CONSULTATION REGULATION IMPACT STATEMENT
(RIS 2010-03)

Proposal to amend the Building Code of Australia to include requirements for private bushfire shelters

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August 2010

The Australian Building Codes Board (ABCB) has commissioned The Centre for International Economics to prepare this Consultation Regulation Impact Statement (RIS) in accordance with the requirements of *Best Practice Regulation: A Guide for Ministerial Councils and National Standard Setting Bodies,* endorsed by the Council of Australian Governments in 2007. Its purpose is to inform interested parties regarding a proposal to amend the Building Code of Australia to include requirements for Private Bushfire Shelters. Comments are invited by COB 22 September 2010. Please title *"Private Bushfire Shelters RIS Public Comment"* and forward by email to: Consultationris@abcb.gov.au

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REPORT

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Proposal to amend the Building Code of Australia to include requirements for private bushfire shelters

Consultation regulation impact statement

Prepared for

Australian Building Codes Board

Centre for International Economics
Canberra & Sydney

August 2010

The Centre for International Economics is a private economic research agency that provides professional, independent and timely analysis of international and domestic events and policies.

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1 Executive summary

This Consultation RIS is targeted at assessing the potential of the 'proposed BCA amendments' for private bushfire shelters in the Building Code of Australia (BCA) to provide additional protection to those residents who find themselves in a bushfire situation.

Private bushfire shelters

The Victorian Bushfire Royal Commission (2009) has stated that:

> While a well designed and constructed shelter may provide a temporary place of refuge during the passage of the fire front, shelters are not a panacea. Misplaced reliance on a shelter can be life threatening. For those situations in which a shelter is a viable option as part of an overall fire plan, the evidence to date suggests that the design, siting and construction of a suitable bunker are neither simple nor inexpensive'.

The VBRC has highlighted evidence of market failure for private bushfire shelters. Concerns that have arisen are that there may be a lack of transparency in the level of quality of shelters in terms of their prospect to save a life. These include:

- confused understanding about standards; and
- contradictory advice on the survival rate within shelters.

With the aim of providing a national standard for private bushfire shelters, the Australian Building Codes Board (ABCB) is proposing BCA amendments (see box 3.1).

This Consultation RIS assesses a range of alternative implementation options against the proposed BCA amendments (central case).

Status quo (Option 1) — no amendments are made to the BCA and current supply options for private bushfire shelters continue in Australia with limited regulatory oversight or provision of information from authorities. Given the progress on public information availability for private bushfire shelters since February 2009, this status quo evaluates more of a 'pens down' approach rather than a no information approach.

Implementation of non-mandatory information guidelines (Option 2) — the 'ABCB Performance Standard for Private Bushfire Shelters[1]' is published as an information source but is not required to be met.

Proposed BCA amendments for private bushfire shelters constructed voluntarily (Option 3) — as the central case, the decision to construct a private bushfire shelter is voluntary, but the Performance Requirement must be met by all private bushfire shelters that are constructed.

A mandatory construction requirement for private bushfire shelters meeting the Performance Requirement (Option 4) — as a risk analysis, there is the potential that development authorities in bushfire prone areas may include a requirement that a private bushfire shelter be constructed before approval is given for the construction of a new residence, in effect removing the voluntary decision of residents to construct or not.

Indicative quantitative results

Given the limited information available on the scale of the market for private bushfire shelters, the quantitative analysis has been conducted at the individual shelter level, utilising expected costs and benefits. The key points of the analytical framework are presented in box 1.1.

1.1 Key points of the analytical framework

- Without sufficient information, consumers are likely to put too much faith in the ability of a private bushfire shelter to protect their lives — that is they will underestimate the costs of the shelters, not knowing the true expectations of loss of life;
- Without a regulatory framework, poor quality shelters will be sold in the market, with limited avenues for consumers to judge tradeoffs in cost and quality, further compromising lives;
- The provision of information to the market, through the Performance Requirements as part of the proposed BCA amendments scenario will alleviate the majority, if not all of the information based market failures currently observed, noting that non-mandatory information guidelines will not be as effective at providing full information.

1 A performance-based standard developed by the ABCB for voluntary use.

Table 1.2 presents the results of an illustrative quantitative modelling exercise. It provides an indication of the relative expected net benefits of an average individual private bushfire shelter.

The expected benefits of an average shelter are dependent on:

- the assumed probability of the shelter saving a life as held by consumers;
- the expected number of people using the shelter; and
- the expected probability of ever having to use the shelter to save a life (which is the combined probability of not being able to survive a bushfire without a shelter and the probability of a bushfire in the area).

Moving across the implementation options, the variables change because:

- consumers are more aware of the limitations of private bushfire shelters and so they assign a lower, and more accurate probability of being able to save their lives in a shelter;
  - this also means a reduction in the misjudgement of consumers as to the true costs of the private bushfire shelters;
- higher quality shelters are more dominant in the market, both increasing the average price, as well as the true probability of a shelter being able to protect lives.

As shown in table 1.2, the only option where the actual benefit cost ratio is equal to that assumed by consumers is under the proposed BCA amendment scenario. Under this scenario, consumers are able to correctly judge the probability of a shelter being able to protect lives, and so there are no unaccounted costs in their purchase decision.

Wherever the assumed benefit cost ratio is greater than the actual benefit cost ratio (status quo and non-mandatory information guidelines), consumers are inefficiently purchasing too many shelters due to an underestimation of the costs involved.

Moving from the status quo to the proposed BCA amendments, the average net present value per shelter increases from $2220 to $17 500 — an eight fold increase.

These results have been subjected to both a scenario based sensitivity analysis as well as a Monte Carlo analysis. In both cases, the input parameters are varied to reflect their perceived level of uncertainty.

1.2 Summary of results of illustrative quantitative model

Variable	*Status quo*	*Non-mandatory information guidelines*	*Proposed BCA amendments*
Value of a life	$3 880 000	$3 880 000	$3 880 000
Years to bushfire event	20	20	20
Net present value of a life	$1 003 000	$1 003 000	$1 003 000
Average number of people per shelter	3	3	3
Probability of survival without a shelter	0.97	0.97	0.97
Probability of a fire in the region	0.80	0.80	0.80
Probability of needing to rely on the shelter for survival	2.40%	2.40%	2.40%
Assumed probability of survival in shelter by the consumer	70%	60%	45%
Assumed benefits of marginal shelter by the consumer	$50 600	$43 300	$32 500
Financial costs of the shelter	$5 000	$10 000	$15 000
Assumed benefit cost ratio by the consumer	10.12	4.33	2.17
Probability of correct use	25%	35%	50%
Probability of the shelter being structurally sound	40%	65%	90%
Actual probability of survival in a shelter	10%	23%	45%
Actual benefits of the shelter	$7 220	$16 430	$32 500
Unaccounted for probability of non-survival in shelter	60%	37%	0%
Unaccounted for costs of loss of life	$43 380	$26 870	$-
Actual benefit cost ratio	1.44	1.64	2.17
Net present value of shelter	$2 220	$6 430	$17 500

Data source: TheCIE 2010.

The main result derived from the sensitivity analyses is that the relative performance of the implementation options does not alter. A summary of the results of the Monte Carlo analysis is presented in table 1.3, where only the status quo and proposed BCA amendments scenario results are reported for simplicity.

1.3 Monte Carlo analysis

	Net present value	
	Status quo	***Proposed BCA amendments***
Minimum	-$5 600	-$17 700
Maximum	$29 400	$313 900
Average	$2 600	$17 900
5th percentile	-$2 500	-$11 900
95th percentile	$10 000	$65 700
Percentage of iterations with positive NPV	71%	73%

Data source: TheCIE 2010.

As the mandatory construction requirement (option 4) removes the voluntary feature of the proposed BCA amendments (option 3), the analysis was conducted separately.

There are considered to be two potential sources of market inefficiencies driven by the mandatory construction requirement:

- new residents who only purchase a shelter because of the requirement with new dwelling construction not because they regard their risk as significant enough to warrant one; and
- existing residents that inefficiently alter their perceptions of the risks of bushfires and survivability in a shelter because of the moves of local councils.

In all cases, once the decision to construct a shelter is no longer voluntary, costs will exceed benefits. People who don't plan to stay will be forced to build and pay for them and some people will use them who should not.

Implementation issues and concerns

Whilst the uptake of the Performance Requirement by States and Territories may assist manufacturers to assess their compliance with the proposed BCA amendment, there is no approved testing protocol to provide verification on the level of stringency in design (and cost) associated with meeting the Performance Requirements of a private bushfire shelter. Such a lack of specification may be associated with an increase in the compliance costs for manufacturers and have an adverse impact on price and competition.

Ongoing monitoring or enforcement mechanisms may be required to ensure that the full range of risks associated with shelters are systematically communicated to the public, although it is noted that this is

not the role of the BCA, especially in terms of private residential constructions.

In addition, where individual State and Territory building compliance programs may not cover formal, independent assessment of constructions, consideration of this in light of the nature of private bushfire shelters may be required and possibly become essential to the integrity of the proposed provisions.

Results and consultation process

Preliminary results drawn out in this Consultation RIS support the adoption of the option to implement the proposed BCA amendments (that is option 3). However, given the immaturity of the market for private bushfire shelters, further information and comments on the chosen analytical framework as well as the modelling is sought through the public consultation process.

- **Understanding bushfires in Australia**
  - Is the profile of bushfire risk appropriately covered in the published literature as summarised here?
  - How is the nature of bushfire risk likely to change over the coming 50 years due to changing weather conditions and climate change?
  - Is there an increasing risk to life and property posed through increasing demand for dwellings on the urban-rural fringe?
  - What is the likelihood of intense bushfire events such as those of Black Saturday recurring in the near to medium term in Australia? In particular, what is the likelihood of this occurring in semi-urban areas?

- **Private bushfire shelters**

  Market for private bushfire shelters:

  - What is the current level of demand for private bushfire shelters?
  - Has there been an increase in demand following the 2009 fires?
    - ⋯ If so, is the demand increase concentrated in any particular regions?
    - ⋯ How big is the potential market for private bushfire shelters?

  Performance of private bushfire shelters:

  - What is the expected increase in the quality of a shelter built to the proposed BCA amendments, in terms of the capacity to save lives?

- What proportion of currently available shelters would not meet the proposed BCA amendments?

Costs:

- Is the assessment of the current market for private bushfire shelters accurate? Including reference to two price levels?
- Are the estimates of $10 000 per shelter under the non-mandatory information guidelines (option 2) and $15 000 per shelter under the proposed BCA amendments (option 3) fair estimates of the expected average prices?

Proposed changes to the BCA

- Are there likely to be discernable differences in shelter quality between the implementation of the proposed BCA amendments and the non-mandatory information guidelines?
- What is the likelihood that local councils in higher risk areas will include mandatory construction requirements (option 4) for private bushfire shelters in new house constructions?
- How would other fire mitigation alternatives, including vegetation clearing, fuel management and emergency services interact with the proposed BCA amendments?
- Are there areas in which these mitigation policies, if properly implemented, would be able to negate the need for a shelter all together?
- Would other mitigation policies provide a viable alternative to the proposed BCA amendments for private bushfire shelters?

Framework for analysis

- What is the expected probability of survival without a private bushfire shelter?
  - That is, where only a house or other building is available.
  - What was the Black Saturday experience?
- What is the expected probability of survival in a shelter:
  - Where there are no mandatory standards?
  - With the proposed BCA amendments?
- What is the expected rate of uptake of shelters under each implementation option?
  - For example, would more residents be likely to construct a shelter if the proposed BCA amendments were implemented compared to the non-mandatory information guidelines option?

- How would the decision to stay or go be altered by the different implementation options, including:
  - Those that would leave irrespective of the availability of any shelter;
  - Those that would decide to stay if an unaccredited shelter is available;
  - Those that would decide to stay only if an accredited shelter is available; and
  - Those that would be required to construct a shelter (by local councils) and still leave.
- What would be the public (non-private) impacts during a bushfire event?
  - *Congestion effects* on roads in a fire event in which the number of people evacuating an area may be reduced?
  - *Changes in response requirements* of emergency services personnel where demand for protection may be reduced due to the availability of private bushfire shelters?
  - *Potential scrambling effects* where people attempt to utilise private bushfire shelters of neighbours, potentially increasing the risks associated with using the shelter?

2 Introduction

Australia is often referred to as the most fire-prone country in the world (McAneney 2007). Bushfires account for a significant portion of historical losses of life and buildings due to natural disaster — particularly in south-eastern Australia (Blong, 2005). Some research suggests that the future risk of bushfires in terms of loss of life and property may be greater than the historical level of bushfire risk, as a result of rising population growth on the urban-bushland boundary and climate change (Hennessy, 2007 Blanchi et al, 2010). In light of these factors, a comprehensive plan to mitigate this bushfire risk is required. The proposed regulations for the private bushfire shelters considered in this Consultation RIS may assist in managing one of the number of potential risks associated with bushfires in Australia.

The Victorian 'Black Saturday' bushfires of February 2009 resulted in considerable loss of life and property and in many ways were uncharacteristic of bushfires experienced in Australia over the past century. For these reasons, a Royal Commission into the Victorian bushfires was established which is in turn part of a broader reassessment of the appropriateness of the established bushfire policies and response mechanisms in Australia.

On 7February 2009, the Black Saturday fires in Victoria resulted in the death of 173 people — two thirds of these victims were inside their homes (VBRC, 2009). Broad classifications of these deaths have been made by the Victorian Bushfires Royal Commission (VBRC).

- 113 people died in their homes, seven in other buildings and a further 27 outside but near to their home. In total, death from 'staying' accounted for 85 per cent of total deaths on that day.
- The remaining 26 people died outside of buildings, including: 11 in vehicles; ten near vehicles or on roads; one on a reserve and four away from locations of the fires.

Directly after the Black Saturday fires, there was a reported increase in the level of both demand and interest in private bushfire shelters.[2]

[2] Note that the terms 'private bushfire shelter', 'bushfire shelter' and 'shelter' are used interchangeably in this Consultation RIS.

This increase in demand suggests that there has been a change in risk preferences or attitudes of Australians following the severity of fires in 2009. There may be a number of factors driving this change in preferences.

- Recognition that it may not be possible to defend a property and survive a bushfire event without the use of a private bushfire shelter, assuming no change in average bushfire intensity.
- Consideration that future bushfire events are more likely to reflect the intensity of Black Saturday fires rather than previous bushfires in Australia.
- An increase in the number of residents requiring peace of mind who never intend to use the shelter, but are willing to pay for the option to use it.

Nature and size of the problem

In deciding to purchase a private bushfire shelter, consumers will weigh up the net benefits they expect in terms of potential protection of life with the cost of purchasing a shelter. However, their expected benefit from the shelter will be determined by the information they have surrounding the probability of success or failure of the shelter in the untested circumstances of a life threatening fire.

The significant increase in interest for private bushfire shelters after the Black Saturday fires indicates that a reasonably large number of consumers may expect a low probability of failure of a private bushfire shelter. However, the amount of information/ evidence available on the rate of success/ failure of commercially available private bushfire shelters immediately after the fire is minimal and unverified. Further, fire safety experts have voiced considerable concerns about the potential for such shelters to provide a high guarantee of safety. If so, shelters may be being constructed that create a false sense of security meaning consumers may not be weighing up all of the expected costs in their decision. This can lead to a market failure where too many consumers are purchasing sub-standard shelters and potentially putting their lives at risk. Given the high value of life, this could represent a large economic problem.

Proposed regulatory solution to address market failure

Currently, the market for private bushfire shelters is relatively immature with only a small number of consumers and suppliers in Australia.

There is also no regulatory oversight of the market in terms of construction standards, testing or quality assurance procedures. Recognising this, the assessment undertaken in this Consultation RIS is directed at evaluating the possible alternative regulatory measures that may be implemented to ensure that the market develops efficiently with well informed consumers and quality guarantees (as understood by consumers) on the products sold. This Consultation RIS considers a single set of amendments developed by the Australian Building Codes Board (ABCB) and alternative implementation options:

- maintenance of a status quo type market structure with no government sponsored construction standards or guidelines;
- introduction of information only non-mandatory guidelines;
- introduction of the proposed BCA amendments for all private bushfire shelters that are voluntarily constructed; and
- as a risk assessment, consideration of the effect of a mandatory construction requirement for private bushfire shelters to be constructed with new dwellings in high risk bushfire areas.

Development of bushfire policy in Australia

It is important to consider how individuals may change their perception of risk and preferences for staying and defending or leaving their property because of the proposed BCA amendments for private bushfire shelters. Answering this question will help to identify whether and how the proposed BCA amendments for private bushfire shelters may be an effective risk mitigation strategy in severe bushfire scenarios. This is particularly important in light of the broader reconsideration of the 'stay or go' policy — currently being considered as part of the Victorian Bushfire Royal Commission – which will assess the level of expectations within the community associated with 'staying' to either actively defend or shelter in houses.

Prior to the Black Saturday bushfires in Victoria, the historical experience of bushfires in Australia had been remarkably consistent. Observed fire patterns across Australia led to a certain level of understanding of fire patterns in Australia. Based on these understandings, the policy of 'prepare, stay and defend or leave early' was developed. More commonly known as 'stay or go', this policy gives residents the option to either evacuate early or to stay and defend their house.

Anecdotal and research evidence has *in the past* suggested that compared to late evacuation, the probability of life and property survival is increased where residents stay and actively defend their property,

extinguishing ember fires as they start. Previous experience had indicated that the most common source of burning houses was ember attacks — which ignite small localised fires in the building structure and take some time to establish before threatening a house.

