alarm sounding and 85%

during the entire 10 minute alarm sound presentation. A total of 7 out of the 48 (~15%) presentations of the alarm signal were not aroused, these cases of 'non-awakenings' were related to reported sleep deprivation. (Thomas & Bruck, 2008)

Another study measuring the waking effectiveness of smoke alarms on adults and children observed that 100% of adults aroused to a 60 dB(A) alarm at the bedhead (Thomas & Bruck, 2008).

Vulnerable population (young, elderly, impaired)

Bruck and Thomas in 2009, conducted a study measuring the waking effectiveness of alarms for adults who are hearing impaired, this included testing auditory, visual and tactile devices. It was observed that an audible alarm, such as a smoke detector, with a reduced 520 Hz square wave T-3 sound at 75 dB(A) was 92% effective at arousing hearing impaired occupants, this was increased to 100% response at 95 dB(A). Note that a 520 Hz square wave T-3 sound is significantly different to the traditional 'high' pitched sound of a ~3100 Hz wave.

It should also be noted that the authors of the study provide the warning that these figures may be overestimations and occupants in an unprimed, unscreened population in a deep sleep may not arouse as per the study. However they provide an indication of how different types of occupants respond to various smoke alarm signals.

When it comes to children, it has been demonstrated that a traditional smoke alarm will prove difficult in arousing children under the age of 16. One study suggested that with an alarm of 60 dB(A) at the pillow only 14% awoke to the sound of a smoke alarm (Thomas & Bruck 2008).

Impairment from alcohol and drugs

Alcohol remains a significant issue in an occupant's ability to respond to a fire. The VU report observed through detailed coronial records relating to over 128 accidental residential fatalities, that a significant number of these fatalities, at least 60 (46%), recorded a Blood Alcohol Content (BAC) over 0.07. It should be noted that not all cases recorded were tested for drugs or alcohol therefore this figure may be higher (Thomas & Bruck 2010).

This was reaffirmed by a study in Japan, which concluded the fire fatality risk to unimpaired adults aged 18 to 64 (which is generally considered low) was drastically increased when alcohol was consumed. The report also observed that over 65% of victims aged 6 to 64 were found to be under the influence of alcohol (Ball & Bruck 2004).

Another report, conducted in the United States, indicated that 40% of residential fire related fatalities involved alcohol impairment. In addition to this, the report went on to observe a greater likelihood of death to burn victims with a high BAC level (Federal Emergency Management Agency 2003). The report concludes that it may be beneficial in reducing unintentional fire injuries by increasing awareness of those who drink and those who are around regular drinkers.

It has been established that the consumption of alcohol, even in moderation, can directly affect an occupant's ability to awake and respond to a smoke alarm (Ball & Bruck 2004).

Smoke alarms in dwellings

It is estimated that Australia has a high percentage of houses with working smoke alarms, with data from October 2007 suggesting more than 90 per cent of residences in NSW, Victoria, Queensland and the ACT have at least one working alarm (Productivity Commission, 2011).

However, a report by the Australian Fire and Emergency Services Authorities Council (AFAC) in 2009, observed that over the period of 1999 to 2006, a smoke alarm was only present in 33.3% of cases where a house fire occurred. The lead recorded reason as to why the smoke alarm was ineffective was because the device was disconnected from a power source (battery or hardwired).

This may indicate that fires are more common in the less then 10 percent of houses that don't have a working smoke alarm or in practice alarms are being disconnected or removed once installed; perhaps due to failure of batteries or nuisance alarms.

Number of alarms

One key finding in the VU report was that there may be a 50% decrease in residential fire fatalities if a smoke alarm was present and all alarms were interconnected in every room of every house in Australia.

This is the most comprehensive solution to the problem identified and may be represented as best practice. As the NCC is a minimum regulation document it may be of value to consider a range of options between the current status quo and the option recommended by the VU report. It should be noted that whilst a 50% increase in fatality prevention is a substantial improvement on the status quo, the findings showed that this would only be achieved if the requirement was applied retrospectively.

Whilst States and Territories have the ability to apply the NCC retrospectively it is not automatic. Without State and Territory retrospective adoption it is likely to contribute to approximately 1.9% of the overall building stock.

Interconnection of smoke alarms

Interconnection of smoke alarms in dwellings was raised in the VU report and is supported by all State and Territory fire authorities. This involves the connection of all individual alarms into a smoke detection 'network'. When one alarm is triggered a signal is sent to each smoke alarm connected to the network and is activated. This enables the detection and notification of a fire for occupants where an alarm is too far away to hear on its own.

An example is a fire developing in a garage and all doors are closed, as demonstrated by the VU report it is unlikely the signal strength of the alarm would be sufficient to arouse an occupant sleeping in a bedroom at the opposite side of the house. If the devices were interconnected the alarm closest to the bedroom would also activate, enabling an increased chance of arousal compared to waiting for the smoke to activate the alarm closest to the occupant.

However it is worth considering that interconnected alarms may have a higher rate of nuisance alarms and subsequent disconnection rate as identified in the background chapter. Particularly where the trigger of an alarm is not rapidly detected and each alarm has to be individually checked to see if an actual threat has been detected.

This RIS presents a range of options for more smoke alarms than required under the current minimum regulation, these options are separated into a) not interconnected and b) interconnection of alarms. The benefit accumulated by interconnection is significant particularly with respect to the effectiveness rate achieved by interconnection when compared to requirements for additional smoke alarms.

Risk of non-compliance

It is worth discussing the effectiveness of further regulatory intervention. This is particularly important due to the likelihood of further nuisance alarms and the propensity for individuals to disconnect smoke alarms in the residential dwellings.

At completion of a new building it is expected that there is a 100% compliance with smoke alarm requirements contained in the NCC. It is hoped that this level of compliance would not decrease over time however no data was discovered which provided information on the distribution of non-compliance with smoke alarm requirements in new and old construction.

Education campaigns provided by all State and Territory fire authorities play an important role over the minimum building regulations in maintaining and ensuring a high level of compliance throughout Australia.

However it is noted that there will be, to some extent, a reduction in the efficiency of any proposal due to the level of non-compliance in the community.

Social issues and perception of risk

There is a significant social issue associated with fire fatalities, with research conducted by Brennan in 1999 observing that fire victims are some of the most vulnerable people in the community and are generally housed in accommodation that provides little support in the event of an emergency. Additionally many fire fatalities are associated with an occupant who is inebriated, has a physical or psychological disability or is under social or economic distress.

Brennan observed that safety programmes aimed at the general public do not have the same effect on these types of occupants in, increasing awareness, improving understanding or modifying behaviour. This is important to note and highlights that design and engineering solutions are only part of the solution and social equity must also be considered to be able to actively reduce fire injuries and fatalities (Brennan 1999).

Low social economic status has been acknowledged by the World Health Organisation to have an increased risk of burns for residents in developed and developing countries, this is particularly related to overcrowding of living conditions, lack of proper safety measures and insufficient supervision (AFAC 2009).

It has been established from multiple studies that people have a tendency to overreact to a low probability event, however tend to underestimate more frequent risks (Ashe & McAneney 2011). It is therefore important to consider how occupants respond both individually and as a community to fire risk in Australia. This would help establish, how much occupants rely on regulation to mitigate their risk and to what extent (if any) would occupants be happy to go over and above minimum regulation, ie purchase additional smoke alarms or take other precautionary measures on their own accord.

In a survey conducted by Ashe and McAneney it was observed that respondents perceived the risk of fire to be much higher then the actual risk. Respondents were asked to rank the risk of death attributed to falls, transport related accidents, poisoning, drowning, homicide and fire from the highest risk to the lowest. It was observed that the perceived risk of fire was ranked the 4th, however out of the selected hazards the actual risk of fire was ranked 6th.

Another example of the perception of risk comes from the United Kingdom where in 1999 it was estimated 81% of British households had a working smoke alarm. However, in two selected London boroughs it was observed that only 16% had a working smoke alarm.

A study was conducted involving the supply and installation of various smoke detection devices for 2145 households in vulnerable areas of London. After a 15 month period the authors returned to test the devices. It was observed that only 51% of houses still had a working device, this rate was further reduced in houses where the participant indicated they were a smoker (Roberts et al 2004).

The report concluded that a major barrier to smoke alarm use is the distress caused by a nuisance alarms. Even though the participants would recommend others use smoke alarms and they considered themselves to be at a higher risk of fire without working smoke alarms there was a high rate of disconnection observed. This suggests that individuals actively balance the immediate and long term risk of fire when they disable smoke alarms (Roberts et al 2004).

This makes it difficult to determine the level of additional precautions individuals take to reduce their personal risk to fire to their own home. No information was found demonstrating the level of additional alarms or other measures taken in households over and above the minimum regulation. However as observed above, community perception and individual actions differ greatly.

International approaches

In observing international practice, the United States has the National Fire Alarm Code (NFPA 74, 1989), which requires all new dwellings to have hardwired, interconnected alarms in all bedrooms and some hallways (Ahren 2010). However this model code requires adoption by government authorities before becoming law. Ahren notes that often States do not adopt the most recent codes and even then, the enforcement of the codes is limited.