Detailed research by CSIRO was able to identify houses as able to provide sufficient protection from the fire front as it passed in most bushfires, given that it was sufficiently protected from ember attack prior to the front arriving. Therefore, it was considered to be very possible for active residents to both defend their houses from ember attacks during the approach and recession of the bushfire front and to shelter inside while the front passes. This result was the impetus for the catch-phrase of 'houses protect people and people protect houses' and the development of the 'stay or go' policy (Handmer and Tibbits, 2005).

The implication of the 'stay or go' policy is that there is an acceptable probability that able bodied residents can defend their property, and that they will be able to survive the passing fire front. A further implication of these research results and policy approach is that residents that defend their property from ember attacks during a bushfire were expected (based on previous experience of bushfires) to have a higher rate of survival than those residents that are unable to or do not physically defend their houses.

Further to the actions of residents, it was found that the chance of survival in a bushfire is increased by the following:

- *accurate information* — the resident is competent and informed to make an assessment of whether or not their houses are 'adequately constructed, maintained and prepared to withstand the impact of a fire at its expected intensity';
- *access to fire information* — the resident is sufficiently informed of the progression of the fire and general fire conditions, both before and during the period of high fire danger; and
- *contingency planning* — the resident has planned contingencies in the event the fire is more intense than previously expected.

Embedded in these policies is an, occasionally implicit, understanding that the greatest risk to human life in the event of bushfire is generally considered to be late evacuation. Severe fires experienced in 1983, known as Ash Wednesday, led to the identification of three broad categories of bushfire victims (Handmer and Tibbits, 2005), these include:

- *ineffective survival strategy* — those that recognised the threat from fire and had sufficient time but chose an inadequate survival strategy;
- *time poor* — those that did not recognise the real threat to their safety in sufficient time to follow an effective survival strategy; and

- *physically constrained* — those who were physically incapable of implementing an effective survival strategy.

There were several conclusions drawn from the 1983 Ash Wednesday fires, which have been considered to be consistent with the broader Australian experience over the past century. Those who perished in last minute evacuations were largely in the first category. That is, death resulted from an insufficient understanding of fire patterns and timing to be able to effectively manage their survival strategy. Of those that remained at home and *did not* undertake late evacuation, those that were 'passively sheltering' were more likely to perish than those that were actively defending their properties.

Black Saturday — changing risks and policy

The proportion of victims that stayed in or near their homes during the Black Saturday fires has been noted to be 'strikingly different from previous fires' (VBRC, 2009). Whilst a review of houses that were destroyed in the Victorian bushfires showed that active defence by those residents who stayed was still a determinant of house survival, direct flame attack appeared to be more prevalent than in previous bushfires observed in Australia. Such an increase in direct flame attack on houses would greatly reduce the ability of residents to defend their homes.

It is in fact the high incidence of direct flame contact from surrounding bushland and the multitude of fire fronts which is considered to have resulted in an elevated incidence of death in those that 'stayed and defended' and has provoked a review into the concepts and policies related to fires.

Reiterated throughout the VBRC has been the finding that in the event of a severe bushfire, many people expect to be able to defend their properties and then at the critical point appear to panic and leave after this fails. It has been suggested that the presence of and access to a bushfire shelter may potentially improve the rate of survival in these cases. A key caveat to this however is that the performance of the individual in terms of accessing and exiting the shelter at the appropriate times is just as important as the quality of the shelter in determining the probability of survival.

In assessing potential options for bushfire policy and private protection measures in Australia, an important question is whether the Black Saturday fires were an anomaly, or whether they signal a change in the

nature of bushfire risk in Australia[3]. Importantly, preliminary research undertaken by the Bushfire Cooperative Research Centre (Bushfire CRC) has indicated that in the future there may indeed be greater potential for exposure to extreme fire events due to more extreme weather and high to very high fuel loads (VBRC, 2009).

Further factors that influence the risks (that is, the potential value of damage and loss, rather than the probability of a fire event) of future bushfire events include an increase in the number of people and houses classified as being located close to or inside the Flame Zone — Bushfire Attack Level (BAL) and high bushfire risk areas. In these cases, the intentions and actions of residents are important factors in reducing the potential for loss of life and property.

Research conducted prior to the Victorian bushfires of 2009 indicated that a significant proportion of those residents living in high bushfire risk areas anticipated that they would 'wait and see' in a bushfire event. That is, as a bushfire is approaching they will attempt to assess the severity of the bushfire and leave if the situation became dangerous. Such responses from residents in high risk areas highlight the complexity of peoples' reactions to bushfires. The key decision making factors are unlikely to be known until the day of the bushfire event, including the amount of information on the bushfire that is available to them, their personal expectations of being able to successfully defend and shelter in their house and their physical capacity, including access to water and services, on that day.

The previously commonplace understanding that those that stayed to actively defend their property had a reasonable prospect of survival has been undermined by the Black Saturday bushfire experience. For those residents that are seeking greater protection should they decide to stay and find that the severity of the fire is too extreme to protect or shelter within their house, access to a private bushfire shelter may provide an important secondary option. It may also provide an important option of last resort for those whose first preference may be to leave early, but who discover they do not have enough time to leave safely.

There are many areas where road access and capacity make it dangerous for large numbers of residents to flee late. Some bushfires can develop and move so quickly that residents have insufficient time to evacuate.

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3 This is of course one of the key issues being considered throughout the VBRC process. This project will draw on the findings of the VBRC as well as referenced materials to consider this issue in light of private bushfire shelters.

An important aspect of any proposed regulation of the market for private bushfire shelters needs to recognise that it might affect residents' perceptions of the risk of bushfire. It may also alter attitudes and preferences towards other risk reducing strategies such as reducing fuel loads, preparing houses against bushfire assault and making decisions about when to leave. But the risks from bushfires are many and varied.

Private bushfire shelters are unlikely to be a 'stand-alone' solution to the risks bushfires pose. Accordingly, an evaluation of the impacts of any regulation needs to consider such regulation as part of a broader approach that assists residents to align their expectations of the level of risk associated with 'staying' to defend their properties.

3 Proposed regulatory changes

As stated by the ABCB, 'bushfire shelters are not a stand-alone solution to mitigation of life safety risk', and effective land-use planning, fuel management and emergency services strategies are simultaneously required (ABCB, 2010). The objective of the proposed regulatory intervention in the market for private bushfire shelters is firstly that the strengths and limitations of life protection both be understood and conveyed to those that are affected by fire, and ensuring that they are included as a part of a broader agenda to mitigate the risk of fire most effectively in the future.

Proposed BCA amendments for private bushfire shelters

There are currently no specific provisions within the BCA that address the design, construction or performance of private bushfire shelters. Given the increased interest in the role that private bushfire shelters may play in protecting lives and property after the Black Saturday bushfires, interim regulations have been introduced in Victoria.

In November 2009, the Victorian government issued interim regulations that are intended to provide guidance to consumers and ensure that performance standards are met by suppliers (Building Commission, 2010). These guidelines are intended to be used in the intervening period in Victoria prior to the creation of national requirements — which are under consideration in this Consultation RIS.

Factors that are included in the interim measures explicitly provide for:

- safe access to the building;
- appropriate sanitary and other facilities;
- a means of determining the external environmental conditions;
- safe egress from the building; and
- a means of identification of the location of the building for the purpose of rescue.

In addition, the shelter must also have regard to:

- the number of occupants likely to use the building;
- actions to which the building may be subjected;

- the effects of nearby permanent features such as topography, vegetation and other buildings;
- the potential external fire intensity; and
- the prevention of conditions within the building that are untenable.

Under the interim Victorian regulations, in order to obtain a building permit, building/property owners have three options. They may purchase an accredited shelter, gain certification of the product from a fire safety engineer or obtain a determination from the Building Appeals Board that the alternative solution complies with the interim regulations.

As of March 2010, one manufacturer had received accreditation for a bushfire shelter design, with an estimated cost of approximately $10 500 per shelter plus GST and before installation costs (Wildfire Safety Bunkers, 2010). A number of other manufacturers were awaiting approval for their designs.

Description of regulatory proposal

The ABCB is proposing to include a new classification within the BCA, being Class 10c — private bushfire shelters. Private bushfire shelters have been defined as 'a structure associated with a Class 1a dwelling that may, as a last resort, provide shelter for occupants from immediate life threatening effects of a bushfire' (ABCB, 2010). Also included in the proposal, in Volume Two, is a new Objective, Functional Statement, Performance Requirement and consequential editorial changes (to both Volumes One and Two), (see box 3.1).

The rationale for investigating the appropriateness of implementing the proposed BCA amendments for private bushfire shelters is to 'further reduce the likelihood of fatalities arising from people defending property subject to bushfire attack' (ABCB, 2010).

The proposed implementation strategy is that all Class 10c buildings will be required to meet the proposed Performance Requirement for private bushfire shelters. The Performance Requirement has been taken from the 'ABCB Performance Standard for Private Bushfire Shelters — Part 1[4]'. Whilst the proposed BCA amendments do not include any Deemed-to-Satisfy (DTS) provisions, the ABCB Performance Standard contains Acceptance Criteria to assist building practitioners and building certifiers in achieving compliance with the Performance Requirement.

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4 A document developed by the ABCB at the request of the VBRC for individual use by States and Territories.

3.1 **Proposed BCA amendments for Private Bushfire Shelters**

1.3.2 Classification

Class 10 — a non-habitable building or structure being:

(a) Class 10a — a non-habitable building being a private garage, carport, shed, or the like; or

(b) Class 10b — a structure being a fence, mast, antenna, retaining or free-standing wall, swimming pool, or the like.

Class 10c — a private bushfire shelter.

Objective

O2.3

The O*bjective* is to:

(a) safeguard the occupants from illness or injury:

  (i) by alerting them of a fire in the building so that they may safely evacuate; and

  (ii) caused by fire from heating appliances installed within the building; and

  (iii) in *alpine areas*, from an emergency while evacuating the building; and

(b) avoid the spread of fire; and

(c) protect a building from the effects of a bushfire; and

(d) reduce the likelihood of fatalities arising from occupants of a Class 1a dwelling not evacuating a property prior to exposure from a bushfire event.

Functional Statement

F2.3.5 Private bushfire shelters

A structure designed for emergency occupation during a bushfire event must provide shelter to occupants from direct and indirect actions of a bushfire.

Performance Requirement

P2.3.5

A *private bushfire shelter* must be designed and constructed to provide a tenable environment for occupants during the passage of untenable conditions arising from a bushfire event, appropriate to the:

(a) location of the private bushfire shelter relative to fire hazards including:

(Continued next page)

3.1 **Proposed BCA amendments for Private Bushfire Shelters** (Continued)

(i) predominant vegetation; and

(ii) adjacent buildings and structures; and

(iii) allotment boundaries; and

(iv) other combustible materials; and

(b) occupancy of the *private bushfire shelter*; and

(c) bushfire intensity having regard for the bushfire attack level; and

(d) fire intensity from adjacent buildings and structures, allotment boundaries and other combustible materials; and

(e) ready access to the private bushfire shelter from the associated dwelling and occupant egress after the fire; and

(f) tenability within the *private bushfire shelter* for the estimated maximum period of occupancy; and

(g) generation of smoke, heat and toxic gases from materials used to construct the *private bushfire shelter*; and

(h) structural and fire loads and actions to which it may reasonably be subjected, appropriate to:

(i) the topography between the *private bushfire shelter* and the predominant vegetation or other fire hazards; and

(ii) the distance between the *private bushfire shelter* and the predominant vegetation or other fire hazards; and

(iii) the size of the potential fire source and fire intensity; and

(iv) wind loading; and

(v) potential impact from debris such as falling tree limbs; and

(i) degree of external signage identifying the location of the *private bushfire shelter*; and

(j) degree of internal signage identifying the design capacity and maximum period of occupancy; and

(k) degree of occupant awareness of outside environmental conditions; and

(l) degree of essential maintenance.

Rationale for intervention

Because bushfire intensity, risk, occurrence and human reaction are so highly variable and the number of known private bushfire shelters to have been tested by fire events are so few, empirical evidence and information about the requirements of life-saving private bushfire shelters is limited. Moreover, few other countries face the bushfire risks that Australia does, so there is no strong international evidence on the requirements of safe bushfire shelters, nor are there examples of whether regulatory standards are effective. Australia stands at the forefront of understanding these requirements and whether and how they should be regulated.

Given the many unknowns about the performance and requirements of bushfire shelters and the high stakes of making mistakes, *prima facie,* unregulated markets may fail to guarantee the supply of life-saving shelters. The flaws of sub-standard shelters may only be discovered after a bushfire, and that may be many years after its installation.

Without some form of regulatory oversight or provision of substantiated information to the market for private bushfire shelters, there is the potential for an information-based market failure to exist. This failure may reduce the capacity of consumers to make a fully informed decision about the quality of shelters and their ability to survive a bushfire through the use of a shelter. Without sufficient information (for both suppliers and consumers) there is a risk that consumers may in the event of a bushfire ineffectively rely on a shelter that is not suitable, or alternatively end up paying for additional strength and features that are not required. That is, they are not fully taking into account the costs of a private bushfire shelter failing. Given the value of life, this cost could be substantial.

The rapid growth in demand for private bushfire shelters is thought to be potentially exacerbating this market failure.

Evidence of market failure

Evidence brought before the VBRC following the Victorian bushfires of 2009 suggests that there is a lack of oversight in the market for bushfire shelters. The concern surrounding these findings is that without a construction standard for private bushfire shelters, or some equivalent process through which consumers may measure the performance of these shelters, a consumer's ability to make informed decisions is restricted.

Through the course of the VBRC, there have been reports of both survival and deaths associated with the use of bushfire shelters.

While it is acknowledged that there is the potential for well-designed bushfire shelters to provide life saving protection from a passing bushfire front, this is not guaranteed. Further, a poorly-designed private bushfire shelter has an even greater potential to place those sheltering inside at risk.

The conclusions of the VBRC (2009) were that:

> While a well designed and constructed shelter may provide a temporary place of refuge during the passage of the fire front, shelters are not a panacea. Misplaced reliance on a shelter can be life threatening. For those situations in which a shelter is a viable option as part of an overall fire plan, the evidence to date suggests that the design, siting and construction of a suitable bunker are neither simple nor inexpensive'.

A review conducted as part of the VBRS process entitled, 'Bushfire Bunkers: A summary of products and concepts', provides information on the current market for bushfire shelters in the aftermath of the Victorian bushfires. The review presents an array of private bushfire shelters that are either currently available for construction or in the design and development phase.

The review indicates two key findings in the market for bushfire shelters. Firstly, there has been an increase in demand for bushfire shelters since 7 February 2009 (VBRC, 2009). Secondly, there is a great divergence in the apparent characteristics of advertised bushfire shelters that have become available.

A number of additional observations about the products and product statements were evident and/or presented in the review.

- *A range of definitions for shelters* — ranging from purpose built underground shelters to cellars and safe rooms that form part of the house structure, to partially buried or fully above ground shelters.
- *Product summaries focused on similar product features* — features most emphasised were strength and structural integrity, as well as air supply and filtration.
- *Confused understanding about standards* — whilst some product specifications noted that there was no current standard for bushfire shelters; others made the claim that the product and/or components of the product met Australian Standards. Such statements were thought to imply that there were standards for the bushfire shelters as a product, rather than standards for the components.
- *Contradictory advice* — including contradictory information on the optimal location relative to houses, either distanced for protection or nearby for easier access.

The nature of private bushfire shelters currently available and presented in the VBRC report varies widely. Many of the advertised products appear to be modifications of pre-existing constructions, such as cyclone shelters and concrete water tanks. The VBRC noted in its review of products available on the market that some modifications of products were made to target survival in bushfire, but many were simply limited to locating the structure underground (as opposed to above ground).

The results of the review indicated that the market for private bushfire shelters was beginning to develop a discontinuity in design, sophistication and cost.

- In the lower price range — there were a number of kit form shelters available that are designed from a range of different materials, from reinforced concrete to composite plastic to galvanised tubing. Product costs range from $1000 and $5000, excluding installation costs.
- In the upper price range — products available included converted above ground concrete cyclone shelters to below ground specific purpose built shelters with independent air supplies, sirens and flashing lights. Prices ranged from around $9000 to $20 000.

Importantly, there was considered to be no clear relationship between cost and the effectiveness of design to prevent loss of life. It is also continuingly difficult to assess the quality of the product, without any existing mechanisms to conduct a comparable test on each product.

Other public policy imperatives

Other reasons for assessing the potential requirement to regulate the market for private bushfire shelters are the potential supplementary benefits to both individuals and communities caught in fire and emergency services personnel. A number of potential subsidiary effects were examined through targeted consultation with representatives of the private bushfire shelter and fire protection industry.

- *The potential for reduced congestion on the roads* — where there was consensus that the size of the private bushfire shelter market was small such that there was unlikely to be any noticeable alleviation of congestion on the roads.
- *The potential relief to emergency services personnel* — where there was consensus that the access of a household to a shelter was unlikely to alter the decision of emergency services personnel of whether to support a house or individuals within a house. Rather, respondents suggested additional due diligence may be required for a household with access to a private bushfire shelter.

- *The potential for scrambling effects* — where the general view was that 'scrambling effects', where the neighbours arrive to use the shelter potentially causing excessive shelter occupancy, were highly likely although were inappropriate and difficult to regulate.

Preliminary discussions with experts in the fire industry showed there to be little evidence to support the inclusion of 'other' public policy considerations into the framework of analysis. This provides some initial guidance that there should be limited, if any, 'externalities' to be included in the assessment of local councils or other government authorities to require the construction of a private bushfire shelter built to the proposed construction standards.

Objectives of the proposed BCA amendments

The objective of the proposed BCA amendments is two fold. Primarily they have been developed to ensure that there is some form of information standard available that indicates the required features of a private bushfire shelter to ensure survival as best as possible. Where this information holds some characteristics of a public good, it is more efficient for government authorities to collate and research this information and publish it centrally. Such public good characteristics of the information included in the standard include the zero marginal cost of use.

The provision of information is assumed to increase a consumer's awareness of not only their risk of threat from bushfire, but also their understanding of what may be achieved through the use of a private bushfire shelter. It is reasonable to assume that there may exist two forms of potential bushfire shelter consumers that may be affected by the additional provision of information:

- those who previously held an inflated perception of the ability of a shelter to protect their life, who through the provision of information in the proposed BCA amendments are subsequently more realistic in their assessments; and
- those who previously held unsubstantiated and low opinions of the effectiveness of a bushfire shelter, who through access to information presented in the proposed BCA amendments subsequently raise their perceptions of the potential to survive in a (well built) private bushfire shelter.

Secondly, the objective of implementing the proposed BCA amendments for private bushfire shelters is to provide consumers with some form of guarantee of the quality of shelter that they are purchasing and its ability to provide life protection.

Where only an information non-mandatory guideline is implemented, there is the potential for asymmetric information to persist in the market. That is, consumers are not able to be sufficiently sure that the shelter they purchase meets the standard, due to the lack of enforcement. While signalling from manufacturers could go some way to alleviating this information asymmetry, there will still remain the risk of lower quality shelters being sold under the guise of higher quality shelters.

Where the proposed BCA amendments are able to alleviate this asymmetry efficiently, it will be preferable to an information only non-mandatory guideline.

3.2 Expected benefits of shelter constructed under proposed BCA amendments

While it is expected that a private bushfire shelter constructed under the proposed BCA amendments will be more expensive than under the status quo market, there are significant benefits that are also expected.

- Higher quality shelters, with a greater probability of being able to structurally protect lives in the event of a fire. Estimated increases in this probability of life will be discussed in section 7.
- Increased levels of education of consumers, including greater information on how to effectively utilise a shelter, and their limitations. Such information would reduce the probability of consumers placing their lives at risk because they do not know how to use a shelter.

Current legislative framework

The BCA contains the required technical provisions for building construction in Australia. The goal of the BCA is to achieve the minimum necessary standards that are nationally consistent to ensure health, safety (including structural safety and safety from fire), amenity and sustainability objectives are met. The BCA is the key mechanism through which the technical building requirements are regulated.

Where building and construction regulations are the authority of the State and Territory governments in Australia, the BCA is given power to cover technical aspects of building construction through individual State and Territory enacting legislation. The enforcement mechanisms of this legislation for the construction and building industry, which can be utilised to target regulatory failures, include:

- issuance of building permits;

- inspections both during and after construction;
- issuance of occupancy or compliance approvals; and
- accreditation or approval of materials or components.

As a performance-based code, the BCA requires that the construction industry is able to provide practical, safe and enduring buildings that are fit for their desired purposes. Within this framework, the BCA has mandatory Performance Requirements ensuring that buildings are not unduly susceptible to environmental elements.

Compliance with the Performance Requirements of the BCA is achieved by using a Building Solution. There are essentially three options for a Building Solution:

- Compliance with the Deemed-to-Satisfy (DTS) Provisions.
- Use of an Alternative Solution justified by the appropriate Assessment Method.
- A mixture of both DTS and Alternative Solutions.

In Volume Two of the BCA compliance with the DTS Provisions can be further broken down into two compliance pathways, they are:

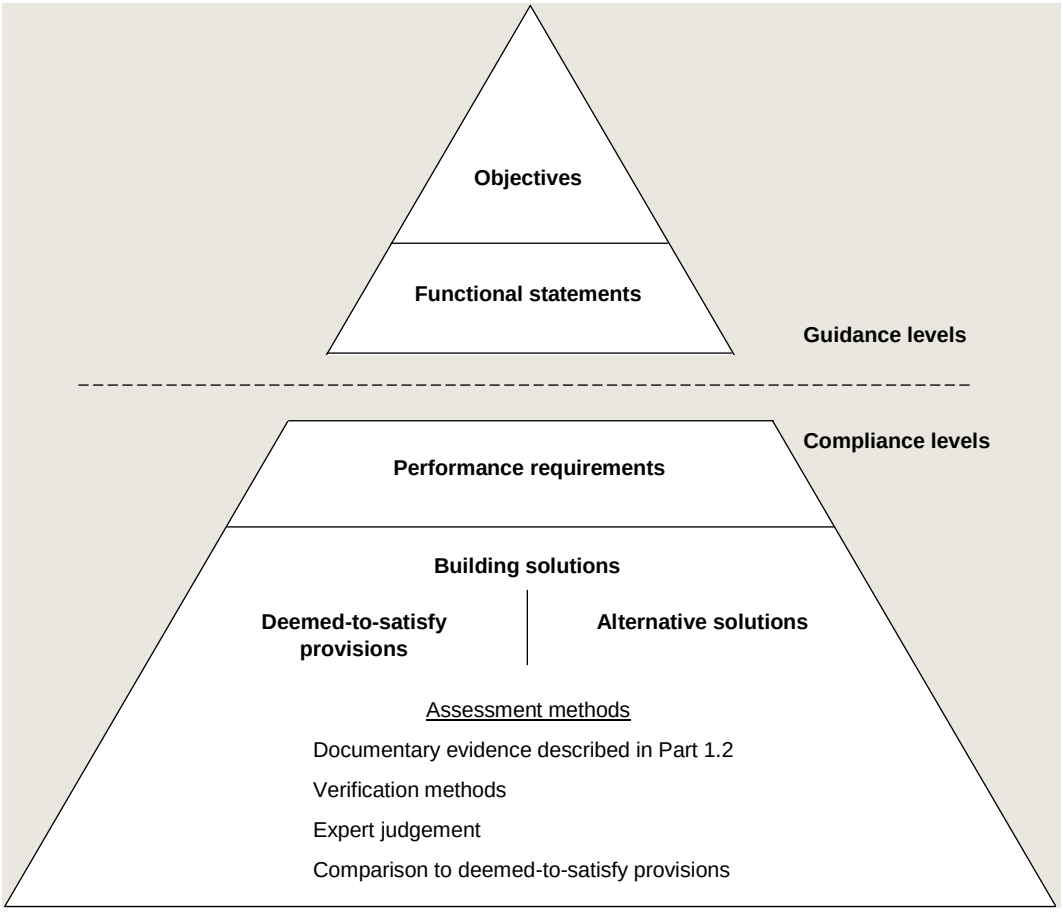
- the appropriate Acceptable Construction Manual; or
- the appropriate Acceptable Construction Practice.

An Alternative Solution is where there is documentary evidence, verification methods and/or expert judgement to ensure that a Building Solution complies with the Performance Requirements other than through the DTS Provisions.

Chart 3.3 provides an illustration of the BCA hierarchy and compliance pathways. The apex of the pyramid identifies the high level, overarching objectives of the BCA. This is followed by Functional Statements referencing the issues that must be addressed to ensure that the objectives mentioned above are achieved. Finally, the Performance Requirements are outlined, stating the required performance of the element or design objectives that underpin the Performance Requirements which may be achieved either through meeting DTS requirements or Alternative Solutions which achieve an equivalent level of performance.

The current fire management provisions for buildings in bushfire prone areas, as specified in the BCA, require that new residential buildings and additions constructed in designated bushfire-prone areas (BPAs) be designed and constructed to reduce the risk of ignition from a bushfire as the fire front passes in order to reduce the danger to life and minimise the risks of building loss (BCA, 2010).

3.3 The BCA Hierarchy



Source: Figure 1.0.3 of BCA Volume Two, Guidance on compliance with the BCA.

The DTS provisions for building in bushfire prone areas refer to the Australian Standard AS 3959-2009 (AS 3959). The standard covers the fire-resistance and combustibility of materials according to their functionality, provisions for fittings and specification for the building structure such as positioning and dimension.

The provisions specified within AS 3959 vary according to the Bushfire Attack Level (BAL) — the expected level of exposure to ember attack, heat flux and direct flame in the event of bushfire. The assessment of a site BAL takes into consideration a number of factors, including the Fire Danger Index, the slope of the land, types of surrounding vegetation and its proximity to any building.

The requirements as set out in AS 3959 are intended to protect buildings while a fire front passes; however the underlying motivation is the protection of housing occupants. Any increase in the risk of house destruction associated with inadequate design and maintenance or a high site BAL level also raises the risk associated with individuals staying to defend their property. Where the BAL is over 40 and for under BAL

40 sites that are not built to AS 3959 (that is, those built before the standard was introduced), it becomes particularly important that house occupants have an alternate option where there is a real prospect that the house may not provide adequate protection.

Options for implementation

In relation to the Australian building industry, the role of the Australian Government, through the ABCB and the BCA, is to observe the operations and interactions within the industry and ensure that construction and development market failures are minimised. This should be conducted in a manner that does not introduce corresponding regulatory failure — regulation should not impose greater costs than would be imposed by allowing the market failure to continue. This not only requires that all potential impacts of the proposed BCA amendments be considered, but a full assessment of the alternatives is undertaken.

To fully explore the options and comply with Council of Australian Governments (COAG) Best Practice Regulation guidelines, new options have been drafted to address the failures of the market for private bushfire shelters in Australia. The following options are being considered:

(a) Status quo — in which no amendments are made to the BCA and current supply options for private bushfire shelters continue in Australia with limited regulatory oversight or provision of information from authorities.

Implementation of non-mandatory guidelines and information — in which the 'ABCB Performance Standard for Private Bushfire Shelters — Part 1[5]' are published as an information source but are not required to be met.

Proposed BCA amendments for voluntarily constructed private bushfire shelters — as the central case, this scenario outlines the Performance Requirement to be met by all private bushfire shelters that are constructed, but does not require a bushfire shelter to be constructed.

A mandatory construction requirement for private bushfire shelters to be constructed and meet the Performance Requirement — where the central case of the RIS is based on a voluntary decision to construct a private bushfire shelter, there is the potential that development authorities in bushfire prone areas may include a requirement that a private bushfire shelter be constructed before approval is given for the construction of a residence.

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5 A performance-based standard developed by the ABCB for voluntary use.

In the wake of the Black Saturday fires, there has been discussion of changes to development applications requiring private bushfire shelters to be included in the construction of all new houses in higher risk areas. Should such development based requirements be enacted, the proposed BCA amendments for private bushfire shelters would essentially become a mandatory requirement in certain areas under local council development application requirements. The inclusion of option 4 is to ensure that this unintended risk is assessed.

4 Bushfire risk

The first step in appraising the relative costs and benefits that may be associated with regulating the market for private bushfire shelters is to understand the extent of bushfire risk both currently and into the future. It is expected that the main driving factor in the market for private bushfire shelters is the perception of bushfire risk for residents in different locations across Australia.

In determining the extent of bushfire risk in Australia, it is important to assess both the probability of an event occurring and the cost of that event should it occur. Over the past 53 years, bushfires have claimed over 400 lives in Australia and destroyed more than 8000 houses (Haynes et al, 2008; Blanchi et al, 2010). Whilst the average probability of a bushfire event endangering a single life or house in Australia is extremely low, there are areas within Australia where individuals and properties are subjected to considerably greater risk. There is the potential for the level of bushfire risk in the future to be greater than the historical trend, as a result of increasing urbanisation and climate change (see Hennessy, 2007).

As a point of clarity, when considering the nature of bushfire events, probability and likelihood will be used to express the observance of a bushfire event. The term risk will be used to express the loss, in terms of life and property, likely to be experienced due to the observance of a bushfire event.

This section comprises a review of current literature and information with respect to the following parameters.

- *The probability of bushfire in Australia* — where bushfire risk varies according to region and climate and the distance of the household to the urban-bushland boundary.
- *The impact of climate change on risk* — allowing for the likelihood of future bushfire events to diverge from the incidence of bushfire in the past.
- *The cost of bushfire in Australia* — in terms of the cost of property destruction and loss of life resulting from a given event.

- *The expected future risk of bushfire in Australia* — where the overall risk of future bushfires would be dependent on the expected probability and cost of bushfire.

Probability of fire

Recent research into the distribution of bushfire events in Australia has highlighted the relatively consistent probability of fire and fire damage from bushfire events and property damage over time.

An assessment conducted by Risk Frontiers, using the PerilAUS database, suggests that the likelihood of losing a house in a bushfire has remained relatively constant for any given year over the past 100 years.

- The assessment showed that over the period 1900-2003, there was an approximately uniform 55 per cent probability of some building destruction in Australia due to bushfires during a given year.
- Analysis of larger bushfires also shows a relatively constant distribution of probability, with an annual probability of losing 25 and 100 houses to bushfires in a year (across a single week of that year) of around 40 and 20 per cent respectively (McAneney and Pitman, 2009).

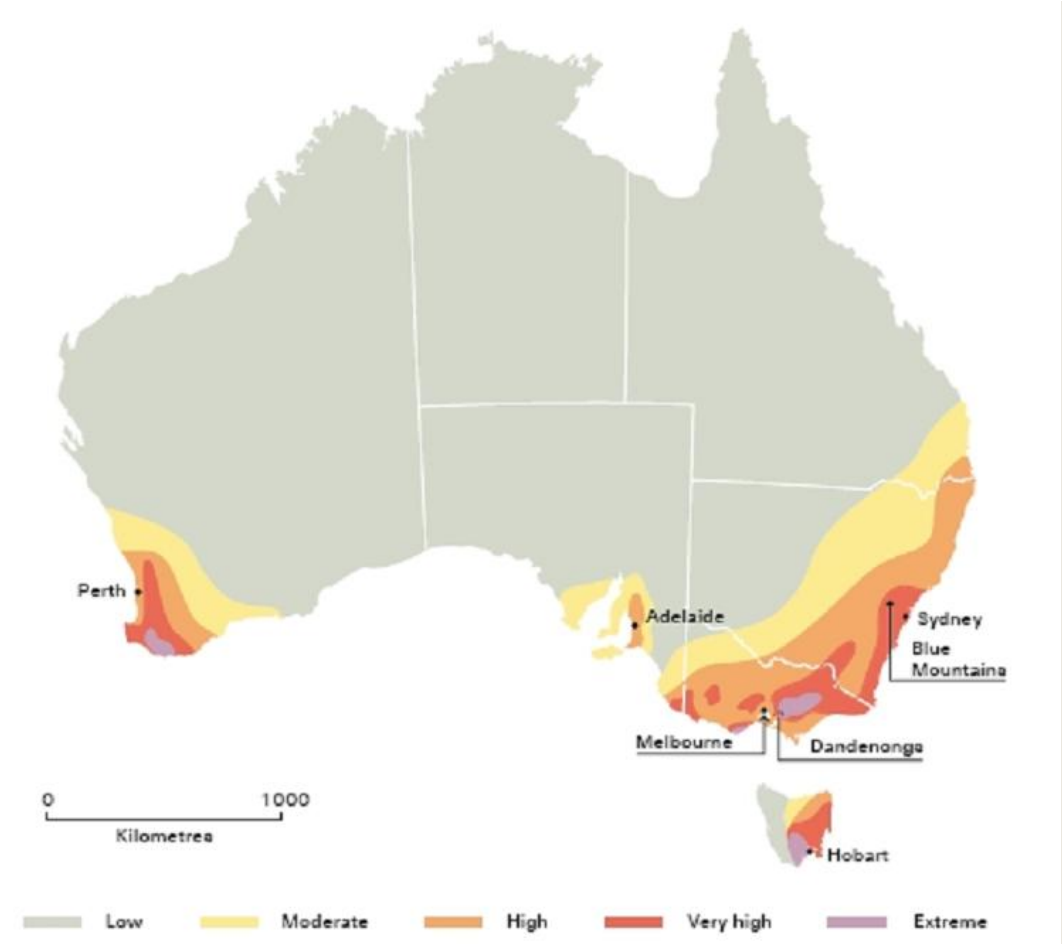
Driven by weather, climate and geographic conditions, the probability of a bushfire event varies by location with the current risk of fire by region being broadly indicated by the prevalence of fire in the past. That is, most high risk areas have experienced bushfire events in the past. Chart 4.1 indicates the risk category by region, with extreme bushfire potential areas being concentrated in the southern and south-eastern regions of Australia (ABCB, 2009).

The impact of climate change on bushfires

Whilst bushfires have been a continuing part of the Australian experience for centuries, there have been a number of particularly large fires over recent years. The severity of bushfire and whether houses and people are exposed to ember attack or by direct flame, has a direct impact on the most effective policies and strategies to protect lives and properties.