A study also referred to in the report, prepared by the US Consumer Product Safety Commission (CPSC) observed that only 19% of all households had interconnected alarms. Further to this only 31% of all households met the requirement to have a smoke alarm in each bedroom.

The United Kingdom adopts BS 5859, which provides a range of system grades and categories to meet the fire risk and building size and type. A new building between one and three storeys would require the following; back up power supply, photoelectric smoke alarms in circulation spaces, a heat alarm in kitchen spaces and an alarm in the main living room. All alarms are to be interconnected via hardwire or via radio linkage. The standard also states that the alarm must produce a sound of at least 85dB at each doorway to a bedroom.

In New Zealand, the Compliance Document for New Zealand Building Code – Warning Systems requires smoke alarms in every sleeping space, or within 3.0m of every sleeping space door so that the alarm must be audible to sleeping occupants on the other side of a closed door. Interconnection of smoke alarm is recommended but not required. A smoke alarm is assumed to be audible if the sound level is at minimum 60 dB(a) within the sleeping area with all doors closed.

The previous Consultation RIS asked stakeholders a number of questions about how adequate are the current arrangements for smoke alarms in detecting and notifying residents of the incidence of fire. Comments included the following:

"The findings of the Victoria University study demonstrate that, on the contrary the status quo requirements do not achieve the Objectives or Performance Requirements of the NCC."

"The current smoke alarm provisions of the NCC are inadequate in dealing with multi storey class 1a dwellings."

"The existing regulatory arrangement does not satisfy the minimum performance requirement to alert occupants of a fire in the building so they may safely evacuate."

To Respond- Whilst the report concluded that the current provisions are deficient in providing complete coverage of early notification to occupants in the event of fire. The objective of providing complete coverage is not necessarily a minimum effective regulation outcome. The authors of the VU report acknowledge the significant increase in cost involved in any regulatory change and whether the benefits likely to be obtained from additional requirements warrant imposition on home builders. It is well established that fire fatalities tend to occur in existing older buildings which fall outside of the Scope of the NCC.

The Nature and extent of the problem

The extent of the problem will be determined by identifying the number of fatalities and injuries attributed to fires in new residential buildings where a smoke alarm was present and may have provided notification to occupants. The nature of the problem will be determined by assessing why and where any fatalities or injuries are occurring. This will help form any rationale for further review.

Incidence of fatalities and injuries

Previously the Consultation RIS utilised a report conducted by AFAC in 2005 to determine the number of fatalities that occurred as a result of residential fires.

The AFAC report observed that over the years 1996 to 2006, there were 52.1 deaths a year attributed to residential fires. To put this in context this is approximately 1 person per 370,000 in Australia.

During consultation with AFAC it has been identified that the report is incomplete and is potentially an inaccurate estimate of the yearly number of fatalities attributed to residential fires.

In response to this, the final RIS has taken estimates contained within the VU report. It is estimated by the authors of the report that between 60 to 100 people die in fires in dwellings in Australia each year. As such the final RIS considers 80 fatalities per year to be an appropriate central estimate yearly occurrence. Other sources of data were investigated to obtain confirmation this central estimate was appropriate however the scope of the available data was much broader than fire fatalities occurring as a result of unintentional house fires. A sensitivity analysis has been applied to between 60- 100 fatalities in the Impact Analysis section.

As the NCC only affects new construction, the figure above needs to be adjusted for the scope of this RIS. It is generally considered that the building stock in Australia increases by approximately 1.9% per year. Therefore it may be expected that <u>1.5 fatalities a year</u> may be attributable to new residential construction and the NCC.

In AFAC's 2009 report, "Accidental Fire Injuries in Residential Structures", it was observed that over the period of July 1999 to 30 June 2006, there were 7322 accidental fires in residential buildings recorded, resulting in 5762 injuries to occupants.

One particular issue is determining where a smoke alarm may have provided early detection and avoided an injury. For example AFAC's 2009 report states that 13.5% of recorded incidents were the result of "foodstuffs being burnt within the confines of cooking equipment". It is unlikely that a smoke alarm would have avoided these injuries, particularly if they were immediate. Additionally it is observed that around 40.6% of people were injured from a fire originating in the kitchen.

Acknowledging the limitations of the data, it is estimated 3026 injuries were attributed to 'an uncontrolled fire in a building or structure', 'exposure to ignition or melting of nightwear or other clothing', or 'exposure to smoke, fire and flames'. This equates to <u>approximately 433 injuries per a year</u> due to residential fires or <u>approximately 1 injury per 18,000 persons.</u>

Like fatalities, the above data represents the entire building stock in Australia and needs to be adjusted for new construction only. Therefore it is estimated that 8.4 injuries per a year may be attributed to new construction and the NCC.

The following table summarises the extent of the problem.

Table 2: Summary of fatalities and injuries in Australia

	Average per Year	Per capita in Australia	Attributed to new construction
Fatalities	80	2 per 370,000	1.5
Injuries	433	1 per 18,000	8.4

The figures attributed to new construction may be less if there was a greater prevalence of residential fires in the existing building stock compared to new construction. The estimated fatalities and injuries, of 1.5 and 8.4 respectively, would be considered very small compared to other accidental hazards affecting Australian people: falls, transportation, poisoning, drowning (Ashe & McAneney, 2001). Any benefits which may be derived by an increase in smoke alarm stringency will be commensurate with the low incidence of fatalities and injuries in new buildings. The numbers of fatalities and injuries represent outcome of the status quo.

Stakeholders, in particular fire safety agencies, expressed concerns that both injury and fatality rates were underestimated based on limited data available. These concerns are noted and the number of fatalities per year has been increased 50 fatalities per year in the Consultation RIS to 80 per year in the final RIS. The cost and occurrence of injury remains unchanged as the methodology contained within Appendix D was considered correct.

Nature of the problem

The VU Report

The nature of the problem is described in the VU report, where it is reported that current smoke alarm requirements contained in the NCC have limited efficacy and have room for improvement. The main improvement detailed in the report is the ability to improve arousal times of occupants.

The problem is occurring where occupants of residential dwellings are not effectively being notified of the presence of a fire and are being fatally injured or injured as a result of failing to safely evacuate a dwelling. This is suggested by the observation that occupants are responding to fire alarm signals too late and not having the time to safely evacuate. This is supported by that fact that fatalities and injuries are continuing to occur under the status quo.

The VU report suggests that increasing the stringency of smoke alarm provisions so that every room in a every residential dwelling had a working smoke alarm would result in 17-30% fewer fatalities, and potentially up to 50% in some circumstances.

The argument raised in the VU report discusses how under the current minimum requirements in the NCC, closed doors and the proximity of alarms is reducing the alarm signal strength at areas where it is most desired; such as in bedrooms when occupants are asleep or in areas remote from the fire ignition point. Occupants are not being notified as quickly, or at all, of the presence of fire.

With doors closed it was determined that the signal strength of an alarm was greatly reduced. However, the level of this reduction greatly depended on the design and layout of the building.

Other factors

It is noted that a range of 'other factors' influence the efficacy of smoke alarms including behavioural and social issues. This highlights that design and engineering solutions are only part of the answer.

A key element that needs to be considered is whether new regulatory intervention would affect any injuries or fatalities occurring in new construction.

The problem of failing to be notified and evacuated from the dwelling due to a fire may be linked to a range of factors, including but not limited to, social economic status, higher risks associated with vulnerable individuals (young, elderly, impaired), disconnection of alarms, impairment by drugs or alcohol, maintenance of property, non-compliance or simply not being effectively notified.

It is also noted that individuals considered vulnerable will not necessarily benefit from an increase in placement of alarms. Those with high frequency hearing loss will find it difficult to hear any alarm, and it has been demonstrated that children fail to arouse to the pitch of a traditional smoke alarm.

There is a strong issue of the use of smoke alarms within the building stock. AFAC reported that out of all residential dwelling fires attended by the fire brigade only 33% were found to have a working smoke alarm.

These factors call into question the significance of the problem in new construction. Particularly if there is such a level of non-compliance and attitude towards nuisance alarms, it may be suggested that the removal of alarms will continue to occur.

These factors may impact differently in the existing building stock and new construction. However there is an issue with lack of data disaggregating new and older construction. This data would enable further quantitative discussion on these other factors.

These other factors, behavioural and social, would be expected to reduce the efficacy of smoke alarms per se, and may be directly responsible for a proportion of fatalities and injuries in residential construction. Hence these aspects of the problem cannot be addressed in the NCC.

Overall, the account of the problem provided in the VU report was comprehensive and warrants review, however issues relating to behavioural and social factors should also be considered. For the benefit of this RIS, the nature of the problem can be treated as a testable hypothesis; 'the current minimum requirements for smoke alarms are deficient in providing early notification of fire in residential dwellings'.

It be noted that there is a hypothesis that the majority of fire fatalities in residential buildings occur in existing older buildings. While this is beyond the scope of this RIS and the NCC, jurisdictions may wish to consider measures in relation to older buildings that may generate a higher level of benefits than achieved through additional requirements in the NCC.