Despite the remarkably consistent prevalence of bushfire throughout Australian history, there has recently been some reconsideration of whether risk and climate models based on the past are an accurate reflection of the current bushfire risk. There are two prominent factors that are placing upwards pressure on bushfire risk in terms of loss of life and property:

4.1 Regional bushfire risks in Australia



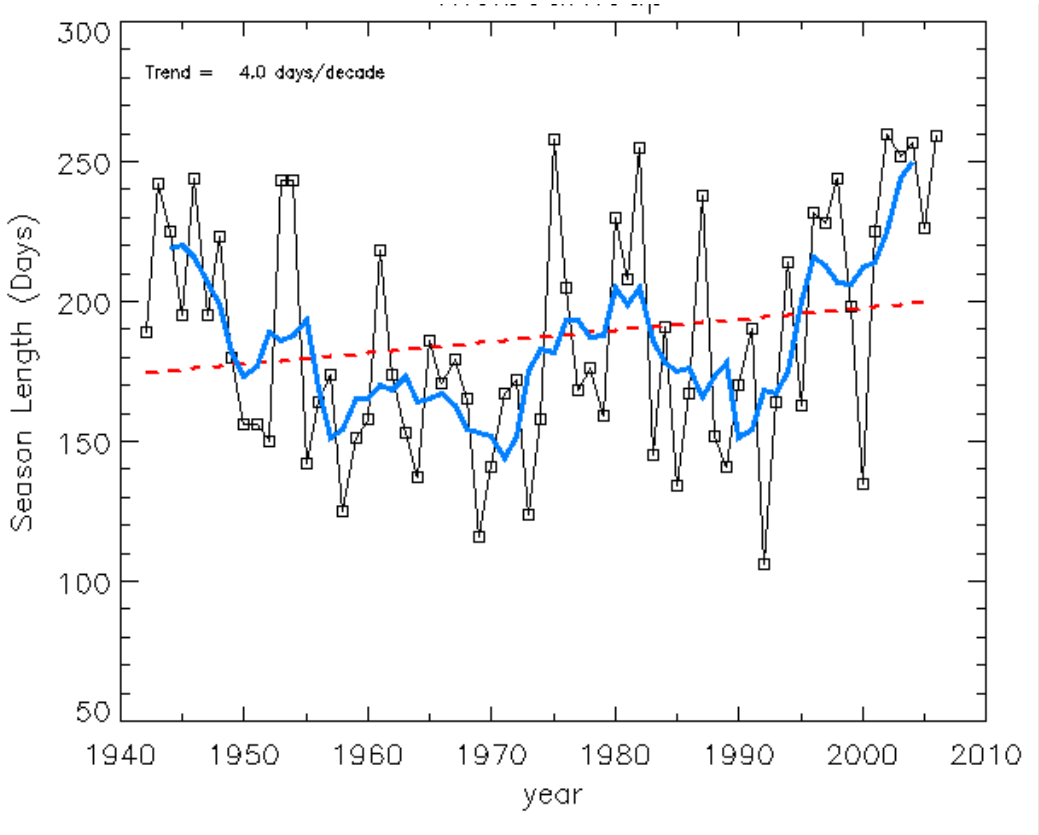
Source: ABCB (2009) Final regulatory Impact Statement for Decision: Proposal to revise the BCA requirements for construction in bushfire prone areas — reproduced from Blong RJ et al. (2000) Natural perils in Australia and New Zealand.

- *climate change and the associated increase in drought severity* — increasing the probability of ignition and fire spread in bushlands; and
- *the increase in number of people living on the urban-bushland boundary* — where the risk of fire may increase as a result of an increasing probability of the burning bushland interfacing with an urban population.

Research into the potential impact of climate change of bushfire risk has indicated that the risk of fire ignition is likely to increase in future as a result of climate change. A study into the potential impacts of climate change on fire weather to 26 separate sites through south-east Australia found that the estimated increase in global temperature as a result of climate change, based on the estimates provided by the Intergovernmental Panel on Climate Change (IPCC), is likely to substantially increase the number of days of 'very high' or 'extreme' fire danger across broad areas of South-East Australia (Hennessy, 2007).

The expansion in the length of the fire season observed since 1990 is posited in the same report to have inter-decadal variability *exacerbated by climate change* (Hennessy, 2007). Chart 4.2 shows the estimated fire season length from 1940 to 2010, taken at Melbourne airport. The chart demonstrates the variation in seasons, showing the broad peaks in the 1940s, the late-1970s to early 1980s, and the 2000s. According to Hennessy there is a general upwards, although not statistically significant, trend in the number of days in the fire season over time.

4.2 **Estimated fire season length**



Note: Estimated fire season length at Melbourne airport — where the blue line is the 5-year running mean, and the red line is the line of best fit.

Data source: Bushfire CRC, 2009.

Climate change is suggested to increase the risk of bushfire through increasing the fire weather risk — only one of several important factors contributing to bushfire risk. The daily temperature, precipitation, relative humidity and wind-speed together constitute the degree of fire weather risk. In addition to fire weather, the fuel load, the terrain and the potential for suppression are critical factors affecting the risk of starting a fire and its rate of spread, intensity or difficulty to suppress (Hennessy, 2006).

The potential for climate change to interact with these other risk factors may compound the risk of climate change. Some of these include:

- *the impact of climate change on the risk of fuel loads* — where further research would be valuable to determine the potential impact of extreme high temperatures on short term desiccation of vegetation and subsequently the risk of the fuel load (Bushfire CRC, 2009).
- *the interaction between climate change and topography* — although air circulations at and behind frontal systems can interact with the topography and fire behaviour these are poorly documented and not well understood (Bushfire CRC, 2009).
- *the influence of climate change on the El Nino — Southern Oscillation cycle* — where there are additional unknown influences of climate change on the prevalence of El Nino conditions as opposed to 'La Nina' or 'Neutral' conditions during which the majority of severe bushfire events on record in Australia have occurred (McAneney et al, 2007).

An increase in fire weather risk, forecast to be a resulting impact of climate change, is anticipated to both increase the probability of a fire (McArthur 1967) and increase the expected intensity of the fire. This may increase the vulnerability of structures and surrounding elements to ignition and destruction by a fire (Blanchi et al, 2010).

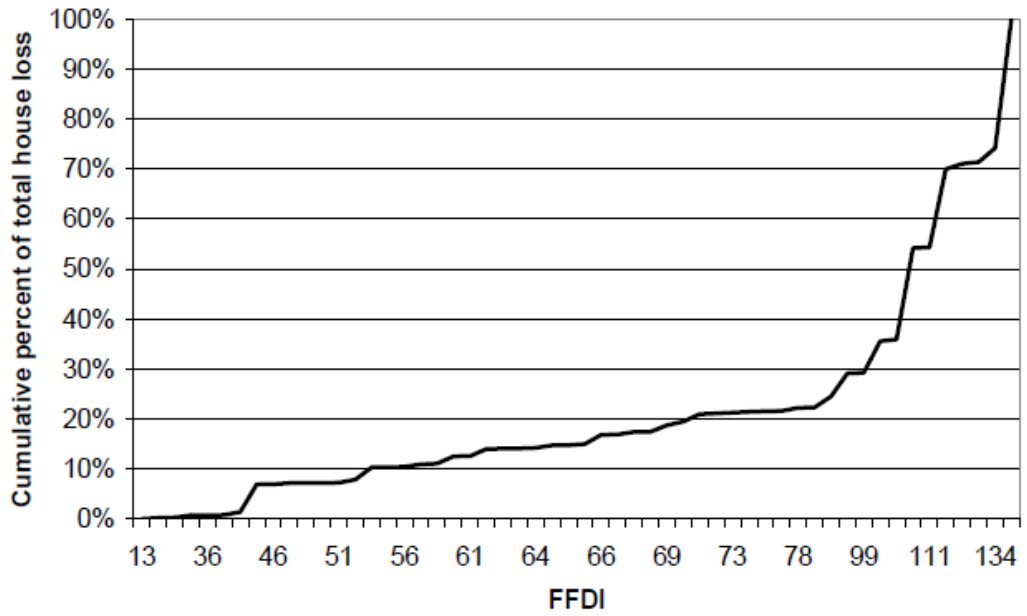
Blanchi et al. (2010) show through analysis of bushfires from 1957 to present that the majority of houses lost in Australian history has occurred where 'extreme' weather conditions occur.

- The study found that approximately 64 per cent of destroyed houses over this period occurred where the Forest Fire Danger Index (FFDI) exceeded 100.
- Greater than 90 per cent of houses burnt over the period occurred during an FFDI of over 50.

To place this in a meaningful context, direct suppression of a fire is considered ineffective and unsafe at an FFDI of over 50 (for a standard fuel level), where urban-rural interface brigade intervention and other community preparedness would comprise the remaining risk mitigation mechanisms (Blanchi et al, 2010).

Chart 4.3 shows the cumulative percent of total house loss related to the FFDI, as illustrated in Blanchi et al. (2010).

4.3 Relation between fire weather risk (FFDI) and house loss



Data source: Blanchi et al. 2010.

Whilst climate change is widely acknowledged as a source of uncertainty and a potential factor to increase the risk of bushfire ignition and spread, some research institutions maintain that this may not materially affect the risk of bushfire in terms of risk to lives and property. Risk Frontiers and the Climate Change Research Centre stated in a report published in 2009 (although written prior to the Victorian bushfires of 2009), that 'the building losses due to bushfires are unlikely to alter materially in the near future'.

The rationale for this is that the losses associated with mega-fires over the last 75 years have been remarkably consistent, in spite of the 'dramatic' combined changes that have not materially affected the likelihood of building losses from bushfire over the past century (McAneney et al, 2009). These changes (are thought to) refer to fuel management practices and technologies, fuel loads and climatic conditions such as drought.

The pivotal question concerning the community following the Victorian bushfires of 2009 is the extent to which our understanding of historical bushfire risk would be a valid representation of future bushfire risk. Increased fire weather risk anticipated to result from climate change is based on *forecasted rather than observed* temperature changes. It may be too early to make a full assessment of the impact of climate change on the interaction of fire ignition potential, fire spread and intensity, and the intersection of bushfire with urban populations. Therefore, there remains a possibility that future bushfire risk will deviate from the observed historical trend.

The cost of bushfire

Another key factor determining the likelihood of purchasing a private bushfire shelter is related to the likelihood that firstly a house is threatened by a bushfire, and secondly that the house is not able to withstand the bushfire.

Although the average risk of bushfire to any household across Australia has a low statistical probability, the risk of bushfire is significantly higher across some regions of Australia. The likelihood of fire ignition and the potential for fire to intersect with the populated area varies by region. At the most basic level, in the event of bushfire, the potential destruction of houses would depend on the number of houses located proximate to bushland.

When considering the risks to property, analysis conducted by Risk Frontiers indicates that the distance to extensive bushland is the single most critical determinant of risk to property destruction from bushfire within a given area. Table 4.4 summarises the risk categories developed by Risk Frontiers based on the observed distance to the urban-bushland boundary.

4.4 **Risk of property destruction from fire, distance to bushland**

Risk rating	***Distance to extensive bushland***	***Proportion of capital city houses***
Very high (5)	Less than 100m	6.0% or 486 000 houses
High (4)	Between 100-200m	3.2% or 259 000 houses
Medium (3)	Between 200-400m	5.0% or 405 000 houses
Low (2)	Between 400-700m	6.1% or 494 000 houses
Negligible (1)	More than 700m	79.7% or 6 456 000 houses

Data source: McAneney, J., Chen, K. and Pitman, A. (2009) *100 years of Australian bushfire property losses: is the risk significant and is it increasing?*, Journal of Environmental Management 90 pp 2819-2822.

With corresponding estimates about the proportion of capital city houses located in each risk zone, these risk categories are put into a meaningful context. Utilising 2006 data from the Australian Bureau of Statistics (ABS), Risk Frontiers estimated that of the 8.1 million dwellings located in Australian capital cities, 6 per cent, or almost half a million, were located less than 100m from the urban-bushland fringe.

The majority of property losses in previous Australian bushfires have been located less than 100 metres from continuous vegetation or bushland. With respect to the Otway Ranges (1983) and Hobart (1967) fires, 70 per cent and 85 per cent were located within 50 and 100 metres from the vegetation boundary respectively (Ahern and Chladil, 1999). Preliminary

analysis of the area of Marysville which was devastated by the 2009 Victorian bushfires, including West Murrindindi Shire, East Murrindindi Shire and Kinglake West showed that between 70–85 per cent of houses destroyed or damaged occurred within 100 metres of forest (Bushfire CRC, 2009). Approximately 40 per cent of houses destroyed were within 10 metres of continuous forest fuels (Bushfire CRC, 2010). Note that this is also a factor of the townships being completely encircled by bushland and vegetation.

The average likelihood of a random home being *threatened* by bushfire on the urban-bushland boundary (within 50m) has been estimated at approximately 1 in 3000 for each year, based on the observation of mega-fires in the last 50 years, excluding the Victorian bushfires of 2009 (McAneney et al, 2007). Given a mega-fire, the probability of home destruction in the first 50 metres is approximately 60 per cent, such that the annual probability of destruction of a home in the urban-bushland boundary is approximately 1 in 5000 (McAneney et al, 2007).

The degree of exposure of a house to fire is dependent on a number of variables and not simply the distance to forest. These include the distance from continuous vegetation, ember reach by high winds, the dryness of vegetation, the fuel load and proximity to buildings, and the proximity of adjacent structures and to other combustible elements (Bushfire CRC, 2009). Distance to bushland appeared to be more prevalent in the case of the Victorian bushfires of 2009, whilst ember attack and the surrounding combustible elements more commonly play a role in bushfire spread, such as the role of house-to-house transfer during the Canberra 2003 fires.

Despite the variability in the cause of spread of fire, the correlation between distance to bushland and house destruction remains remarkably consistent. Furthermore, the distance to bushland appears to be a strong indicator of the future distribution of risk across the housing population.

Difference by State and Territory

The level of occurrence of bushfires in Australia has been highly variable across the State and Territories, with the majority of house losses over the period 1939 to 2009 occurring in Victoria.

The considerable variation in bushfire ‘risk’ across the States is also coupled with significant differentiation across areas within a State, suggesting that, where possible, the assessment of private risk and risk mitigation strategies may be most appropriately assessed by an individual with the assistance of information, regulation and policy that assist the individual to effectively mitigate their risk.

According to Blanchi et al. (2010), the incidence of fire is 'neither cyclic nor predictable', where the trend in housing losses varies by State and the bulk of houses are lost during infrequent major fire events (for most states). The majority of housing losses, for each State, were comprised by:

- *four major events in Victoria* — where approximately 60 per cent of housing losses occurred during the Black Friday fire 1939 (650 houses); the January 1944 fire (434 houses), Ash Wednesday fire in 1983 (1513 houses) and the Victorian bushfires in 2009 (2131 houses);
- *six significant events in New South Wales* — where each fire resulted in the loss of between 100 to 200 houses;
- *one significant event Western Australia* — where a single major fire event in 1961 caused the majority of housing losses;
- *one major event in Tasmania* — where one major fire event in February 1967 caused the loss of almost 1300 houses;
- *one major event in South Australia* — where the extreme fire event in 1983 known as Ash Wednesday caused the destruction of 383 houses, and to a lesser extent during the 2005 fires which destroyed 90 residential dwellings;
- *one major event in the Australian Capital Territory* — where the Canberra fire in 2003 caused the loss of almost 500 houses;
- *no major event in Queensland* — where the absence of a major fire event is considered to be the result of its tropical to subtropical climate and losses only occurred in the past 15 years; and
- *no major event in the Northern Territory* — as a result of extensive community experience with fire, mild fire weather conditions and low population density there have been no major losses despite being the most bushfire-prone region.

Table 4.5 indicates the number of housing losses by state, over the period 1939-2009.

A general observation of the higher incidence of fire in south-eastern Australia over the past 70 years indicates greater risk to Victoria, New South Wales, Tasmania, the ACT and South Australia. It is difficult and potentially inaccurate to quantify the extent of State variation in risk, which would be determined not only by the fire weather severity but also by urban design and building regulations, fuel management and changing land-use practices, changing fire frequencies and community attitudes (Blanchi, 2010).

Where risk profiles vary by region and even by site, as opposed to at the State level, there will be different benefits derived from the construction of

private bushfire shelters across there different risk profiles. As the proposed implementation options being considered in this Consultation RIS ensure that it is voluntary to construct a shelter[6], these differing risk profiles will result in differing demand profiles by region, across Australia.

4.5 Housing losses by state over the period 1939-2009

State	*House losses*	*Portion of total losses*
	No.	%
Victoria	6 861	61.9
New South Wales	1 530	13.8
Tasmania	1 376	12.4
South Australia	548	4.9
Australian Capital Territory	521	4.7
Western Australia	212	1.9
Queensland	43	0.4
Northern Territory	1	0.0
Total	11 092	100.0

Data source: Blanchi et al. 2010.

Financial losses

The financial losses from bushfire have been significant to Australia over the past century.

The incidence of major fire outbreaks in Australia, where at least 488 houses are destroyed (including the Canberra fires of 2003), is approximately 1 in 15 years — based on the past 85 years.

The effects of major and significant fire incidents since 1926 are presented in table 4.6. Whilst records for fire incidents prior to 1926 are available, they are incomplete and potentially unreliable, such that literature tends to focus on records following 1926. For the purposes of table 4.6, a major fire incident is one where 450 or more houses are destroyed, whereas a significant event is one where over 50 houses are destroyed and there is significant loss of life.

To enable a basis for comparison, the average loss for every house destroyed has been included in table 4.6. The estimates for the value of houses destroyed and value of insured losses for property damage are presented in today's prices or present value terms.

6 The mandatory construction requirement being considered in this Consultation RIS is only being presented to illustrate the potentially inefficient market outcome this would generate.

4.6 Major bushfire event and cost

	Year	*Houses destroyed*	*Other assets destroyed*[b]	*Houses damaged*	*Present value insured losses from property damage*	*Average value of losses for every house destroyed*
		No.	No.	No.	$m	$/loss
Major bushfire event						
Black Saturday	2009	2 129	2 588	832	1 350	$630 000
Canberra	2003	488	4	315	414	$850 000
Ash Wednesday	1983	2 500	1 500	1 700	856	$340 000
Hobart	1967	1 293	2 780	Unknown	1 058	$820 000
Black Friday	1939	1 300	Unknown	Unknown	939	$720 000
Black Sunday[a]	1926	1 000	Unknown	Unknown	Unknown	n.a.
Other significant bushfires						
Eyre Peninsula	2005	50	Unknown	Unknown	32	$630 000
Sydney	1994	205	50	70	Unknown	$430 000
Lara	1969	230	21	Unknown	87	n.a.
Dandenong	1962	454	Unknown	Unknown	270	$600 000

[a] Reported losses are the value of insured losses, adjusted for inflation.