Objectives

The ABCB's mission is to address the issues of health, safety, amenity and sustainability in the design, construction and performance of buildings. This will be achieved through the NCC and the development of effective regulatory systems and appropriate non-regulatory solutions.

Objectives of the ABCB

The objectives of the ABCB are to:

- develop codes and standards that accord with strategic priorities established by Ministers from time to time, having regard to societal needs and expectations;
- establish codes and standards that are the minimum necessary to efficiently achieve the relevant Mission objectives; and
- ensure that, in determining the area of regulation and the level of the requirements:
    - there is a rigorously tested rationale for the regulation;
    - the regulations are effective and proportional to the issues being addressed such that the regulation would generate benefits to society greater than the costs (that is, net benefits);
    - there is no regulatory or non-regulatory alternative (whether under the responsibility of the Board or not) that would generate higher net benefits; and
    - the competitive effects of the regulation have been considered and the regulation is no more restrictive than necessary in the public interest.

The specific ABCB objective is to safeguard occupants from illness or injury by alerting them of a fire in the building so they may safely evacuate.

Options

This chapter identifies alternative means of achieving the Government objective of "safeguarding occupants from illness or injury by alerting them of a fire in the building so they may safely evacuate."

The RIS identifies seven options:

Table 3: Proposed Options

Option	Proposed revisions
Status Quo	Smoke alarms installed in accordance with the current NCC requirements;
Option 1a	Smoke alarm system installed in accordance with current NCC requirements **plus** smoke alarms in every bedroom. Not interconnected.
Option 1b	Smoke alarm system installed in accordance with current NCC requirements **plus** smoke alarms in every bedroom. Interconnected.
Option 2a	Smoke alarm system installed in accordance with current NCC requirements **plus** smoke alarms in every room. Excluding Kitchen, Bathroom, Toilet and Laundry. Not interconnected.
Option 2b	Smoke alarm system installed in accordance with current NCC requirements **plus** smoke alarms in every room. Excluding Kitchen, Bathroom, Toilet and Laundry. Interconnected.
Option 3a	Smoke alarm system installed in accordance with current NCC requirements **plus** smoke alarms in every room. No rooms excluded. Not interconnected.
Option 3b	Smoke alarm system installed in accordance with current NCC requirements **plus** smoke alarms in every room. No rooms excluded. Interconnected.

**a) Options without interconnection*

**b) Options with interconnection*

All options identified above will meet the objective to safeguard occupants from illness or injury by alerting them of a fire in the building so they may safely evacuate.

Status Quo

The status quo is the default option for decision makers in considering options to address the problem. 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, the RIS would recommend the status quo.

Option 1a

Option 1a requires that in addition to the status quo, smoke alarms to be located in all bedrooms. It is estimated that the effectiveness rate of this option would amount to 17% of the total fatalities. This option has the potential to avoid fatalities where the room of fire origin is the bedroom and where the door to that room is closed.

Option 1b

Option 1b requires in addition to the status quo, the interconnection of smoke alarms in all bedrooms It is estimated that the effectiveness rate of this option will amount to 40% of the total fatalities. This option has the potential to avoid fatalities where the room of fire origin is the bedroom and where the door is closed and provides increased early notification in the event of fire occurring in other rooms through the bedroom interconnected smoke alarm.

Option 2a

Option 2a requires in addition to the status quo and option 1, smoke alarms to be installed in every room in the dwelling excluding the kitchen, bathroom, toilet and laundry. It is estimated that the effectiveness rate of this option will amount 25% of the total fatalities. This option has the benefit associated with option 1a with the additional benefit of providing early notification to sleeping areas in close proximity to fire that occurs in living areas. Depending on whether the doors to the sleeping areas are open or closed may directly impact the effectiveness of this option where the room of fire origin is not the bedroom.

Option 2b

Option 2b requires in addition to the status quo and option 1, the interconnection of smoke alarms in all rooms excluding the kitchen, bathroom, toilet and laundry. It is estimated that the effectiveness rate of this option will amount to 45% of the total fatalities. It has the advantage of providing notification to sleeping areas to fire that occurs in living areas that may not be in close proximity via the interconnected smoke alarm present in the bedroom. It is assumed the effectiveness of this option is not dependent on the doors to the sleeping areas being open or closed.

Option 3a

Option 3a requires in addition to the status quo and option 2, smoke alarms in all rooms of the dwelling. It is estimated that the effectiveness rate of this option will amount to 30% of the total fatalities. This option has the benefit of requiring smoke alarms in every room to detect smoke during the early stages of fire development.

Option 3b

Option 3b requires in addition to the status quo and option 2, the interconnection of smoke alarms in all rooms of the dwelling. It is estimated that the effectiveness rate of this option will amount to 50% of the total fatalities. This option will provide the benefits of both interconnection and additional smoke alarms in every room providing early detection and notification. Due to the complexity of the smoke alarm system, the probability of both nuisance alarms and system failure is increased.

Impact Analysis

This chapter identifies members of the community likely to be affected by the proposals.

Any costs and benefits are formally assessed through a cost benefit analysis where significant costs and benefits are quantified and evidence is provided to support key parameters and assumptions.

The assessment of costs includes business compliance costs that could occur on implementation of the proposals. The impact analysis provides a net present value for each proposal. A sensitivity analysis is undertaken to indicate the robustness of the outcomes to changes in key parameters and assumptions. The impact of the proposals on competition is considered in the final section.

This impact analysis presents results based on historic fatality and injury data due to non-controllable residential fires.

As per the proposals only new residential dwellings and sole-occupancy units are considered in this analysis. The proposals seek to increase the efficacy of smoke alarms in Class 1 and Class 1b (houses, hostels and boarding houses), 2 (apartments), 3 (hotels/motels) and Class 4 parts of buildings (Caretaker units).

Groups affected by the proposals

Any regulatory change is likely to affect a range of groups in the community including new home buyers, developers, suppliers, builders, training providers, insurance industry, State and Territory fire and building authorities. This is due to the additional costs associated with compliance, enforcement, and education of the new provisions.

Assessment of costs

The approach taken to calculate the costs associated with each proposal is to estimate the number of new houses being built each year in Australia then to quantify the cost associated with each proposal. Lastly, any business compliance costs are considered.

Together, the construction and compliance costs become inputs to calculate the present value of costs for each proposal. The proposals are then assessed on the basis of a finite period of ten years, to comply with Office of Best Practice Regulation (OBPR) guidance.

Number of new residential dwellings built in Australia

The total number of new residential dwellings built in Australia is approximately 162,500 per year, see table below. These figures were derived from the Australia Bureau of Statistics and the Victoria Building Commission, see appendix A.

Table 3: Number of residential dwelling unit completions (2009/10)

Classification	Number of dwelling unit completions (No.)	Percentage of total dwelling units (No.)
Class 1 (Houses)	103,373	≈64%
Class 2 (Apartments)	42,931	≈26%

Class 3 (Hotel/motel)	15872	≈10%
Class 4 (Caretaker)	155	>1%
Total	162,332	100.00%

It is noted that there will be a distinct difference in the number of smoke alarms between a single and double storey house. Therefore it is important to disaggregate Class 1 buildings into the proportion of single and double storeys, this is taken to be 19.3% which has been inferred from the Victoria Building Commission.

Therefore, the distribution of classifications and single and double storey residential dwellings is as follows:

Table 4: Number of building dwellings for each affected (2009/10)

Location	Class 1 (single storey)	Class 1 (double storey)	Class 2	Class 3	Class 4	Total
Australia	83,422	19,951	42,931	15,872	155	162,332

Estimate of the costs

In order to determine the costs of the proposals outlined above, two standard house designs representing a typical single and double storey home in Australia were provided by the Housing Industry Association (HIA), see appendix B.

- Multiple sources were used to obtain indicative cost figures for smoke alarms, including cost figures provided in the VU report, various electrical supplier websites and informal discussions with licensed electrical contractors.
- A summary of quotes for smoke alarms is found below. It is acknowledged that there may be suppliers who provide cheaper prices however, these may not be accessible for the general public so a figure of $30 is proposed.

Table 5: Smoke alarm prices

Supplier	Supply Price
Supplier 1	$29.98
Supplier 2	$36.20
Supplier 3	$26.90
Supplier 4	$24.00
Rawlinsons (2011)	$25.50-$39.00

**All devices listed above, are designed in accordance with AS 3786, have 240V for connection to mains power and are inter-connectable.*

In considering the house designs the following assumptions for each of the smoke alarm systems were applied –

1. Truss roof, slab on ground, timber framed brick veneer design.
2. Installation to occur as standard for new house construction.
3. Alarms to be ceiling mounted and mains connected.

4. Tradesperson access as typically provided during construction of a new house.
5. All smoke alarms with interconnectivity feature.
6. Interconnection systems to require separate circuit back to switchboard.
7. Switchboard located inside garage.
8. Systems without interconnection to be wired into existing lighting circuit (current industry practice).
9. Smoke alarms to be replaced every 10 years.

Stakeholders were asked whether they believed the costs associated with smoke alarm installation estimated in the Consultation RIS reflected costs occurred by industry. A number of stakeholders believed that the estimated costs of installation were excessive and the final RIS has amended the costs accordingly.

Indicative cost for components used in the estimate include –

1. Labour (Electrician) - $80 per hour (representative of rates supplied by Rawlinson 2011 throughout Australia)
2. Cost of smoke alarm - $30 each
3. Standard cabling costs have been estimated as $80 per 100m for twin & earth mains cable for connection to mains power.
4. Cable clips have been allowed at 1m intervals. Cost $18 per 500.
5. Interconnection cabling costs have been estimated at $52 per 100m being a single core double insulated mains cable.

With the above assumptions the costs likely to occur over and above the status quo for new residential construction are as follows.

For a detailed methodology of these costs see appendix C.

Table 6: Incremental costs associated with smoke alarm installation proposals

Proposed Smoke Alarm Option	1 Storey House	2 Storey House
Option 1 a	$413	$660
Option 1 b	$497	$783
Option 2 a	$660	$908
Option 2 b	$807	$1094
Option 3 a	$990	$1485
Option 3 b	$1221	$1794

Therefore, the proposed systems over and above the current status quo vary from an increase of $248- $1056 for single storey and $495- $1629 for double storey with the main variable being the number of smoke alarms and associated labour.

It is noted that smoke alarms are required to be replaced due to manufacturers warranty and AS 3786 which states that “smoke alarms shall have a recommended service life of at least 10 years under normal conditions of use”. The cost of replacing smoke alarms three times has been factored into the analysis over a 40 year period of life of the house, see appendix C.

Therefore over the life of the regulations (10 years), the present value of the additional incremental costs over and above the status quo (discount rate of 7 per cent) associated with each proposed amendment on a national aggregated level is summarised in the table below.

Table 7: Present value calculation for costs (2009/10 dollars)

Proposed amendment	Present value costs($)
Option 1 a	$446,275,732
Option 1 b	$554,592,775
Option 2 a	$846,377,366
Option 2 b	$1,037,955,667
Option 3 a	$1,429,790,325
Option 3 b	$1,723,102,324

Estimate of the benefits

The quantified potential benefits takes into account the avoided costs of hospital separations due to injuries and the cost of fatalities. The benefits quantification is presented at an aggregate level (whole of Australia).

Key information in determining the quantitative benefits, are briefly summarized;

- The average fire death and injury rate attributed to new housing in Australia is 1.5 fatalities per annum and 8.4 injuries per annum.

  — Central estimate based VU report.

- Value of a statistical life (VOSL) is $3.8 million.

  — OBPR guidelines indexed by the CPI to 2011 prices.

- Average hospitalisation costs and morbidity costs per burn injury patient is estimated to be $13,726.

  —1997 MURAC Report and AIHW Australian Hospital Statistics 09-10.

- The effectiveness rate of any smoke alarm amendment would apply to both fatalities and injuries equally.

  —Interpolated from the VU report with increased stringencies applied to all options.

This reflects the nature of the problem and hence the benefits from avoiding the problem – as described in the VU report. However other behavioural and social factors diminish the efficacy of smoke alarms in providing early notifications and enabling occupants to evacuate. Hence the benefits calculated indicate the maximum benefits that can be achieved.

The basis for calculating benefits of early notification of fire in new residential buildings is the theoretical 100% effectiveness scenario of $5.87 million for fatalities and $112,860 for injuries each year. The effectiveness rate is then adjusted drawing on the VU report and the attributes of each option.

For further detail see appendix D.

Table 8: Benefits attributed to the proposed amendments in Year 1

Proposed amendment	Effectiveness rate (%)	Benefits in Avoided Injuries	Benefits in Avoided Fatalities	Total Benefits
Option 1 a	17%	$19,601	$969,000	$988,601
Option 1 b	40%	$ 46,119	$2,280,000	$2,326,119
Option 2 a	25%	$28,825	$1,425,000	$1,453,825
Option 2 b	45%	$51,884	$2,565,000	$2,616,884
Option 3 a	30%	$34,590	$1,710,000	$1,744,590
Option 3 b	50%	$57,649	$2,850,000	$2,907,649

The effectiveness rate of each option has been interpolated from the VU report where it was suggested that smoke alarms in every room of every dwelling in Australia would result in 17%-30% reduction in fatalities and up to 50% with interconnection. It has been assumed that injuries would be reduced to the same level as fatalities.

The rates represent an educated estimate into the increased effectiveness of having additional smoke alarms in a residential dwelling. Interconnection of alarms was perceived to have an increase in effectiveness due to the connection of alarms which would signal all alarms at once. Occupants in rooms away from a signalling alarm would be notified of the fire and be able to respond quicker hence all options involving interconnection have been allocated the highest effectiveness rates estimated.

The options involving additional smoke alarms without interconnection have been appropriately weighted up to 30%.

Therefore the present value for benefits attributed to each proposed option over a 10 year timeframe, allowing for a physical depreciation period for new buildings of 40 years, is presented in the Table below.

Table 9: Present value calculation for benefits

Proposed amendment	Present value benefits ($)
Option 1 a	$105,982,229
Option 1 b	$249,369,844
Option 2 a	$155,381,219
Option 2 b	$280,541,088
Option 3 a	$187,027,412
Option 3 b	$311,712,353

Evaluation of options

The options being considered result in the following net present values.

Table 10: Net Present Value of options

Proposed amendments	Benefits ($)	Cost ($)	BCR	NPV ($)
Option 1 a	$105,982,229	$446,275,732	0.24	(-) $340,293,503
Option 1 b	$249,369,844	$554,592,775	0.45	(-) $305,222,931
Option 2 a	$155,381,219	$846,377,366	0.18	(-) $690,996,147
Option 2 b	$280,541,088	$1,037,955,667	0.27	(-) $757,414,579
Option 3 a	$187,027,412	$1,429,790,325	0.13	(-) $1,242,762,913
Option 3 b	$311,712,353	$1,723,102,324	0.18	(-) $1,411,389,971

Observed in the above table, mandating any of the proposed smoke alarm systems would result in a negative net present value and a Benefit Cost Ratio (BCR) significantly less than 1 for all options.

Sensitivity analysis

A sensitivity analysis has been conducted on the net present values for each of the proposed smoke alarm amendments by varying the parameters around the major assumptions.

The aggregate construction costs imposed by the proposed smoke alarm amendments to the NCC and associated benefits can vary if the assumptions used to quantify these costs/benefits change. These include:

- **Installation costs**: Smoke alarm supply and installation costs may vary particularly between States and Territories, where labour rates vary. Therefore a variation of ± 10% will be assessed.
- **Fatality/Injury Rate:** The assumed average fatality/injury rate has a large impact on the benefits.
- **Discount rate:** A discount rate of 3% and 11% will also be assessed.

The result of the sensitivity analysis is presented in the table below.

Table 11: Net Present Value Sensitivity Analysis

Parameter	Net Present Value Smoke Alarm System ($'000,000)					
	1 a	1 b	2 a	2 b	3 a	3 b
Installation Costs						
Low (-10%)	-306.3	-260.4	-626.9	-674.2	-1,134.7	-1,274
High (+10%)	-374.3	-350.1	-755.1	-840.7	-1,350.9	-1,548.8
Fatality and Injury Rate						
Low (1 Fatality/ 6 Injuries)	-375.5	-388.1	-742.3	-850.7	-1,305	-1,515
High (2 Fatalities/ 12 Injuries)	-304.8	-221.6	-638.3	-663.4	-1,118.1	-1,306.9
Discount Rate						
Low - 3%	-481.2	-328.4	-1,005.9	-986.6	-1,851.1	-1,950.8
High - 11%	-284.8	-291.9	-556.8	-658	-1,002.7	-1,182.1

As observed above, variation in the major assumptions still results in a large negative net present value for each option.

Business compliance costs

The building industry takes the time and effort to become familiar with all updates to the NCC each year, such as attending the annual NCC seminar series in each jurisdiction. Participants at the seminars spend up to 1 day each year in familiarising themselves with all new NCC amendments. In addition to this practitioners will need to spend time in determining how any amendments may effect how they conduct business. It is difficult to provide an estimate as to these compliance costs and the ABCB invites stakeholders to provide information that would help in determining total compliance costs. However, the incremental contribution of these straight forward proposals to the fixed compliance cost would be a minor part of the overall annual NCC update process.

Any cost associated with the smoke alarm proposal would be absorbed into this fixed cost to keep up to date with the yearly update of the NCC. Costs already applicable to business primarily include education costs.

Assessment of competition impacts

The proposed smoke alarm provisions will not adversely affect or restrict the number and range of suppliers of smoke alarms or restrict/reduce the number of businesses operating in the design and construction industry.

The smoke alarm amendments do not restrict the use of any particular material for the construction of the building components that are affected. To the contrary the proposed arrangements will increase demand for smoke alarms and the required services for maintenance.