[b] Other assets include buildings, farms and infrastructure. Cars have been excluded.

Note: A major or significant bushfire event is an event with over 450 houses burned or loss of greater than five lives (respectively) in a one week period. Insured cost of Dandenong bushfires ($30.5m) adjusted by factor of number of houses burned in three days (450) relative to number burned over two months (600).

Data source: Emergency Management Australia database 2010. Adjustments made for inflation — based on RBA Inflation Calculator.

The cost of bushfire varies according to the number of houses destroyed, displaying a direct positive relationship with insured losses. The average insured losses for every house destroyed in 'major' or 'significant' bushfire event, between 1926 and 2009, has ranged between $340 000 to $850 000.

As well as housing destruction there would be additional property threatened — with the extent of this damage be dependent on not only the asset value in that area but potentially whether people stayed to protect their property. This would account for much of the variation in cost per house destroyed, in addition to the variation in asset values between regions (and in time), as well as the fire severity and capacity of emergency services and individuals to defend property.

5 *Individual risk and private bushfire shelters*

It is important to understand that there are varying levels of bushfire risk that are associated with an individual's response to a fire event. That is, it is the actions of the resident both before the bushfire and during that will have the most influence on their probability of survival and the probability of property survival.

Risks associated with response to fire

Whilst fires are extremely complex, there is considerable documented evidence suggesting that the level of risk to individuals in fire varies by their type of response to the fire. In the 50 years to 2007, there have been approximately 257 deaths from bushfires. The Bushfire CRC has conducted research on the circumstances surrounding each of these deaths (Haynes et al, 2008).

Table 5.1 provides a summary of deaths related to bushfires over the period 1956–2007. A significant portion of deaths reportedly resulted from defending property (over 28 per cent), late evacuation (26 per cent) and passively sheltering or awaiting rescue (13 per cent).

Whilst 'late evacuation' is known to present associated risks, a number of risks of 'staying and defending' — a strategy previously understood to have a reasonable prospect of success — have also been highlighted, particularly in the Victorian bushfires of 2009. Preliminary results from a survey of the residents of fire affected regions, conducted by the Bushfire CRC, indicated a range of difficulties experienced by residents leading up to and during the fire.

> The capacity of those that stayed to defend their homes and properties was inhibited by the severity of conditions, where heat exhaustion, dehydration, breathing difficulties and eye irritation may have diminished the capacity to defend their houses and subsequently their lives (Bushfire CRC, 2009).

5.1 Bushfire fatalities 1956-2007 — activity at time of death

Activity at time of death	*Deaths from bushfire*	*Percentage of deaths*
	No.	%
Late evacuation	66	26
Defending property from outside		
Suburban location	28	11
Rural location	35	13
Inside defendable property		
Actively defending	1	<1
Meagre and unsuccessful attempts to defend	4	2
Passively sheltering	26	10
Activities unknown	4	2
Travelling through the area unaware	28	11
Waiting rescue	7	3
Other or unknown	58	22
Total	**257**	**100**

Data source: Haynes, K. et al. (2008) 100 years of Australian civilian bushfire fatalities: exploring trends in relation to the 'stay or go policy'.

The potential role for private bushfire shelters

The current number of private bushfire shelters constructed in Australia is thought to be low, with Victoria anecdotally suggested as having the highest incidence. The manner in which demand for private bushfire shelters reportedly increased, particularly within but also outside of Victoria, directly after the Black Saturday fires may signal a potentially ongoing change in preferences for shelters, but may also represent a short term phenomena where residents' risk assessments are unduly influenced by extreme and recent events.

In the event of a major bushfire, a private bushfire shelter could provide an important survival option, as a measure of last resort, where the house has been destroyed or as an alternative to late evacuation.

This is not to suggest, however, that all private bushfire shelters available at present or in the past would be sufficient to prevent all of these deaths or necessarily better protect other individuals whose 'activity' during the fire threat did not result in death.

It is important to recognise that an 'adequate' shelter would be one that is able to address a multitude of risks, some of which may already be raised

by AS 3959 in providing strength to buildings in the event of a bushfire (for example, resistance to a given level of radiant heat), but that have the potential to be further strengthened in a shelter. Other risks may require further risk mitigation strategies from the individual and/or regulatory authorities. The possibility of a private bushfire shelter to be used as a measure to save lives would require that the following measures be met.

- *Maintenance of tenable and safe conditions for the occupants during the fire* — where the provisions for the shelter construction and design within the proposed BCA amendments are expected to promote a safe and tenable environment during a bushfire event.
- *Safe route to the shelter* — the proposed BCA amendments include the provision for the location of the private bushfire shelter relative to fire hazards, including predominant vegetation, adjacent buildings and structures, allotment boundaries and other combustible materials, as well as the external signage detailing the location of the shelter.
- *The maintenance of the private bushfire shelter* — whilst there is a provision in the proposed BCA amendments for the 'appropriate degree of essential maintenance', the individual is ultimately responsible to undertake the necessary maintenance to ensure that the private bushfire shelter provides a safe and tenable environment in the event of fire.
- *The appropriate use of the private bushfire shelter with respect to entry and exit time* – where there are varied opinions among experts, the individual must make an assessment about the safe use of the shelter in a bushfire event. The proposed BCA amendments include provisions for internal signage and the degree of occupant awareness of outside environmental conditions such as through a window.
- *The appropriate use of the private bushfire shelter with respect to storage and occupancy* — where there are provisions within the proposed BCA amendments related to the occupancy of the shelter, it is ultimately the responsibility of the individual to ensure that the number of occupants and storage in the private bushfire shelter is appropriate to the design.

The proposed BCA amendments have been developed to largely address the major risks associated with the construction of a private bushfire shelter. It is therefore considered that a private bushfire shelter built and designed in accordance with the amendments would enable an individual to have over a 90 per cent prospect of survival provided they got to the shelter on time and used it optimally.

It must be emphasised that individual performance is a key component of the prospect of survival in a private bushfire shelter, where some

associated risks can only partly be mitigated through the proposed BCA amendments. Whilst there is potentially some scope to expand the proposed BCA amendments to try to address these behavioural elements, it is inevitable that there will be errors in judgement of individuals in the event of a bushfire. Consultation with the private bushfire shelter industry and associated experts indicated that the prospect of survival in a bushfire shelter, accounting for behavioural errors and errors in judgement, may be as low as 50 per cent.

Used incorrectly, closing the door too early, staying too long or having too many people in the shelter, could for instance result in suffocation in a sealed shelter.

The relative importance of shelters in risk mitigation

In light of the risks associated with the 'behavioural' elements of private bushfire shelter use, and considering that the proposed provisions are only able to target the construction risk factors, it is important that the private bushfire shelter remain only one part of an array of bushfire risk mitigation requirements. Whilst the safest option is to leave early, there are alternative or complementary risk mitigation strategies that may be used to reduce the risk to those who stay to protect their property or are unable to leave early. These strategies range from building construction and design, landscaping, emergency management arrangements, water supply and utilities, access arrangements and asset protection zones.

The extent to which the current building stock is at a 'high' level of risk from inadequate building design and construction, excessive hazards present in the environment surrounding the house and inadequate preparation and maintenance of the house and landscape depends on a range of factors. These include:

- the location of the house with respect to the surrounding bushland — where there are different risk profiles for houses at varying distances within the first 100 metres;
- the surrounding legislative and policy environment of the State — where the numbers of houses in compliance with AS 3959 (2009) depends on the time of construction of the building stock and any renovations requiring building permits; and
- the extent of compliance with State and local requirements — where there may be recommendations made to residents to reduce specified 'hazards' there is little enforcement capacity other than through the building and renovation permit application process.

The distribution of bushfire risk across the community is relevant to discussing the implications of a mandatory construction requirement for private bushfire shelters for all new Class 1a buildings in designated bushfire prone areas. The appropriateness of such a measure would depend on whether the individuals have the correct information to understand their potential risk and reactions, or whether this information is better understood by governing authorities. Such an assessment would also consider any associated externalities of having private bushfire shelters available in the community.

6 Evaluation of options

It is possible to develop an analytical benefit cost framework to illustrate both the current market and projected market outcomes of introducing the proposed BCA amendments to the BCA. By comparing these two it is possible to identify and illustrate the relative benefits and costs of introducing non-mandatory guidelines or the proposed BCA amendments compared to the status quo. The framework is built around the actual benefits of saving lives relative to the financial costs of the private bushfire shelter and the costs of lives that may be lost through using the shelter if it fails.

In deciding to purchase a private bushfire shelter consumers will weigh up the benefits that they expect in terms of potential protection of life with the cost of purchase, plus the probability of failure of the shelter and potentially devastating costs of the loss of life should this happen. Should they be misinformed about the probability of failure, they will underestimate the true cost of a shelter and would be likely to make an inefficient choice.

The four implementation options being considered in this Consultation RIS will differ in terms of:

- the average quality of shelters available and their ability to protect lives (the benefits);
- the financial costs of the shelter, which will vary across the options due to varying quality;
- the amount of information provided to consumers as to the efficacy of private bushfire shelters and how to use them effectively; and
- the cost of loss of lives due to misinformation, failure of shelters and the potential for catastrophic misuse of shelters.

The demand for private bushfire shelters is considered to be a function of both the actual quality of the shelter and its ability to protect life, as well as perceptions consumers hold about the ability of shelters to protect life. In turn, the supply of private bushfire shelters reflects the marginal costs of production. This includes both the marginal costs of the components of the shelters (including labour) as well as the costs of accreditation or compliance where these are applicable.

The market for private bushfire shelters is small and relatively new. Collective understanding of the market is limited to observations of the movements in the demand and supply of shelters post-February 2009 up to the point where interim accreditation measures were announced in Victoria. Despite the increase in monitoring of the private bushfire shelter market as a result of the VBRC process, considerable uncertainty remains around the size and nature of the private bushfire shelter market.

As such, this evaluation of the implementation options will essentially involve some elements of judgement about how the market may evolve. A quantitative model is used to assess the relative net benefits at the individual shelter level of the implementation options, relative to the status quo. The model provides a consistent framework to identify and make explicit all important parameters, assumptions and judgements about the market.

Discussions with fire industry experts provide the basis for the probabilistic framework to be used to evaluate the implementation options — where a confidence interval is used to reflect the extent of uncertainty around each parameter. These parameters are outlined prior to presenting the quantitative model to illustrate the relative net benefit of each implementation option.

The section will identify the parameters relevant to the framework for analysis, appraising their relative importance in the model and their impact on the net benefit assessment under each implementation option. Where necessary for modelling purposes, estimates have been provided on the value of parameters, based on research and consultation with the fire industry. Members of the fire industry involved in these initial discussions included State fire authorities, rural fire services, fire industry associations, fire safety experts, building surveyors and private bushfire shelter manufacturers.

Value of lives and houses

The objective of regulating the market for private bushfire shelters is to provide a known standard of quality in the market along with information on survivability to increase the capacity of individuals to effectively assess their level of risk. The benefits are expected to be the potential for individuals to increase their prospect of survival and potentially to reduce the loss of life through well informed decisions.

Whilst the option to use a private bushfire shelter may allow those that stay to defend their properties to have a greater prospect of survival, following discussions with both fire safety industry representatives and

manufacturers, there is no clear evidence to suggest that the presence of a shelter would encourage residents to stay to defend their houses where they would otherwise have left. That is, it is assumed that there will be no change in the number of houses defended from the baseline. Subsequently, the estimated benefit derived from regulating the market will be presented in terms of the value of life, and will not include the value of houses.

It is always difficult to place an estimate on the value of life (VOL). However, either implicitly or explicitly, many policy decisions are determining VOLs.

Following the guidelines set out by the Office of Best Practice Regulation, this Consultation RIS utilises a value of a statistical life of $3.88 million, brought up to 2010 dollars (OBPR, 2008).

Probability of fire and probability of survival without a shelter

The probability of fire and probability of survival without a private bushfire shelter are considered to be important factors in determining the demand for shelters. The expected benefits of constructing a private bushfire shelter in the first instance are heavily tempered by the probability that the area will be affected by bushfires and whether or not there is a direct risk to lives if there is a bushfire in the area. These pieces of information provide the baseline against which individuals will assess the private costs and benefits of constructing a private bushfire shelter in the first instance.

The probability of fire and probability of survival without a shelter *for each individual* would not alter under each implementation option; however, it will be different across different regions in Australia.[7]

Rate of uptake

Evidence presented at the VBRC indicates that there was an increase in the level of demand for private bushfire shelters since the Victorian Black Saturday bushfires of February 2009 until the announcement of the Victorian interim regulations.[8]

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7 It should be noted that even in regions with a lower probability of fire, and a higher probability of survival without a shelter, there will still be individuals that, due to private risk assessments and preferences, will still efficiently choose to purchase a shelter.

8 At which point, market movements could no longer be observed since there was a block placed on the sale of shelters until accreditation.

This preliminary increase in demand indicates that peoples' preferences for constructing shelters are affected by events and information including the observed bushfire events and the stories of survival and deaths associated with shelters.

There is some evidence that the announcement of the interim regulations for private bushfire shelters in Victoria signalled to consumers that the average quality of a shelter was lower than previously expected. Reports from manufacturers of a sharp drop in demand following the announcement may indicate that consumers held a preference for higher quality shelters and were willing to wait to purchase them.

For the purposes of the evaluation presented in section 7, it is assumed that without information or the proposed BCA amendments, consumers have an unjustifiably high perception of the benefits of bushfire shelters. In turn, the provision of information and regulation of the quality of shelters is expected to reduce the perceived benefits and bring them into line with actual benefits of shelters.

It is important to acknowledge that there are likely to be two distinct markets operating following either of the implementation options. Where the enforcement capacity of regulators is limited, there is still the allowance for individuals to firstly make the choice of whether to construct a shelter at all and secondly, whether to construct one to standard. Whilst taking the option of building a shelter not to standard is easier for individuals under the non-mandatory guideline option, it could continue to be a possibility under the proposed BCA amendments and mandatory construction requirement options. This could be observed, for example, through an increase in the number of over specified wine cellars, storage sheds and children's play houses.

The assessment of the rate of uptake involves considerable levels of uncertainty and the immaturity of the market has limited the possibility of making conclusions about the market for shelters. Discussion on changes in the rate of uptake may only be answered empirically, following the evolution and maturation of the market. As the quantitative analyses of the status quo, non-mandatory guidelines and the proposed BCA amendments are conducted at the individual shelter level, the rate of uptake is not an input requirement for the modelling. For the mandatory construction requirement evaluation, a rate of uptake of 3 per cent has been utilised, which was considered to be at the higher end of demand estimates for high risk areas.

Impact to decision making

Whether the proposed provisions (under each implementation option) would enable sufficient information to allow an individual to accurately assess their relative risks is an important factor. A closely related issue to the rate of uptake of a shelter is the issue of the perceived level of risk of using a shelter in the event of a bushfire, and whether the perceived risk adequately reflects reality.

Where expectations are aligned with reality, individuals would decide to invest in a private bushfire shelter to the point that the benefits are at least as high as the costs. Importantly, this would not preclude residents being able to accurately assess in a bushfire event that it is safer to leave early in the event of a bushfire, even if they possess a bushfire shelter.

However, where there is a chance that individuals purchasing a private bushfire shelter may acquire a false sense of security, following the introduction of the proposed provisions (under each of the implementation options) and this places individuals in unnecessary danger, this may lower the community benefits. That is, these residents purchased a bushfire shelter based on their perceived benefits, where actual benefits are much lower. As will be discussed, this risk of inflating perceptions due to the standards is considered to be highest under the mandatory construction requirement option. For all other options, perceived risk and actual risk are assumed to converge with the provision of additional information and greater stringency.

There are considered to be several different 'types' of individuals intending to use a private bushfire shelter. These include:

- *those intending to stay to actively defend their property* — utilising the private bushfire shelter as a measure of last resort;
- *those intending to 'wait and see' whether they will stay or leave* depending on the expectations and information about the severity of the fire and whether the house is defensible against the fire front — where the private bushfire shelter provides a potentially safer option to late evacuation; and
- *those intending to leave early* — utilising the private bushfire shelter as a measure of last resort where they are unable to leave or have insufficient warning.

Preliminary discussions with the bushfire safety industry, including fire authorities and shelter manufacturers have indicated that the presence of a private bushfire shelter is unlikely to change an individual's decision to stay and defend or to leave in a bushfire situation.

That is, the provision of information through non-mandatory guidelines or the proposed BCA amendments scenario is not likely to lead to a change in preference of whether to 'stay' or 'go'. This does not however, preclude those people with a plan to 'wait and see' to inefficiently rely on a poor quality shelter.

However, there was also some concern expressed during initial discussions with the fire industry that a mandatory construction requirement may foster higher-than-realistic expectations of the prospect of survival in a shelter. Where local councils are in a position of authority, some residents and members of the community may misperceive this as an endorsement of shelters as a measure of protection. This remains a hypothetical question and would be more appropriate to discuss qualitatively than to estimate in the modelling.

Further information on these assessments is sought through the public consultation phase.

Probability of survival in a shelter

The quality of private bushfire shelters being constructed in an unregulated market is one of the key concerns that arose through the VBRC in reference to shelters. Immediately after the Black Saturday fires, there was no national standard for the construction of shelters, nor was there a central source of information for consumers on the relative quality of shelters, nor the preferred characteristics that would increase the chances of survival. This situation has somewhat been improved based on the work to publish both the Victorian interim regulations as well as the national requirement being evaluated here.