Further, any additional costs for enhanced smoke alarm systems would most likely be passed on to the building purchaser and not incurred by the builder or developer.

The proposed smoke alarm amendments do not impact or alter suppliers' nor builders' incentives to compete vigorously. Within the smoke alarm industry there remains an incentive for manufacturers to continue to design the most cost effective smoke alarm for compliance with the NCC DtS provisions.

Overall, it is considered that there will not be any competition impacts associated with the proposed smoke alarm amendments. Furthermore, because the proposed options constitute 'deemed-to-satisfy' regulation, they provide flexibility to builders to meet the NCC Performance Requirements by proposing alternative building solutions.

Stakeholders did not comment on any compliance cost or competition impacts as a result of the options proposed.

Consultation

Consultation is the cornerstone of the Australian Building Codes Board (ABCB) and their commitment to create a contemporary and relevant construction code that delivers good societal outcomes for health, safety, amenity and sustainability in the built environment.

The ABCB believes meaningful consultation can promote trust between industry, the community and government, providing transparency to allow stakeholders to see and judge the quality of government actions and regulatory decisions. Consultation also provides an opportunity for stakeholders to participate in the development of policy solutions and encourages broad ownership of solutions. Furthermore, an appropriate consultation process can lead to the revision and modification of preliminary recommendations before a final decision is made, thereby delivering a better outcome for all.

Stakeholders

Comments were received from twelve stakeholders in response to the Consultation RIS, deriving from: State and Territory administrations, local government; and industry groups. The majority of submissions received were in support of retaining the status quo

State and Local Government submissions were received from–

1. New South Wales building administration
2. South Australian building administration
3. Tasmanian building administration
4. Victorian building administration
5. Western Australian building administration
6. Sydney City Council

Industry organisations included–

1. Australasia Fire and Emergency Service Authorities Council (AFAC)
2. Fire Protection Association (FPA)
3. FP-002 Standards Australia Committee
4. Housing Industry Association (HIA)
5. Master Builders Association (MBA)
6. Metropolitan Fire Brigade (MFB)

Comments from Government Agencies

The majority of Government agencies suggested that retaining the Status quo was the preferred option as they believe that the net costs associated with all options presented appeared to be unreasonable.

NSW Building Administration

NSW and their Stakeholders support option 1b as they believe it provides a suitable balance between implementation costs and addressing the deficiencies identified in the VU Report.

NSW believe the status quo does not provide sufficient warning protection to occupants sleeping in their bedroom where that room is the room of fire origin, especially when the door to the bedroom is closed. In these circumstances they believe that the room could be completely consumed with smoke before the smoke alarm is activated.

NSW also commented on methodological aspects of the RIS and provided the following in relation to costs;

- The costs of each proposal within Appendix C of the RIS is questioned as to whether they are an accurate reflection of the costs associated with the implementation of each proposal.

~ ABCB Response: Appendix C has been amened to align with other Stakeholder comments, reducing the cost calculations.

- The replacement of smoke alarms every ten years is not mandatory, and thus the inclusion of this cost is questioned.

~ ABCB Response: Whilst the replacement of smoke alarms every ten years is not mandatory, AS3786 states that smoke alarms must have a service life of at least 10 years and as such ten years is taken to be a suitable estimate.

- The calculations in the RIS and also the death and injury rates have been underestimated, and it was considered that the injury and fatality rates need to be reviewed to address the concerns.

~ ABCB Response: The fatality rate has been increased to address these concerns. 80 fatalities per year is an appropriate estimation in lieu of the 52 originally assumed. In regards to injury rates, it is acknowledged limited data is available to support a definitive number however the estimates given are considered to be appropriate refer to Appendix D for methodology.

- The labour cost allowance seems excessive especially in relation to the interconnection component. The two storey design used as an example in the RIS requires two smoke alarms in order to comply with the current NCC provisions contrary to the three specified in the RIS.

~ ABCB Response: Labour costs and number of required smoke alarms has been revised in light of stakeholder information.

Sydney City Council,

Sydney City was the sole local government respondent to the Smoke Alarm Consultation RIS and their comments were not dissimilar to the views held by the NSW building administration.

Sydney City acknowledge the compliance and cost issues associated with option 1 however they believe that in relation to class 1a dwellings option 1b should be adopted. They suggest that concession may be appropriate in all other residential buildings to retain the status quo on the basis that the occurrence of false alarms in buildings such as boarding houses and flats may encourage unauthorised disconnection of the systems rendering them ineffective.

Sydney City believe that the current smoke alarm provisions contained in the NCC are inadequate in dealing with multi storey class 1a dwellings and suggest as a minimum the interconnection of smoke alarms is critical to alert all residents on each level to ensure that sufficient time is available to reach the exits.

Sydney City provided the following recommendations;

- Increase the sound pressure level and change the frequency of smoke alarms to reflect the findings of the VU report.

~ ABCB Response: The primary focus of the VU report was intended to address the effectiveness of smoke alarms in reaction to their placement (location). It was not intended to specifically address the issue of type of detection or frequency.

- Provide clearer guidelines for the location of smoke alarms to deal more comprehensively with the various designs of dwellings which have specific design features which may require special or enhanced smoke alarm assessment and consideration.

~ ABCB Response: Evidence is required to demonstrate if the current provisions are insufficient in dealing with multi storey dwellings.

The Council concluded by stating that if based on the findings of the RIS, the ABCB determines that no change to the smoke alarm provisions are warranted, it is suggested that a different form of consideration should be undertaken to establish if minor and less costly changes can be applied to enhance fire safety.

Comments from Industry Organisation

Comments received from industry can be broken down into two categories;

1. Comments from fire safety agencies

2. Comments from the building industry

Comments from fire safety agencies

Comments were received from a number of fire safety agencies including the Australasia Fire and Emergency Service Authorities Council, the Fire Protection Association, the FP-002 Standards Australia Committee, and the Metropolitan Fire Brigade.

Australasia Fire and Emergency Service Authorities Council

AFAC expressed criticism and were opposed to the methodology presented in the RIS. AFAC considers that given that the costs are substantially upfront with the benefits progressively accumulating, this biases the RIS against the reform options. AFAC believe that applying a discount rate is flawed, although they say a discount rate may be used address the erosion in value over time of future cash amounts when reflected in today's dollars. AFAC suggest that carrying forward a figure relevant today into the future and then discounting back to obtain an NPV is not appropriate and seriously underestimates the true costs and benefits.

~ABCB Response: AFAC apparently reject the standard techniques of quantitative cost benefit analysis and the COAG (2007) Best Practice Regulation Guide. *This disregard for proper procedure is regrettable. Quantitative cost benefit analysis can handle the costs and benefits occurring in different years in the future by discounting the different streams of costs and benefits to obtain their present values, which can then be compared. For example, the additional costs are measured over a 10 year period, while the benefits accumulating to the residents of each new house are measured over a 40 year period. This is standard procedure and does not involve any bias. Hence the discount rate is a central feature of quantitative cost benefit analysis and indeed this RIS adopts a discount rate of 7% as recommended by the Office of Best Practice Regulation. All estimates of the costs and benefits in this RIS are expressed in "real terms" or in "constant prices" that do not include an inflationary component; hence it would be inappropriate to use the discount rate to address erosion over time of future cash amounts.*

AFAC also provide comment on the calculation of maintenance costs and believe that requiring replacement of smoke alarms every 10 years should not require four replacements as the fourth replacement would not be due until year 41.

~ABCB Response: The RIS has been amened to calculate the cost of three replacements.

AFAC considers that the fire death and injury figures used in the RIS are significantly underestimated, both from the number of deaths and injuries estimated and the cost of injury treatment.

~ABCB Response: Fatality rates that were sourced from AFAC have been revised on the basis of the VU report and it is considered that 80 fatalities attributed to residential house fires an appropriate average estimation. The cost of injuries have been reviewed and considered appropriate. See appendix D for methodology.

There is also concern that the RIS also adopts an effectiveness rate of 20% for option 1B based on judgement. They suggest that the effectiveness rates assumed are particularly low given the VU report uses 50% for the detectors in all rooms scenario. On this basis, they believe a value of 40% would seem more plausible.

~ABCB Response: The effectiveness rates applied to each option have been revised. The revised effectiveness rates are now more clearly aligned with the conclusions of VU report.

FP-002 Standards Australia Committee

FP-002 is the Standards Australia Committee responsible for the updating and maintaining the Standards applicable to smoke alarms.

The Committee considers that option 1b is the minimum installation requirement that will satisfy the Performance Requirements relevant to early notification of occupants in the event of a fire. The committee believes that existing regulatory arrangements do not satisfy the minimum performance requirement to alert occupants in the event of a fire.

The Committee recommends that if option 1b is not the preferred option then an additional option be considered being an interconnected smoke alarm located in the master bedroom of a multi room dwelling be required by the NCC as they suggest this could be a cost effective means of achieving the minimum sound pressure level specified in AS1670.