The following outlines our understanding of the shift in quality that may occur with the introduction of the proposed provisions under each implementation option. These assumptions were formed through the consultation period with the fire industry.

- *Under the non-mandatory information only scenario* — the average level of quality is expected to increase above the status quo. That is, while there will still be some private bushfire shelters not constructed to standard, there will be a greater proportion that will be constructed to standard.
- *Under the proposed BCA amendments scenario for private bushfire shelters* — it is expected that the average quality of private bushfire shelters would increase above the status quo and information only scenarios. In this situation, no shelters in the market for private bushfire shelters would be constructed below standards.

- *Under a mandatory construction requirement scenario for private bushfire shelters* — the average quality should be constructed to meet the Performance Requirement.

The quality of the private bushfire shelters, that is, the probability that they will save lives if used, is a key variable both in terms of the decision to construct as well as the estimated benefits of the options. Discussions with the fire industry highlighted the considerable uncertainty surrounding these parameters; however it is possible to identify confidence intervals within which the average 'quality' may be expected to fall.

In terms of the average prospect of survival of a shelter the following may be implied from these discussions:

- *under the status quo* — the average prospect of survival in a shelter is expected to lie between approximately 30-40 per cent, accounting for design and construction errors;
- *under the proposed BCA amendments for private bushfire shelters where the shelter is used appropriately* — it is expected that there would be a prospect of survival of between approximately 90 to 95 per cent;
- *behavioural errors* — under all scenarios, it was presented that there is a high element of risk associated with private actions and that up to 25 to 50 per cent of occupants may make ineffective decisions with respect to using the shelter that may result in fatality.

There was broad consensus during consultation with fire industry experts that the introduction of the proposed BCA amendments for private bushfire shelter construction would increase the average quality of a private bushfire shelter. This was based on the experts' understanding of the range of risks associated with fire, and the belief that the risks related to construction and design has predominantly been addressed by the Performance Requirement for private bushfire shelters. Allowing for random defects in design, there was the view that a shelter used appropriately may yield a fairly high average prospect of survival.

The most significant risk of using a private bushfire shelter design to the proposed Performance Requirement is of ineffective decision making by individuals both before and during a fire. The key risks identified in terms of behaviour were with respect to the duration of occupancy, the ability of the occupant to safely enter and exit the shelter, the appropriate use of the shelter in terms of number of occupants and use of ventilation or other technical elements, and the adequate management of the shelter and surrounding environment.

The risk of ineffective decision making is considered to be of equivalent significance to the design and construction of the shelter.

Therefore, the average probability of survival in a private bushfire shelter would reflect both the quality of the shelter as well as the probability that it would be utilised correctly and able to protect lives.

Further information on the quality of a shelter, in terms of the prospect of survival, as well as the risk of behavioural elements is sought through the public consultation phase.

Cost of private bushfire shelters

The average cost of a private bushfire shelter is expected to change under the different implementation options. This will be driven predominantly by the removal of lower quality and cheaper materials and designs from the market stringency of regulations and level of information provided to the market both increase. An increase in the average standard of quality is expected to be associated with an increase in the cost of inputs (marginal costs) and potentially increased fixed costs associated with entering the market.

A review conducted as a part of the VBRC process entitled, 'Bushfire Bunkers: A summary of products and concepts', provides information on the current market for private bushfire shelters in the aftermath of the Victorian bushfires. The products available on the market reportedly ranged from $2000 to $40 000 (VBRC). However, where there is a lack of market information on the number of each type of shelter sold, it is difficult to assess the average cost of a shelter.

Experiences reported by manufacturers have indicated that the market for private bushfire shelters is relatively price sensitive, and therefore, under the status quo scenario it is assumed that the average price likely to be at the lower end of the observed range. It is estimated that the average cost of a shelter may be approximately $5000 including the cost of installation and/or excavation.

An increase in the level of quality associated with the introduction of regulation would drive an increase in the minimum cost. Since the introduction of interim regulations in Victoria there has been one shelter accredited. The cost of the shelter available is approximately $10 500 excluding GST, plus the cost of delivery and installation (see Wildfire safety bunkers, promotional material, 2010). Based on limited market observations, the average cost of a shelter may be assumed to be approximately $15 000 inclusive of delivery and installation under the proposed BCA amendments scenario. Installation costs can vary

considerably depending on the difficulty and location of the site for the shelter.

Although not able to be observed, it is expected that the average price of a shelter in the non-mandatory guidelines scenario would be lower than under the proposed BCA amendments scenario. Where a manufacturer does not seek to have their shelter independently quality assured there would be a lower cost of compliance. A figure of $10 000 is used to evaluate the non-mandatory guidelines scenario.

Under a mandatory construction requirement scenario, the average quality of a private bushfire shelter is expected to be consistent with the proposed BCA amendments scenario. The potential increase in market demand under a mandatory construction requirement option may have slight price effects — placing slight upwards pressure on prices. Given that the extent to which demand may increase is unknown; it has been assumed that the minimum price of a shelter may approximate the average price under the proposed BCA amendments scenario.

Further clarification on these estimates is sought through the public consultation phase.

7 Quantitative assessment

Voluntary construction (Options 1, 2 and 3)

Tables 7.1 through to 7.6 present the results of an initial quantitative assessment of the alternate implementation options. The net present values are reported in terms of the true expected benefits and costs. That is, accounting for the probability of fire, life protection, correct use and the expected costs — both the financial costs of the shelters and the value of life lost.

This presentation of the average shelter is necessary due to the lack of information available on the size of the potential market for private bushfire shelters and the characteristics of demand. However, through initial discussions with fire industry professionals, information was provided on the level of misjudgement of costs within each of the market scenarios allowing for an average shelter level analysis.

All three implementation scenarios are estimated based on the following common assumptions:

- the net present Value of Life (VOL) is equal to $1.003 million per person, assuming that the fire occurs 20 years from purchase;
- the average number of occupants per shelter is 3;
- the average probability of loss of life in the event of a severe bushfire is 3 per cent[9]; and
- there is an 80 per cent chance of a bushfire occurring in the area within the next 40 years:
  - this implies a 2.4 per cent (3 per cent of 80 per cent) probability of the private bushfire shelter having to be relied upon to save lives.

Also included is an illustrative analysis of the marginal shelter purchased in each implementation scenario. Consumers will continue to purchase private bushfire shelters to the point where their private estimates of the

9 On Black Saturday approximately 1 per cent of the people living in the areas devastated died. However, during consultation, the view was there are 'other areas where the average probability of loss of life could realistically be around 3 per cent.

benefits are equal to their private estimates of the costs. At this point, the privately estimated benefit cost ratio is equal to one for this marginal private bushfire shelter.

However, where the actual benefits are lower than expected benefits, this means that the purchase of that final shelter imposes net cost.

Status quo shelter evaluation

Table 7.1 presents the results of the expected benefits and costs under the status quo implementation scenario. Overall, consumers in the status quo market scenario are considered to have a high expectation of the private bushfire shelter being able to protect their lives. In table 7.1 this is represented in row H where there is an expectation that 70 per cent of the lives sheltering will be protected.

7.1 **Illustrative quantitative model — for average shelter, status quo**

Variable	*Calculation*	*Value*
Value of a life	A	$3 880 000
Years to bushfire event	B	20
Net present value of a life	C	$1 003 000
Average number of people per shelter	D	3
Probability of survival without a shelter	E	0.97
Probability of a fire in the region	F	0.80
Probability of needing to rely on the shelter for survival	G = (1-E)xF	2.40%
Assumed probability of survival in shelter by the consumer	H	70%
Assumed benefits of marginal shelter by the consumer	I = HxGxDxC	$50 600
Financial costs of the shelter	J	$5 000
Assumed benefit cost ratio by the consumer	K = I/J	10.12
Probability of correct use	L	25%
Probability of the shelter being structurally sound	M	40%
Actual probability of survival in a shelter	N = LxM	10%
Actual benefits of the shelter	O = NxCxDxG	$7 220
Unaccounted for probability of non-survival in shelter	P = H-N	60%
Unaccounted for costs of loss of life	Q = I - O	$43 380
Actual benefit cost ratio	R = O/J	1.44
Net present value of shelter	S = O - J	$2 220

Data source: TheCIE analysis.

These figures mean that there are a total of $50 600 expected benefits, in terms of saved lives, assumed to be achieved per shelter in the status quo market. Note that this is a net figure as it already accounts for the 30 per cent loss of life, the flip side of the 70 per cent assumed probability of survival.

Therefore, with a market cost of $5000, each shelter sold in the status quo market is assumed to be providing an expected benefit cost ratio of 10.12 to 1 by the consumer.

However, the true probability of survival in a shelter is dependent on:

- the probability that the shelter is structurally able to protect a life in bushfire conditions; and
- the probability that the shelter is used effectively.

Within the status quo scenario, a shelter is considered to have a 10 per cent probability of being able to protect a life, through:

- a 25 per cent probability that the shelter will be used correctly; and
- a 40 per cent chance that the shelter will be structurally sound and able to withstand the bushfire conditions.

These two factors reflect the relatively poor levels of consumer education and construction regulations in the status quo market.

In this case, where consumers are expecting a 70 per cent probability of survival, they have misjudged the prospect of life by 60 percentage points. The unaccounted for cost of life is equal to $43 380, as indicated in row Q. This reflects the cost associated with endangering the life of a person as a result of them having greater than realistic expectations of the probability of survival in a shelter.

The actual benefit cost ratio of the shelter sold in the status quo market is 1.44, with an average net present value per shelter of $2220.

Status quo marginal shelter

Table 7.2 assesses the benefits and costs of the average shelter.

However, the benefits and costs will vary by consumer, as a function of the probability that the shelter will ever be called upon to save lives. The lower the probability of the shelter being called upon, the lower will be the expected benefits. This probability may be lower for certain consumers for example, if their chance of being in the area when a fire comes through is lower, or where they have other fire protection measures that may be relied upon first.

As discussed, if costs of unexpected death are not being fully accounted for, consumers will purchase too many shelters, going beyond the point of equating true benefits with true costs. It will be these marginal consumers who expect a net benefit but are in fact facing net costs. In this case, there will be a group of consumers, and society as a whole, on whom the current market failure will impose real economic costs.

Using the expected benefits framework as above, the marginal shelter purchased in the status quo market will have an expected benefit of $5000 (equal to the expected costs). This is achieved when consumers with a very low probability of ever having to use a shelter still purchase one. A shelter with an expected value of $5000 only requires a 0.24 per cent probability of ever having to be relied upon to protect lives. This is calculated in row E, where the $5000 worth of expected benefits are derived from the $1.003 million value of life, three people using the shelter, an expected rate of survival of 70 per cent and an expected probability of actually having to utilise the shelter at 0.24 per cent over the next 40 years.

7.2 Illustrative quantitative model — for marginal shelter, status quo

Variable	*Calculation*	*Value*
Value of a life	A	$1 003 000
Average number of people per shelter	B	3
Probability of needing to rely on the shelter for survival	C	0.24%
Assumed probability of survival in shelter by the consumer	D	70%
Assumed benefits by the consumer	E = AxBxCxD	$5 000
Assumed costs	F	$5 000
Assumed benefit cost ratio by the consumer	G = E/F	1.00
Actual probability of survival in shelter	H	10%
Actual benefits of the shelter	I = HxAxBxC	$700
Unaccounted for costs of loss of life	J = (D-H)x(AxBxC)	$4 200
Actual benefit cost ratio	K = I/F	0.14

Note: Rounding error may mean that some figures do not calculate exactly.
Data source: TheCIE analysis.

As shown in rows G and K, the marginal shelter has an assumed benefit cost ratio of 1.00 by the consumer but an actual benefit cost ratio of 0.14. That is, while the assumed costs are $5000 and consumers think that they have accounted for all of the costs, there is an additional cost of lives valued at $4200 that were not accounted for.

Non-mandatory guideline information only scenario

Through the provision of additional information, in the form of information only construction guidelines for private bushfire shelters, there are two factors that work together to improve the efficiency of the market.

- Higher quality shelters are provided to the market, at a higher price, with a higher probability of survival if they are used.
- Greater information is available on the true costs of a private bushfire shelter, such that the unaccounted for probability of loss of life is reduced.

The greater level of information available to the market, as well as an increasing average quality of shelters works to reduce the unaccounted for costs of lives.

- Consumers are more aware of the limitations of private bushfire shelters in protecting lives, and so reduce their expectations to a 60 per cent probability of survival inside a shelter in bushfire conditions.
- Consumers are also more informed of the key structural characteristics of a good private bushfire shelter, such that lower quality shelters are partially excluded from the market. The average probability of a shelter being structurally sound and able to protect lives increases to 65 per cent.
- Consumers are assumed to have been provided with more effective information on how to use the shelters (for example, access, sealing and timing of use) such that the probability of correctly utilising the shelter has increased to 35 per cent.

Overall, consumers assume a 60 per cent rate of survival in a private bushfire shelter and the actual expected rate of survival is 22.75 per cent.

As shown in row K, the assumed benefit cost ratio is 4.33 for the average shelter under the information guidelines implementation scenario. However, taking into account the unexpected loss of life of $26 870 (from the difference in 60 per cent assumed rate of survival and 22.75 per cent actual rate of survival), the benefit cost ratio is only 1.64.

The net present value of the shelter is $6 430, representing an almost three fold increase over the net present value of a shelter in the status quo market.

7.3 Illustrative quantitative model — for average shelter, information guidelines

Variable	*Calculation*	*Value*
Value of a life	A	$3 880 000
Years to bushfire event	B	20
Net present value of a life	C	$1 003 000
Average number of people per shelter	D	3
Probability of survival without a shelter	E	0.97
Probability of a fire in the region	F	0.80
Probability of needing to rely on the shelter for survival	G = (1-E)xF	2.40%
Assumed probability of survival in shelter by the consumer	H	60%
Assumed benefits of marginal shelter by the consumer	I = HxGxDxC	$43 300
Financial costs of the shelter	J	$10 000
Assumed benefit cost ratio by the consumer	K = I/J	4.33
Probability of correct use	L	35%
Probability of the shelter being structurally sound	M	65%
Actual probability of survival in a shelter	N = LxM	23%
Actual benefits of the shelter	O = NxCxDxG	$16 430
Unaccounted for probability of non-survival in shelter	P = H-N	37%
Unaccounted for costs of loss of life	Q = I - O	$26 870
Actual benefit cost ratio	R = O/J	1.64
Net present value of shelter	S = O - J	$6 430

Data source: TheCIE analysis.

Non-mandatory information guidelines marginal shelter

The marginal shelter purchased in the non-mandatory information guideline scenario will have an expected benefit of $10 000 (equal to the expected costs). As with the status quo market, this is achieved when consumers with a very low probability of ever having to use a shelter still purchase one. A shelter with an expected value of $10 000 only requires a 0.55 per cent probability of ever having to be relied upon to protect lives. This is calculated in row E, where the $10 000 worth of expected benefits are derived from the $1.003 million value of life, three people using the shelter, an expected rate of survival of 60 per cent and an expected probability of having to utilise the shelter at 0.55 per cent over the next 40 years.

7.4 Illustrative quantitative model — for marginal shelter, information guidelines

Variable	*Calculation*	*Value*
Value of a life	A	$1 003 000
Average number of people per shelter	B	3
Probability of needing to rely on the shelter for survival	C	0.55%
Assumed probability of survival in shelter by the consumer	D	60%
Assumed benefits by the consumer	E = AxBxCxD	$10 000
Assumed costs	F	$10 000
Assumed benefit cost ratio by the consumer	G = E/F	1.00
Actual probability of survival in shelter	H	23%
Actual benefits of the shelter	I = HxAxBxC	$3 800
Unaccounted for costs of loss of life	J = (D-H)x(AxBxC)	$6 100
Actual benefit cost ratio	K = I/F	0.38

Note: Rounding error may mean that some figures do not calculate exactly.
Data source: TheCIE analysis.

As shown in rows G and K, the marginal shelter has an assumed benefit cost ratio of 1.00 by the consumer but an actual benefit cost ratio of 0.62, as there is an additional $6100 of costs to lives that are not accounted for.

Proposed BCA amendments scenario

Under the proposed BCA amendments, where every private bushfire shelter is required to meet the Performance Requirements, it is assumed that complete information is provided to the market. The result of this is that consumers are fully able to appreciate the limitations of a private bushfire shelter in saving their lives, with no unaccounted for lost lives.

Moving to a Performance Requirement has the effect of increasing firstly the financial costs of the average shelter, but also increasing the probability of surviving in these higher quality shelters.

Under the proposed BCA amendments implementation scenario, it is assumed that consumers expect a 45 per cent rate of survival when purchasing a private bushfire shelter and this assumption is accurate.

7.5 Illustrative quantitative model — for average shelter, proposed BCA amendments

Variable	*Calculation*	*Value*
Value of a life	A	$3 880 000
Years to bushfire event	B	20
Net present value of a life	C	$1 003 000
Average number of people per shelter	D	3
Probability of survival without a shelter	E	0.97
Probability of a fire in the region	F	0.80
Probability of needing to rely on the shelter for survival	G = (1-E)xF	2.40%
Assumed probability of survival in shelter by the consumer	H	45%
Assumed benefits of marginal shelter by the consumer	I = HxGxDxC	$32 500
Financial costs of the shelter	J	$15 000
Assumed benefit cost ratio by the consumer	K = I/J	2.17
Probability of correct use	L	50%
Probability of the shelter being structurally sound	M	90%
Actual probability of survival in a shelter	N = LxM	45%
Actual benefits of the shelter	O = NxCxDxG	$32 500
Unaccounted for probability of non-survival in shelter	P = H-N	0%
Unaccounted for costs of loss of life	Q = I - O	$0
Actual benefit cost ratio	R = O/J	2.17
Net present value of shelter	S = O - J	$17 500

Data source: TheCIE analysis.