~ABCB response: The option of requiring an interconnected smoke alarm in the master bedroom is noted, however it is likely that due to the significant net costs associated with all other options, this alternative is unlikely to present a benefit.

The Committee disagree with the cost of smoke alarm installation in the RIS and have provided amended costs to which they believe reflects current industry practice.

~ABCB response: The final RIS has been recalculated to align with the cost calculations submitted on behalf of the Standards committee.

Metropolitan Fire Brigade

The MFB recommends that the ABCB advocate the adoption of Option 1 (Smoke alarms installed in all bedrooms additional to current requirements) rather than the RIS recommendation and conclusion to maintain the current requirements with no change.

The MFB express concern that any benefit from the options presented are likely to impact on new construction only, and that further retrospective regulatory changes must also be considered so as to address fire safety factors in existing homes.

~ABCB response: Concerns expressed by MFB in relation to existing buildings are not unfounded. Any change to current NCC provisions will not apply to the existing building stock where studies have shown the majority of fire fatalities occur.

MFB conclude by recommending that any change in requirements should be inclusive of greater education and awareness of cultural and behavioural fire safety factors which contribute greatly to fire related death in existing homes.

~ABCB response: Greater education and awareness is an important aspect of any regulatory change and will be considered if required.

Fire Protection Association

The Fire Protection Association (FPA) recommends the placement of smoke alarms in all sleeping areas and living areas and having these smoke alarms interconnected.

FPA believe that the RIS does not adequately address issues relating to health, safety, amenity, and sustainability in buildings and suggest that these issues have been given less weight then the economic implications.

FPA Australia considers that Government have an ethical responsibility to set minimum requirements based on community expectation for safety such as those referenced in the current Objectives relating to automatic warning and detection of smoke. They consider that the cost benefit analysis approach would be made redundant if the outcome is to establish or retain requirements that have been demonstrated not to achieve their objective.

~ABCB response: The purpose of a RIS analyses is to quantify in monetary value the costs and benefits of proposed options. The RIS where possible provides quantification of the health and safety benefits and provides estimates based on research available. Indication that the benefits amount to a significant less monetary value then the costs suggests that the benefit of the options presented are minor.

FPA Australia believes that the rationale of regulatory change is dependant on significant fatalities and injuries being recoded prior to revising the requirements is unsatisfactory and contends that community would not support this approach when it relates to life safety matters.

~ABCB response: The RIS utilises data based on past fatalities as it gives an indication of the likely benefits the options will incur.

FPA recommend that based on the information currently available regarding the relative performance of photoelectric and ionisation smoke alarms, all residential buildings should be fitted with photoelectric alarms in the first instance in order to treat the highest safety risk in residential buildings. FPA believe that ionisation smoke alarms are effective in detecting fast flaming fires that could contribute to some of the fire risk in residential buildings but should be considered supplementary to photoelectric alarms.

~ABCB response: Differences in activation times between ionisation and photoelectric alarms is outside the scope of this RIS.

In relation to interconnection of smoke alarms, "considering that interconnected alarms may have a higher rate of nuisance alarms and subsequent disconnection. FPA considers that interconnection does not create nuisance alarms. Smoke alarm type, location and activity variables create nuisance alarms.

~ABCB response: The requirement for many more smoke alarms than currently required and their interconnection makes it likely that the reliability of the system may be adversely affected simply because of the increased number of components and their interconnection. This could lead to both a greater frequency of false alarms and a greater frequency of failure to operate4 as intended in the event of a fire.

Comments from the building industry

Both HIA and MBA support retaining the status quo. Both agencies agree that the options presented would impose a significant negative cost (NPV) on the community, even with a sensitivity analysis applied.

In addition the risk to the occupants of new buildings is extremely low and therefore regulatory intervention is unwarranted.

~ABCB response: Comments are noted.

Conclusion

This Regulatory Impact Statement (RIS) provides an analysis and evaluation of the current smoke alarm provisions contained in the National Construction Code (NCC) against a number of options to improve occupant notification and response times in the event of fire.

The nature of the problem is that occupants may not be sufficiently notified of a fire in residential dwellings in Class 1, 2, 3 and Class 4 parts of buildings to enable, as required, emergency egress. The extent of the problem which may be attributed to new construction, and therefore the NCC, was observed to be approximately 1.5 fatalities and 8.4 injuries annually due to residential fires.

It was observed that other factors (behavioural and social), such as social economic status, higher risks associated with vulnerable individuals (young, elderly, impaired), disconnection of alarms, impaired by drugs or alcohol, maintenance of property, and non-compliance also reduced the efficacy of smoke alarms. This in part would be expected to continue and may be directly responsible for a proportion of current fatalities and injuries. Hence strengthened regulations only form part of the solution.

A range of options were considered to address the problem. All proposals were considered with and without interconnection of alarms. Proposals include;

- Status Quo: smoke alarms installed in accordance with the current NCC requirements;
- Option 1: Smoke alarms as per the status quo and installed in all bedrooms;
- Option 2: Smoke alarms installed in every room excluding the kitchens, bathrooms, toilets and laundries; and
- Option 3: Smoke alarms installed in every room of the dwelling.

The cost benefit analysis has been amended since the Consultation RIS in response to stakeholder advice on the occurrence of fatalities and cost of installation of smoke alarms. The revised analysis indicates that all options present a significant net cost with low cost benefit ratios not dissimilar to the findings of the Consultation RIS.

The costs and benefits associated with each proposal were as follows:

Proposed amendments	Benefits ($)	Cost ($)	BCR	NPV ($)
Option 1a	$105,982,200	$446,275,732	0.24	(-) $340,293,503
Option 1b	$249,369,844	$ 554,592,775	0.45	(-) $305,222,931
Option 2a	$155,381,219	$846,377,366	0.18	(-) $690,996,147
Option 2b	$280,541,088	$1,037,955,667	0.27	(-) $757,414,579
Option 3a	$187,027,412	$1,429,790,325	0.13	(-) $1,242,762,913
Option 3b	$311,712,353	$1,723,102,324	0.18	(-) $1,411,389,971

*a) Options without interconnection

*b) Options with interconnection

The benefits quantified in the final RIS are higher than calculated from the Consultation RIS. This is a result of the effectiveness rates of each option being revised to align with the findings of the VU report and stakeholder submissions.

The authors of the VU report estimate that installation of smoke alarms in every room, in every dwelling would result in 17-30% fewer fatalities and that interconnected smoke alarms in every room in every dwelling would lead to about 50% fewer fatalities. The VU concludes that the great majority of this benefit would be obtained if interconnected smoke alarms were placed in bedrooms lounge rooms and kitchens.

Applying the same logic, each option has been proportionally weighted up to an effectiveness rate of 50%.

Due to the low number of fatalities and injuries attributed to new construction, the benefits of the proposals were also low. It was therefore observed that all options would provide a large net cost to the community, even with a sensitivity analysis applied to the major variables.

Of the options proposed, Option 1b presents the lowest net cost to industry however the costs associated with this option is still considered to be an excessive burden on the construction industry and therefore retaining the status quo is preferred.

Therefore, this RIS recommends that the status quo be maintained and no change be made to the NCC.

Implementation and review

As this Final RIS recommends that the status quo be maintained, there is no implementation issues associated with the recommendation.

If the board is inclined to support any option that requires additional requirements to that of the Status Quo then that option would be included in the 2014 public comment draft of potential changes to the NCC released for public comment in June 2013. That option could apply from May 2014.

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A Calculation of the number of new Class 1, 2, 3 and 4 buildings

The estimated construction activity for Class 1, 2, 3 and 4 buildings in Australia was based on a combination of a specific data requested from the Victorian Building Commission and ABS Building Approvals Data.[2]

Victorian Building Commission data relating to the number of building permits across each BCA class was used to indicate the ratio of Class 3 to Class 2 buildings and also the ratio of Class 4 to Class 1 buildings. These ratios were then imposed on ABS figures in order to obtain a national snapshot.

- Victorian Building Commission data

Table A-1 below provides a summary of the total number of residential building permits issued across BCA Classes 1-4 in Victoria for 2008/09.3

Table A-1: Number of residential Victorian building permits (2008/09)

Building class	Number of building permits	Percentage of total permits (Class 1- 4)	Ratio to Class 2	Ratio to Class 1
Class 1	53,958	97.34%	n/a	n/a
Class 2	1,017	1.83%	n/a	n/a
Class 3	376	0.68%	36.97%	n/a
Class 4	81	0.15%	n/a	0.15%
Total	**55,432**	**100.00%**		

- Australian Bureau of Statistics data

Table A-2 below outlines the annual average number of dwelling unit completions per Building Class for Class 1 and 2 residential dwellings nationally over the period 2001 -2010.4 Class 3 and 4 have been extrapolated from using ratios derived from Victorian Building Commission data in Table A-1.