With full information on the limitations of private bushfire shelters, there are no unaccounted for loss of life costs in the decision to purchase. Therefore, the expected benefits of the shelter reported in row I as $32 500 accurately account for a 45 per cent loss of life. The total costs of the shelter are represented by the $15 000 financial costs.

The benefit cost ratio of the average private bushfire shelter under the proposed BCA amendment scenario is 2.17, with a net present value of $17 500.

Relative to the status quo implementation scenario, the provision of accurate information through the proposed BCA amendments more than doubles the benefit cost ratio of the average shelter, and delivered an almost eight fold increase in the expected net present value of the average

shelter, from $2220 to $17 500. Moreover, many marginal shelters that would have imposed real economic costs would not be built.

Proposed BCA amendments marginal shelter

The marginal shelter purchased in the proposed BCA amendments scenario will have an expected benefit of $15 000 (equal to the expected costs). In this case, consumers will continue to purchase shelters to the point where there is a 1.11 per cent probability of ever having to rely upon one to protect their lives. This is calculated in row E, where the $15 000 worth of expected benefits are derived from the $1.003 million value of life, three people using the shelter, an expected rate of survival of 45 per cent and an expected probability of having to utilise the shelter at 1.11 per cent over the next 40 years.

As the proposed BCA amendments implementation scenario is assumed to provide complete information to the market, the marginal shelter has an assumed and actual benefit cost ratio of 1.00 as shown in rows G and K. That is, consumers have fully accounted for the expected loss of lives in the expected benefits, so there are no costs except for the $15 000 construction costs.

The provision of complete and accurate information to the market is considered to have removed the inefficient purchasing decisions as identified in both the status quo and information guidelines scenarios.

7.6 Illustrative quantitative model — for marginal shelter, proposed BCA amendment scenario

Variable	***Calculation***	***Value***
Value of a life	A	$1 003 000
Average number of people per shelter	B	3
Probability of needing to rely on the shelter for survival	C	1.11%
Assumed probability of survival in shelter by the consumer	D	45%
Assumed benefits by the consumer	E = AxBxCxD	$15 000
Assumed costs	F	$15 000
Assumed benefit cost ratio by the consumer	G = E/F	1.00
Actual probability of survival in shelter	H	45%
Actual benefits of the shelter	I = HxAxBxC	$15 000
Unaccounted for costs of loss of life	J = (D-H)x(AxBxC)	$-
Actual benefit cost ratio	K = I/F	1.00

Note: Rounding error may mean that some figures do not calculate exactly.
Data source: TheCIE analysis.

Mandatory construction (Option 4)

Any mandatory construction requirements for private bushfire shelters are likely to introduce market inefficiencies over and above the proposed BCA amendments outcome. As well as those new residents who would have purchased a shelter irrespective of the mandatory construction requirement, under the mandatory construction requirement there would be two other types of consumers.

- New residents who only purchase a shelter because of the requirement with new dwelling constructions.
- Existing residents that inefficiently alter their perceptions of the risks of bushfires and survivability in a shelter because of the moves of local authorities.

Market inefficiencies are almost certainly associated with these two groups. This is because we know from the results presented in table 7.6 that all private bushfire shelters that fall into these two categories under the mandatory construction requirements will have a less than 1.11 per cent probability of ever having to be relied upon to save a life. Were they to have a greater than 1.11 per cent probability of being used, they would be efficiently purchased irrespective of the mandatory construction requirement. This 1.11 per cent is a combined probability of the likelihood of surviving a bushfire without a private bushfire shelter, and the probability of a bushfire coming through the area, either of these two components may be affecting the change for any consumer.

If such a mandatory construction requirement was implemented it would be confined to high risk areas. Therefore, as an example, in an area with a 100 per cent probability of a bushfire occurring in the next 40 years, residents that have a greater than 99 per cent probability of surviving the bushfire without a private bushfire shelter will incur a net cost from the purchase[10].

For both of the examples presented here, changes in the assumed probability of needing to use the shelter, and the assumed change in perceptions will alter the estimated benefit cost ratio, it will always remain below 1.

[10] Note that in the Black Saturday fires, approximately 3 per cent of the population did not survive the fires.

New residents constructing shelters as required

Those residents that are only purchasing a shelter because the local council is enforcing the purchase know that their private benefits are below the expected costs of the shelter; otherwise it would have been purchased voluntarily.

As illustrated in table 7.7, while it will be local councils in high risk areas (100 per cent chance of fire) that impose the requirement, this group of residents are likely to have a higher personal probability of survival due to:

- preference to evacuate early;
- limited time of residence in the high risk area; or
- high fire protection included in their dwelling.

7.7 Illustrative quantitative model — mandatory construction requirement

Variable	*Calculation*	*Value*
Value of a life	A	$3 880 000
Years to bushfire event	B	20
Net present value of a life	C	$1 003 000
Average number of people per shelter	D	3
Probability of survival without a shelter	E	99%
Probability of a fire in the region	F	100%
Probability of needing to rely on the shelter for survival	G = (1-E)xF	1.00%
Assumed probability of survival in shelter by the consumer	H	45%
Assumed benefits of marginal shelter by the consumer	I = HxGxDxC	$13 500
Financial costs of the shelter	J	$15 000
Assumed benefit cost ratio by the consumer	K = I/J	0.90
Probability of correct use	L	50%
Probability of the shelter being structurally sound	M	90%
Actual probability of survival in a shelter	N = LxM	45%
Actual benefits of the shelter	O = NxCxDxG	$13 500
Unaccounted for probability of non-survival in shelter	P = H-N	0%
Unaccounted for costs of loss of life	Q = I - O	$-
Actual benefit cost ratio	R = O/J	0.90
Net present value of shelter	S = O - J	-$1 500

Data source: TheCIE analysis.

If on average, these residents have a 99 per cent probability of survival without a private bushfire shelter, the expected benefits of the purchase are equal to $13 500. This is calculated in row I, using a survival rate of 45 per cent from the use of a private bushfire shelter.

Therefore, where the costs of the shelter are $15 000 and the benefits are $13 500, these additional shelters have an indicative benefit cost ratio of approximately 0.9 but will not incur an additional cost of life as consumers remain fully aware of the limitations of the shelter they have been forced to purchase.

Existing residents altering their perceptions

Under the proposed BCA amendments, shelters are expected to have a 45 per cent probability of saving lives. All consumers are considered to be aware of this probability. However, should local councils enforce the construction of private bushfire shelters for new dwellings in an area, this may signal to some residents that the councils are supporting the use of private bushfire shelters, and through this, change their perception of the safety of these private bushfire shelters.

As an indication of the effect this may have, table 7.8 presents the benefit cost ratio of a shelter constructed where:

- residents have a 99 per cent probability of surviving a bushfire without a private bushfire shelter; and
- these residents consider that councils are signalling an increase in rate of survival in a shelter from 45 per cent to 55 per cent.

As illustrated in row I, an increase in the expected rate of survival from 45 to 55 per cent increases the assumed benefits of the purchased shelter to $16 500. However, the actual benefits of the shelter are only $13 500, accounting for a 1 per cent probability of ever having to be used, and a 45 per cent expected rate of survival. Residents are therefore not accounting for an additional $3 000 in terms of loss of life from these shelters.

Overall, where consumers are assuming a benefit cost ratio of 1.10, the actual benefit cost ratio remains at 0.90. This additional inefficiency in the market will result in too many shelters being purchased, due to an incorrect estimation of the costs and benefits of the private bushfire shelters.

7.8 Illustrative quantitative model — mandatory construction requirement

Variable	*Calculation*	*Value*
Value of a life	A	$3 880 000
Years to bushfire event	B	20
Net present value of a life	C	$1 003 000
Average number of people per shelter	D	3
Probability of survival without a shelter	E	99%
Probability of a fire in the region	F	100%
Probability of needing to rely on the shelter for survival	G = (1-E)xF	1.00%
Assumed probability of survival in shelter by the consumer	H	55%
Assumed benefits of marginal shelter by the consumer	I = HxGxDxC	$16 500
Financial costs of the shelter	J	$15 000
Assumed benefit cost ratio by the consumer	K = I/J	1.10
Probability of correct use	L	50%
Probability of the shelter being structurally sound	M	90%
Actual probability of survival in a shelter	N = LxM	45%
Actual benefits of the shelter	O = NxCxDxG	$13 500
Unaccounted for probability of non-survival in shelter	P = H-N	10%
Unaccounted for costs of loss of life	Q = I - O	$3 000
Actual benefit cost ratio	R = O/J	0.90
Net present value of shelter	S = O - J	-$1 500

Data source: TheCIE estimates.

8 Sensitivity analysis

Two forms of sensitivity analyses have been applied to the model results presented in table 7.1. Firstly, a number of scenario based sensitivity analyses have been conducted to illustrate the effects of uncertainty in specific variables used in the model. Then, a Monte Carlo based sensitivity analysis has been conducted to provide a distribution of likely benefit cost ratios based on defined uncertainties in all of the model parameters. Combined, these analyses show that relative results across the implementation options are fairly robust to uncertainty in the parameters.

Note that no sensitivity analysis has been undertaken on the mandatory construction requirement as by definition there is no potential for a benefit cost ratio above 1 to be achieved.

Discount rate

The benefits of the proposed BCA amendments are termed in relation to the number of lives that maybe saved or lost and the monetary value that is placed on those lives. In this case, discussion of discount rates becomes theoretical rather than practical, requiring an assessment of the value of years of life in the future relative to now. The economic literature has discussed the use of discount rates with respect to the value of lives, and results vary across a range of perspectives, including:

- age dependent discount rates which account for the remaining years of life;
- lower discount rates applied to the value of life than to financial assets; and,
- a zero discount rate applied to the value of life.

The quantitative results presented in section 7 have followed OBPR guidelines in assuming a 7 per cent discount rate, with an additional assumption of a fire being observed 20 years after construction. This 7 per cent discount rate is applied to both the value of lives saved as well as the value of lives lost. Table 8.1 presents the actual net present value results, assuming that a fire occurs 20 years after construction.

8.1 **Net present value of shelters, by discount rate**

Discount rate	*Status quo*	*Non-mandatory guidelines*	*Proposed BCA amendments*
Zero	$22 940	$53 550	$110 710
3 per cent	$10 470	$25 180	$54 600
5 per cent	$5 530	$13 950	$32 370
7 per cent (central case)	$2 220	$6 430	$17 500
11 per cent	-$1 540	-$2 120	$580

Note: Fire event observed 20 years after construction
Data source: TheCIE analysis

The results indicate that while the application of a lower discount rate does have a significant effect on the net present value of the private bushfire shelters. This effect is generated through a change in the value of lives saved in the future as immediate costs are not affected by changes in the discount rate.

Average cost of a shelter

While effort has been made to identify reasonable estimates of the cost of a shelter across the three different implementation options, given the immaturity of the market, these assumptions have been tested. Table 8.2 presents the results of additional price premiums on shelter construction of 10 per cent, 20 per cent, 50 per cent and 100 per cent.

8.2 **Net present value of shelters, by construction cost premium**

Cost premium	*Status quo*	*Non-mandatory guidelines*	*Proposed BCA amendments*
Zero (central case)	$2 220	$6 430	$17 500
10 per cent	$1 720	$5 430	$16 000
20 per cent	$1 220	$4 430	$14 500
50 per cent	-$280	$1 430	$10 000
100 per cent	-$2 780	-$3 570	$2 500

Data source: TheCIE analysis

Compared to the results in table 8.1, these figures show that a change in the discount rate used has a greater effect on the net present value of a shelter than a change in the up front construction costs.

This result is driven by the fact that relative to a value of a life of $3.88 million in 20 years; altering the upfront cost of a status quo shelter for example by $5000 is relatively insignificant.

Number of lives saved and lost per shelter

There are no prescriptions in the proposed provisions (under all implementation options) about the number of people that must be able to be accommodated in the shelters. However, designs that have been, or are in the process of being, accredited generally allow for up to six people to shelter inside. In the central case, it was assumed that three lives were saved through the correct use of a shelter in a bushfire event. However, this may be considered to be too high if there is a propensity for families to generally leave only one or two members in the fire with the remainder fleeing, or too low if there is the potential for scrambling effects above the family unit.

Table 8.3 presents the estimated net present value of each shelter based on one through to six occupants in each.

8.3 **Net present value of shelters, by average number of occupants**

Number of Occupants	*Status quo*	*Non-mandatory guidelines*	*Proposed BCA amendments*
One person	-$2 600	-$4 500	-$4 200
Two people	-$200	$1 000	$6 700
Three people (central case)	$2 200	$6 400	$17 500
Four people	$4 600	$11 900	$28 300
Five people	$7 000	$17 400	$39 200
Six people	$9 400	$22 900	$50 000

Data source: TheCIE analysis.

With only one person expected to be saved per shelter, all three implementation scenarios will return a negative net present value. That is, with only one person expected to be saved, with a 2.4 per cent probability of having to use it (an 80 per cent probability of a fire occurring and a 3 per cent probability of not surviving without a shelter), the construction costs outweigh the expected benefits.

However, note that in this scenario, under full information of the Performance Requirement, no shelters will be inefficiently purchased.

In contrast, in the status quo and information guidelines scenarios, where consumers do not accurately account for the costs of lives that may be lost, these shelters will still be purchased.

Probability of a fire

The expected benefits of a private bushfire shelter are heavily dependent on the probability of it having to be used. Where there is a zero risk of fire in the region, consumers will have a zero benefit in terms of lives saved (although they may derive some peace of mind benefits from knowing the shelter is there 'just in case').

The results in section 7 and the preceding sensitivity analyses have assumed an 80 per cent probability of fire in the region, and a 3 per cent probability of not being able to survive the fire without a private bushfire shelter. The results in table 8.4 indicate the effect that changes in the probability of a fire have on the net present value of the shelters.

8.4 **Net present value of shelters, by probability of fire**

Probability of fire	*Status quo*	*Non-mandatory guidelines*	*Proposed BCA amendments*
50 per cent	-$500	$300	$5 300
65 per cent	$900	$3 300	$11 400
80 per cent	$2 200	$6 400	$17 500
95 per cent	$3 600	$9 500	$23 600

Data source: TheCIE analysis.

At a relatively low regional probability of fire, 50 per cent, status quo shelters do not return a positive net benefit, however higher quality shelters sold under information guidelines and the proposed BCA amendments do still retain a positive net benefit.

Aggregation and size of market assumptions

The analysis has been conducted at the individual shelter level, firstly due to a lack of information on the size of the market for private bushfire shelters, but also due to the nature of the implementation options. By allowing for a voluntary decision to construct the bushfire shelter, it is known that residents will only take the initial steps of construction where the private benefits are greater than the private costs.

Therefore, the results of the analysis presented in table 7.1 are unlikely to change markedly depending on aggregation options across regions in Australia, or based on different assumption of take up rates.

Monte Carlo simulation

Where the previous sensitivity analyses have provided discrete estimation of single parameter changes within the results, the following Monte Carlo simulation allows for testing of the combined effects of changing the underlying parameter values. The simulation varies all key parameters and recalculates the benefit cost ratio. Ten thousand Monte Carlo simulations have been conducted for each implementation option. Only the status quo and the proposed amendments have been reported for simplicity.

Due to the immaturity of the market, all model inputs are considered to have a degree of uncertainty and are varied to reflect the level of perceived uncertainty. Most inputs have been varied around the expected mean value, which is the central case presented in the illustrative quantitative model.

The distributions for parameters are presented in table 8.5.

With only one exception, the input parameters have been drawn from a normal distribution in the Monte Carlo simulation exercise. A normal distribution is used to allow for variation in the parameter, where it is expected to cluster around the mean. The mean and standard deviations are shown in the brackets in table 8.5, as well as the truncation limits to ensure realistic results, accounting for issues such as non-negative probabilities, and percentages less than 100.

The uncertainty parameter included for the proposed BCA amendments scenario allows for some level of misinformation in this scenario. The variable inflates expected probability of survival held by consumers by the given proportion above the actual probability (for example, 1.2 times greater than 45 per cent).

Results of Monte Carlo simulation

The results of the Monte Carlo analysis are presented in table 8.6.

The average net present value of a private bushfire shelter in the status quo market is approximately $2 600, compared to an average of $17 700 under a performance requirement.

A key point to note is the increased variability reported in the proposed BCA amendments scenario compared to the status quo.

8.5 Monte Carlo simulation variables

Model input	*Scenario*	*Central case*	*Monte Carlo distribution*
Value of a life	All options	$3.88 million	Normal ($3.88m, $0.3m) Truncated at $0 and $5m
Years to bushfire event	All options	20 years	Normal (20 years, 5 years) Truncated at 5 years and 40 years
Average number of people per shelter	All options	3 people	Normal (3 people, 1 person) Truncated at 0 and 6 people
Probability of needing to rely on the shelter for survival	All options	2.4%	Normal (2.4%, 0.24%) Truncated at 0% and 5%
Assumed probability of survival in shelter by the consumer	Status quo	70%	Normal (70%, 7%) Truncated at zero
	Proposed BCA amendments		Assumed equal to actual probability
Financial costs of the shelter	Status quo	$5 000	Normal ($5 000, $500) Truncated at zero
	Proposed BCA amendments	$15 000	Normal ($15 000, $1500) Truncated at zero
Probability of correct use	Status quo	25%	Normal (25%, 2.5%) Truncated at zero and 100%
	Proposed BCA amendments	50%	Normal (50%, 5%) Truncated at zero and 100%
Probability of the shelter being structurally sound	Status quo	40%	Normal (40%, 4%) Truncated at zero and 100%
	Proposed BCA amendments	90%	Normal (90%, 9%) Truncated at zero and 100%
Uncertainty parameter for the proposed BCA amendments scenario	Proposed BCA amendments	1	Discrete 1.0 = 42% 1.2 = 33% 1.4 = 13% 1.6 = 8% 1.8 = 4%

Data source: TheCIE 2010.