Table A-2: Annual average number of residential dwelling unit completions

Building class	Number of dwelling unit completions	Percentage of total dwelling units	Ratio to Class 2	Ratio to Class 1
Class 1	103,373	63.68%	n/a	n/a
Class 2	42,931	26.45%	n/a	n/a
Class 3	15872	9.78%	36.97%	n/a
Class 4	155	0.10%	n/a	0.15%
Total	**162,332**	**100.00%**		

It is important to note that while the Victorian Building Commission does not collect building approval data, which directly corresponds to the approval data reported by ABS, the data it collects on building permit volumes are essentially gathered from the same source. The key difference being that the ABS applies a cost threshold of $10,000 for residential buildings and $50,000 for commercial buildings

[2] ABS Catalogue number 8731.0, "Building approvals, Australia"
[3] Unpublished data sourced through specific data request to the Building Commission.
[4] Australian Bureau of Statistics, *Building Activity*, Cat. No 8731.0 – Table 37

when collating the data for approvals, while the permit volume data from the Victorian Building Commission does not impose this restriction.[5] Therefore, the building approval data from the ABS is effectively a subset of the permit volume data from the Victorian Building Commission, and so is comparable for the purposes of this analysis.

The above figures rely on an assumed proportional breakdown of aggregate ABS data, they should be considered only as an indicative estimate of annual building activity within each BCA class.

The proportion of double storey buildings for Class 1 buildings is assumed to be 19.3%.[6] Therefore the distribution of classifications and double and single storey residential dwellings is as follows:

Table A-3: Indicative estimate of building dwellings for each affected BCA class (volume in 2009/10)

	Class 1 (single)	Class 1 (double)	Class 2	Class 3	Class 4	Total
Australia	83,422	19,951	42,931	15,872	155	162,332

[5] This explanation was provided by the Building Commission of Victoria's Information Analyst.
[6] Victorian Building Commission Data

B HIA House Plans

Figure B-1: Single Storey

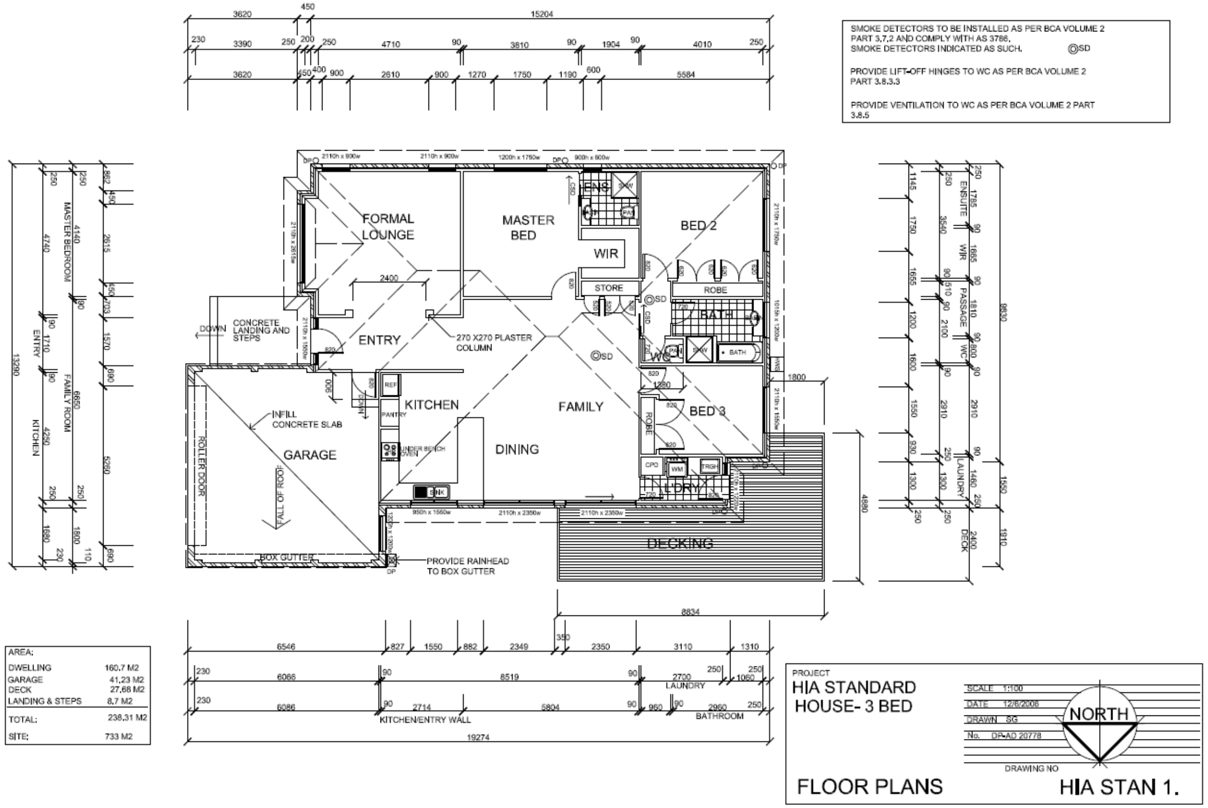
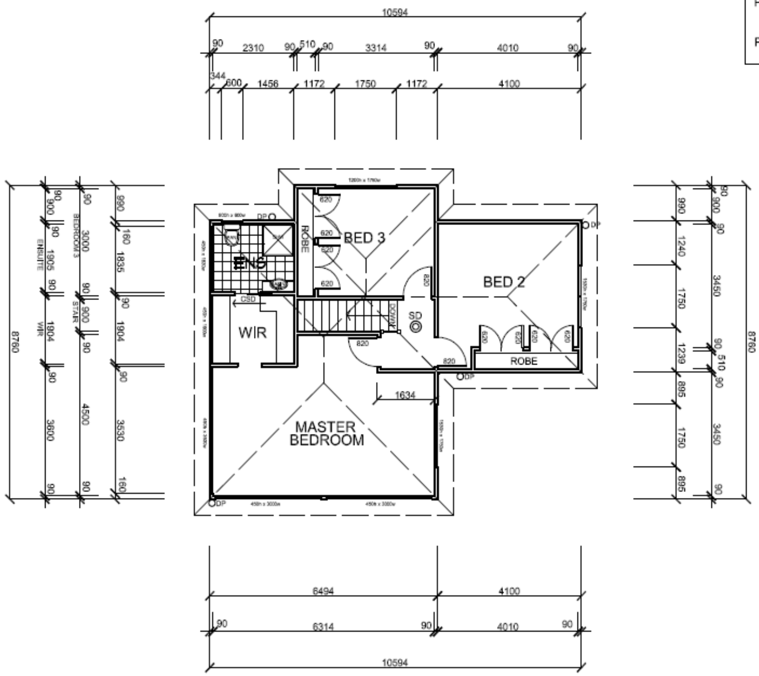


Figure B-3: Double Storey - First Floor

SMOKE DETECTORS TO BE INSTALLED AS PER BCA VOLUME 2
DENOTED ◎SD

PROVIDE LIFT-OFF HINGES TO WC AS PER BCA VOLUME 2

PROVIDE VENTILATION TO WC AS PER BCA VOLUME 2 PART



UPPER FLOOR PLAN

PROJECT HIA STANDARD HOUSE- 4 BED	SCALE 1:100 DATE 23/7/2008 DRAWN SG No. DP-AD 20778 NORTH
FLOOR PLANS	DRAWING NO HIA STAN 2.

C Costs for each proposal

The costs for each proposal were determined by reviewing the plans supplied by HIA and determining where a smoke alarm would be required under each option. For options which required interconnection an estimation of linear metres of wire was also conducted.

The following assumptions for the cost estimates for each of the 7 smoke alarm options are applied to both house designs –

1. Truss roof, slab on ground, timber framed brick veneer design.
2. Installation to occur as standard for new house construction.
3. Alarms to be ceiling mounted and mains connected.
4. Tradesperson access provided during construction of a new house.
5. Smoke alarms with interconnectivity function to be used.
6. Interconnection systems to require separate circuit back to switchboard
7. Switchboard located inside garage right of roller door.
8. Systems without interconnection to be wired into existing lighting circuit.
9. Smoke alarm to be replaced every 10 years.

This section will perform the analysis on each of the proposed smoke alarm provisions as follows:

1. Identify the supply and labour components expected in a smoke alarm system;
2. Determine the number of smoke alarms in each proposed smoke alarm system based on the HIA designs for single and double storey houses;
3. Combine points 1 and 2 and calculate the indicative cost impact for each proposed smoke alarm system.

Indicative cost components used in the estimate include –

1. Labour (Electrician) - $80 per hour
2. Cost of smoke alarm - $30 each
3. Interconnection wiring - $52 per 100m

Therefore the following table shows the cost for both the status quo and each proposed smoke alarm option.

Table C-1: Cost estimates for proposed smoke alarm options attributed to a single storey house

Single Storey	Number of Smoke Alarms	Smoke Alarm Cost	Labour Cost[7]	Standard wiring	Inter-connection Labour[8]	Inter-connection Wire Cost[9]	Total	Replacement Cost[10]
Status Quo	2	60	80	25	0	0	165	140
Option 1 a	5	150	200	63	0	0	413	230
Option 1 b	5	150	200	63	52	32	497	230
Option 2 a	8	240	320	100	0	0	660	320
Option 2 b	8	240	320	100	91	56	807	320
Option 3 a	12	360	480	150	0	0	990	440
Option 3 b	12	360	480	150	143	88	1221	440

Table C-2: Cost estimates for proposed smoke alarm options attributed to a double storey house

Double Storey	Number of Smoke Alarms	Smoke Alarm Cost	Labour Cost	Standard wiring	Inter-connection Labour	Inter-connection Wire Cost	Total	Replacement Cost
Status Quo	2	60	80	25	0	0	165	170
Option 1 a	8	240	320	100	0	0	660	320
Option 1 b	8	240	320	100	91	32	783	320
Option 2 a	11	330	440	138	0	0	908	410
Option 2 b	11	330	440	138	130	56	1094	410
Option	18	540	720	225	0	0	1485	620

[7] Based on $80/hr for an electrician
[8] Based on $80/hr for an electrician
[9] Based on $2/lm for the cost of wire, 3 core (positive, negative, earth) + single core wire (neutral)
[10] Cost to replace alarms every ten years

Double Storey	Number of Smoke Alarms	Smoke Alarm Cost	Labour Cost	Standard wiring	Inter-connection Labour	Inter-connection Wire Cost	Total	Replacement Cost
3 a								
Option 3 b	18	540	720	225	221	88	1794	620

Therefore the additional cost over the status quo for each option is as follows:

Table C-3: Increased building costs over and above the status quo for a single storey design

Proposed Smoke Alarm Option	System Cost Difference ($)	Replacement Cost Difference ($)
Option 1 a	**248**	**90**
Option 1 b	**332**	**90**
Option 2 a	**495**	**180**
Option 2 b	**648**	**180**
Option 3 a	**825**	**300**
Option 3 b	**1056**	**300**

Table C-4: Increased building costs over and above the status quo for a double storey design

Proposed Smoke Alarm Option	System Cost Difference ($)	Replacement Cost Difference ($)
Option 1a	**495**	**150**
Option 1 b	**618**	**150**
Option 2 a	**743**	**240**
Option 2 b	**929**	**240**
Option 3 a	**1320**	**450**
Option 3b	**1629**	**450**

Therefore the aggregate impact of the estimated increase in design and construction costs for each of the 7 proposed smoke alarm options is calculated based on annual building activity and the estimated cost impacts for the relevant representative sample of affected buildings.

The aggregate cost impact for the smoke alarm option amendments is calculated taking into account:

- The construction activity in Building Class 1 to 4's nationally;
- The percentage of buildings within each BCA class that are multi-storey dwellings and are therefore impacted by the proposed smoke alarm amendments.

- The proportion of double storey buildings for Class 1 buildings is assumed to be 19.3%.[11]
- The proportion of Class 3 sole occupancy units to Class 2 sole occupancy units is assumed to be the same proportion as Class 3 building permits to Class 2 building permits in the Victorian Building Commission data.
- The proportion of Class 4 buildings to Class 1 buildings is assumed to be the same proportion as Class 4 building permits to Class 1 building permits in the Victorian Building Commission data.
- Smoke alarms are required to be replaced every ten years, thus replacement costs occur every ten years.

Table C-5: Indicative smoke alarm option cost per BCA class – Total Dwellings in Australia ($'000s) – Year 1

Option	Class 1 (single) ($'000s)	Class 1 (double) ($'000s)	Class 2 ($'000s)	Class 3 ($'000s)	Class 4 ($'000s)	Total ($'000s)
Status Quo	13,765	3,292	7,084	2,619	26	31,709
Option 1 a	34,453	13,168	17,731	6,555	64	71,971
Option 1 b	41,461	15,622	21,337	7,888	77	86,385
Option 2 a	55,059	18,116	28,334	10,476	102	112,087
Option 2 b	67,322	21,826	34,645	12,809	125	136,727
Option 3 a	82,588	29,627	42,502	15,713	153	170,583
Option 3 b	101,858	35,792	52,419	19,380	189	209,638

Table C-6: Indicative smoke alarm option replacement cost per BCA Class – Total Dwellings in Australia ($'000s) – Year 1

Option	Class 1 (single) ($'000s)	Class 1 (double) ($'000s)	Class 2 ($'000s)	Class 3 ($'000s)	Class 4 ($'000s)	Total ($'000s)
Status Quo	11,679	3,392	7,298	2,222	22	24,613
Option 1 a	19,187	6,384	13,738	3,651	36	42,996
Option 1 b	19,187	6,384	13,738	3,651	36	42,996
Option 2 a	26,695	8,180	17,602	5,079	50	57,606
Option 2 b	26,695	8,180	17,602	5,079	50	57,606
Option 3 a	36,706	12,370	26,617	6,984	68	82,745
Option 3 b	36,706	12,370	26,617	6,984	68	82,745

[11] Victorian Building Commission Data

Table C-7: Indicative incremental increase in smoke alarm option costs over and above the status quo per BCA Class – Total Dwellings in Australia ($'000s) - Year 1

Option	Class 1 (single) ($'000s)	Class 1 (double) ($'000s)	Class 2 ($'000s)	Class 3 ($'000s)	Class 4 ($'000s)	Total ($'000s)
Option 1 a	20,689	9,876	10,647	3,936	38	45,186
Option 1 b	27,696	12,330	14,252	5,270	51	59,599
Option 2 a	41,294	14,824	21,251	7,857	77	85,303
Option 2 b	54,057	18,534	27,819	10,285	100	110,795
Option 3 a	68,823	26,335	35,418	13,094	155	143,825
Option 3 b	88,094	32,500	45,335	16,761	164	182,854

Table C-8: Indicative incremental increase in smoke alarm option replacement costs over and above the status quo per BCA class – Total dwellings in Australia ($'000s) - Year 1

Option	Class 1 (single) ($'000s)	Class 1 (double) ($'000s)	Class 2 ($'000s)	Class 3 ($'000s)	Class 4 ($'000s)	Total
Option 1 a	7,508	2,993	3,864	1,428	14	15,807
Option 1 b	7,508	2,993	3,864	1,428	14	15,807
Option 2 a	15,016	4,788	7,728	2,857	28	30,417
Option 2 b	15,016	4,788	7,728	2,857	28	30,417
Option 3 a	25,027	8,978	12,879	4,762	47	51,693
Option 3 b	25,027	8,978	12,879	4,762	47	51,693

Detailed benefits assumptions/calculations

C.1 Cost of hospital separations and fatalities – assumptions and calculations

Cost of hospital separations and fatalities by proposed amendment

Current annual injury/fatality costs attributed to accidental house fire injuries and fatalities
Ratio of New to Existing Housing Stock In 2010, there were 8.395 million private dwellings in Australia.12 In 2010 total completions of new residential dwellings were 162,332.13 The ratio of new to existing residential dwellings is therefore 1.93 per cent. Cost of Injuries: In Table 7.19 of the AIHW Australian Hospital Statistics for 09-10, the number of burn related injury separations in public hospitals is 8485 cases. The total cost to public hospitals is $71,892,000. Therefore the average cost per injury due to smoke/fire/burns equates to about $8475.83. In Table 6-2 of the 1997 MUARC report on "Cost of Injuries in Victoria", the ratio of morbidity costs (loss productivity) to direct hospitalisation costs is about 61.8%. If we assume this ratio is the same for the rest of Australia and that it has remained the same since 1997 we can apply this ratio to the average cost per injury (as previously determined) to come up with the average morbidity cost per injury. Thus, the average morbidity cost per injury due to smoke/fire/burns injuries equates to about $5238. In the 2009 AFAC report, "Accidental Fire Injuries in Residential Structures" the total number of accidental fire injuries that occurred in the home over the 7 year period between 1999-2006 is 6147. Of those, 3026 have the potential to be positively impacted if there was an increase presence of smoke alarms. Annualised, the number of accidental house fire injuries equates to about 433 per year Combining the above 3 points, the annual cost of injuries across existing building stock (nationally) due to accidental fires occurring in a residential structure is estimated to be approximately $5.94 million The ratio of new housing stock to existing housing stock is about 1.9%. Thus the annual cost of injuries attributed to new housing is $112,860,00 Cost of fatalities: • Best estimates suggest that beteen 60 and 100 fatalities occur annually as a result of residential fires. As a central estimate 80 fatalities was chosen to be appropriate estimation. • The economic value of life is assumed to be $3.8 million according to guidance provided by the Office of Best Practice Regulation (http://www.finance.gov.au/obpr/docs/ValuingStatisticalLife.pdf)

[12] ABS, Australian Social Trends, Data Cube: Housing, Cat. No. 4102.0, Table 1.
[13] See Table A-2

Current annual injury/fatality costs attributed to accidental house fire injuries and fatalities
• Combining the above 2 points, the annual cost of fatalities across existing building stock (nationally) due to accidental fires occurring in a residential structure is estimated to be approximately $304 million • The ratio of new housing stock to existing housing stock 1.93%. Thus the annual cost of fatalities attributed to new housing is $5.87 million