- Minimum net present value in the status quo is -$5600 compared to -$11 500 under the proposed BCA amendments, with the 5th percentile for the status quo at -$2500 and for the performance requirement at -$11 900.
- Maximum net present value in the status quo is $29,400 compared to $313 900 under the proposed BCA amendments, with the 95th percentile for the status quo at $10 000 and for the proposed BCA amendments at $65 700.

This variability reflects a combination of the assumed variability in costs and benefits across the two scenarios:

- a one standard deviation in costs in the status quo market would increase shelter costs by $500 (10 per cent), but under the proposed BCA amendments, this same 10 per cent cost increase would raise the shelter price by $1500; and
- a 10 per cent (one standard deviation increase) in the structural quality of a shelter in the status quo scenario would only increase the probability of survival once inside by 0.4 percentage points but the same 10 per cent (one standard deviation) increase in a shelter under the proposed BCA amendments would increase the probability of survival by more than double that to 0.9 percentage points.

8.6 Net present value under each implementation option

	Net present value	
	Status quo	***Proposed BCA amendments***
Minimum	-$5 600	-$17 700
Maximum	$29 400	$313 900
Average	$2 600	$17 900
5th percentile	-$2 500	-$11 900
95th percentile	$10 000	$65 700
Percentage of iterations with positive NPV	71%	73%

Data source: TheCIE 2010.

Status quo

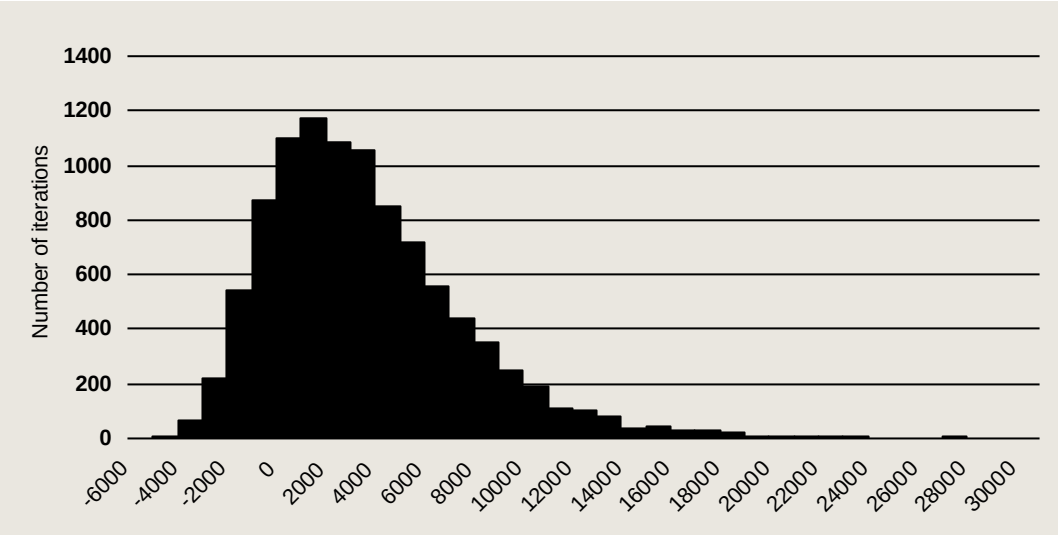
As shown in table 8.6, the status quo results have the lowest level of variation, where 90 per cent of iterations have a net benefit of between -$2500 and $10 000. Overall, there is a relatively high probability of a positive average net return — 71 per cent.

Chart 8.7 shows the frequency of iterations at the respective net present values under the status quo in the absence of regulation.

Proposed BCA amendments

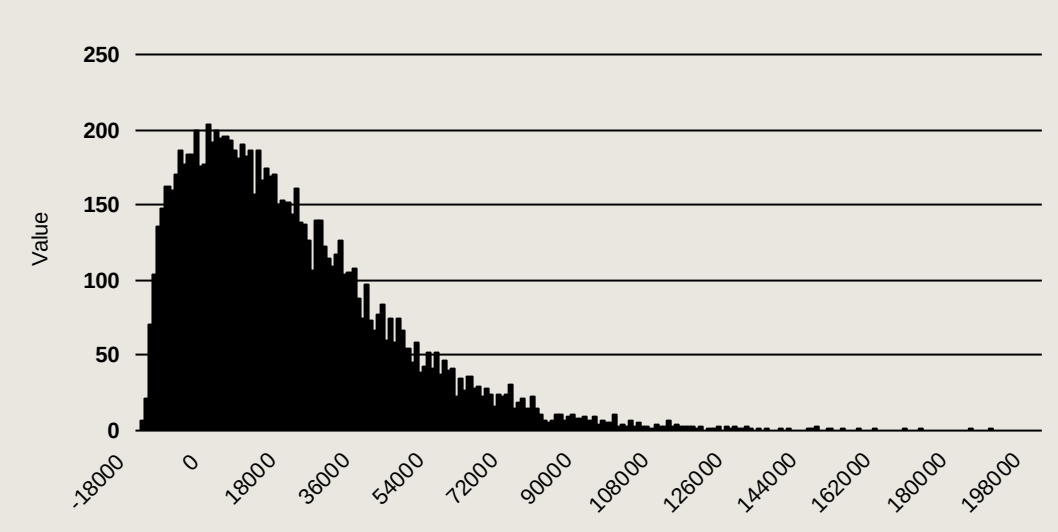
Under the Performance Requirements, or proposed BCA amendments, a greater degree of variability is observed, as well as a significantly higher average net present value. However, again, a significantly high proportion – 73 per cent – of observations is above zero. Chart 8.8 shows the frequency of iterations at the respective net present values.

8.7 Status quo market– Monte Carlo analysis



Data source: TheCIE 2010.

8.8 Proposed BCA amendments – Monte Carlo analysis



Data source: TheCIE 2010.

In summary, based on the assumption that risks are communicated accurately to consumers through the proposed BCA amendments significant net benefits are expected for the community. Relative to the status quo arrangements, inclusion of the proposed BCA amendments into the BCA is expected to produce an almost seven-fold increase in the net benefits to the community.

9 Implementation issues

Prior to the proposed BCA amendments being implemented, there are a number of other issues that potentially also need to be evaluated — noting that some of these are beyond the scope of the BCA, and this Consultation RIS.

It is generally understood across those parts of the fire protection industry that the proposed BCA amendments address the main areas of risk in terms of the *design and construction* of a private bushfire shelter.[11] It has been highlighted that the key risks associated with the use of shelters would be determined by the decision-making of individuals using a private bushfire shelter.

In light of this, there is a potential need for ongoing monitoring or enforcement mechanisms to ensure the risks are communicated to individuals. Furthermore, where there may not be provisions to ensure ongoing quality assurance processes are undertaken through State and Territory construction legislation, such communication of risks to consumers could become critical to the integrity of the proposed BCA amendments.

Further, from a supply side perspective, an important issue is the impact that the assessment and approval process may have on business uncertainty. The greater the specification and transparency of the assessment processes, the less uncertainty is placed on manufacturers. There is also the potential to lower the cost of compliance (through limiting the number of manufacturers that need to re-submit applications) and through this, have a positive and efficient impact on competition.

This section discusses these issues in more detail — including the extent to which these issues may be addressed through the proposed BCA amendments as opposed to requiring alternate mechanisms at the State and Territory level.

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11 Noting some contention around the flexibility of sealed and unsealed shelters in different BAL sites.

Potential risks associated with proposed BCA amendments

The appropriateness of the technical aspects of the proposed BCA amendments would be the role for fire industry experts to determine. From an economic view point, however, it is important that the potential risks of a private bushfire shelter built to the current proposed BCA amendments be transparent and understood by consumers.

There are two important concepts which would guide an assessment of the 'efficient' level at which the proposed BCA amendments should be set.

- The product quality should be high — and at the very minimum be set at a level higher than the average quality that could be obtained under the status quo scenario, firstly as the existence of the proposed BCA amendments is likely to signal to consumers that the product has a high level of quality, and secondly, should the requirements not meet the average quality of status quo shelters, it is redundant.
- Individuals should be able to interpret the information provided — this is to ensure that their expectations of the risk associated with the use of a private bushfire shelter are consistent with the actual level of risk. As long as consumers are fully aware of the strengths and limitations of the product they may voluntarily construct, an efficient market outcome is possible.

Furthermore, it would be important for State and Territory regulators to implement quality assurance processes to ensure the ongoing integrity of the proposed regulation. Failure to ensure that constructed quality remains high and at a level that is consistent with consumer expectations may potentially lead to sub-optimal outcomes. Such sub-optimality could result in the loss of life due to poor shelter design and construction failure. Such quality assurance and compliance issues lie within the jurisdiction of individual States and Territories. It is expected that compliance and certification procedures that currently apply to general building and construction would also apply to private bushfire shelters. Where there are limited provisions for oversight and compliance at the State level, due to the fundamentally different nature of private bushfire shelters than general construction, it may be necessary for additional measures to be enacted.

Setting the standard at the optimal level of quality

Determining the desirable 'stringency' of the requirements is inherently difficult. In theory, in setting the level of performance it would be necessary to increase the stringency up to the point where the marginal benefit of this increased stringency is equal to the marginal cost of constructing this increased quality.

Although there is confidence that the proposed BCA amendments address most of the potential risks associated with the construction of the shelter, there are several areas in which there are differing views on the relative risks associated with details of the proposed BCA amendments. The existence of such differing opinions explain the absence of an industry wide consensus on a testing method to define what constitutes a pass or fail for a manufacturer seeking to accredit their shelter.

The variance in individual risk profiles and attitudes towards risk also make it difficult to assess the potential benefits of modifying the proposed BCA amendments. The benefit (ability to save lives) from improving the quality of a private bushfire shelter may be affected by the probability that a given house may be subject to fire and destruction, the expected severity of the bushfire at that location, the intended fire response plan of the individual and the personal performance of an individual in the event of a fire outbreak. As such, the marginal benefit of the proposed BCA amendments may be difficult to estimate.

It is important that the introduction of regulation into the market for private bushfire shelters encourages individuals to effectively manage their risk to life safety.

A question that has been posed is whether it is better to have a greater number of shelters at a lower quality and lower cost, or to have fewer numbers of shelters at a higher quality and cost. The expected increase in the cost of a private bushfire shelter resulting from the introduction of regulation into the market for shelters may potentially reduce the number of individuals deciding to implement a shelter and the number of people that may potentially use the shelter in the event of a fire — and their subsequent level of risk.

Some individuals who may be excluded from the market for a private bushfire shelter built to the proposed BCA amendments because the cost associated is too high may still to be better off under the proposed regulation. In this case, the information provided in the BCA may increase their awareness about the associated risks such that they determine that the actual risks associated with not having a shelter combined with the cost of the shelter exceed the potential benefits they would achieve if they had one.

Alternatively, should the proposed BCA amendments be enacted, there is discussion that individuals may still be able to have a shelter constructed to below standard.

Depending on the level of enforcement or market restriction undertaken by local councils, it may be possible for residents to construct over specified

wine cellars or secondary storage sheds for example, that they are happy to use in the event of a fire. Although this outcome may be considered undesirable to some regulators, the option for individuals to continue to build a non-accredited shelter would mitigate the risk that the increased cost of a shelter built to the proposed BCA amendments may adversely affect efficient personal decision-making. It also alleviates the risk that some forms of accreditation processes may impede the level of innovation allowed in a market where accreditation standards are not able to keep up with progress in private fields of research and development.

The above example would only be an efficient outcome when the residents constructing a wine cellar-cum-shelter are fully aware of the trade offs they are making in terms of price and quality.

Risks not mitigated by the proposed BCA amendments

Throughout preliminary consultation with the fire safety and protection industry (including fire services, State governments, building safety inspectors and shelter manufacturers), the predominant view held was that the proposed BCA amendments would achieve an acceptable and high level of quality. It is understood that:

- most of the key areas of risk associated with the design and construction elements of a shelter have been addressed within the proposed BCA amendments and the non-mandatory guidelines contained within the ABCB Performance Standard for Private Bushfire Shelters;
- the remaining risk associated with the construction of a shelter built to the proposed BCA amendments is the allowance for the design to change (with respect to the requirement to seal a shelter) at different site Bushfire Attack Levels — although there are differing views on the extent of this risk;
- the potential for *behavioural error* remains the greatest risk to residents, above design and construction factors, as the performance of individuals cannot be controlled to ensure factors such as correct timing of entry and exit and sealing of a shelter.

Included in the 'ABCB Performance Standard for Private Bushfire Shelters — Part 1', are informative appendices providing guidance for variable requirements of shelters located at sites with different levels of bushfire risk, that is, bushfire attack levels (BAL). Under the guidance of the Performance Standard, a private bushfire shelter located at a site with a BAL of 29 or under would not be required to be fully sealed.

It is understood that the rationale for the differential requirements is that sealing would limit the entry of smoke and to some extent the available supply of air and would not be required unless the shelter is exposed to direct flame attack. In addition, sealing a shelter increases the potential risks associated with the timing of entry and exit from a shelter and where additional air supplies are not available, should this timing be miscalculated suffocation may be a risk.

The cost of a sealed shelter is also reported to be up to $5000 more than an unsealed shelter.

Based on preliminary discussions there is currently a lack of consensus on the extent to which this flexibility on sealing is desirable or poses a risk. Although it is possible under the proposed BCA amendments for building surveyors to issue a permit for an unsealed shelter at a BAL of below 40 and comply with the Performance Requirement, there has been a lack of willingness to do so as a result of the perceived excessive level of risk. Furthermore, several experts in the fire industry expressed the view that the proposed BCA amendments should require all shelters to be built to meet the BAL of flame zone and that all shelters should be sealed.

There are a number of reasons for the reservation associated with unsealed shelters. Firstly, a private bushfire shelter is designed to be used where a house no longer provides a tenable and safe environment to protect the individual. Where the house is expected to withstand flame temperature of up to 1090K flame temperature and at an FDI of 100 (for a house built to AS 3959), the shelter would be employed only in the event that conditions are beyond this. The inference is that a shelter is only likely to be required in conditions where there is severe and direct flame contact, against which an unsealed shelter may not be able to protect.

There is also hesitation around the use of unsealed shelters due to the potential for a BAL to change over time. This potential is driven by BAL assessments being static assessments of bushfire conditions as viewed on a single day. The assessments are based on current weather conditions, the distance to continuous vegetation or a combustible structure as well as the level of maintenance of the surrounding environment. A concern expressed by fire industry experts was that a BAL could easily be increased through the actions of residents in the event of a fire, for example parking a vehicle near to the bushfire shelter, exposing it to direct flame contact. Even if the purchaser of the shelter were aware of these risks, subsequent property owners may not receive this information.

Simultaneously, there is concern that sealed shelters could be associated with a greater level of risk of behavioural errors.

Some concern was raised that, in a sealed shelter, the occupants could be starved of oxygen as a result of inappropriate use of the shelter. Such potential human errors include: entering the shelter too early; attempting to shelter an excessive number of occupants; and opening air ventilation units at inappropriate times.

The guidelines contained within the ABCB Performance Standard partly address these behavioural risks with some guidance on the level of maintenance required, however specific technical information relating to the maintenance of a private bushfire shelter should be sought from State and Territory governments. Such guidance is expected to increase awareness of the potential risks of using the shelter even when used properly. There have been suggestions that these guidelines could go further, for instance, to include a requirement to have safety equipment contained within the shelter, to include more information on the nature of fire and safe behaviour in the event of a fire or to require those purchasing a shelter to submit a bushfire response plan detailing their fire risk mitigation plan.

Whilst there is the potential that further specification may yield some reduction in behavioural risks, human behaviour cannot be completely controlled for and fires present unpredictable conditions. The prospect of survival for a person using a shelter in the event of a fire would be determined not only by the preparation of the person, but the personal performance during the fire — the ability of that person to withstand the considerable physical and mental stress associated with exposure to fire.

It is understood that most of those risks that can be controlled are already addressed within the proposed BCA amendments and the non-mandatory guidelines contained within the ABCB Performance Standard. Adjustments to include greater specification for behavioural risks and the determination of the appropriateness of differential construction requirements may alter the average level of shelter quality — although this would be a matter for consideration by experts.

Communication of risks

It is important that the consumer is able to grasp the source and extent of the uncertainty associated with using a shelter, including the key risks outlined. Although the prospect of survival achieved by a shelter built to the proposed BCA amendments is inherently uncertain, the regulation would derive a net benefit to the individuals (voluntarily considering implementing a shelter) based on both the actual probability of survival as well as the level of perceived risk. There will be an efficient outcome where the consumers' perceived risk equates to the actual risk of the shelter.

There is evidence to suggest that the Victorian interim regulations did work to adjust the expectations of individuals to be more in line with the actual level of risk of using a private bushfire shelter. Since the announcement of the development of an accreditation process in Victoria, many manufacturers report that there has been a reduction in the demand for the shelters. For some individuals, the announcement of a construction standard to be introduced in the future may have suggested that the risk of using a shelter, or constructing an unaccredited shelter, was greater than previously perceived by individuals.

There is early evidence to suggest the disclosure of risk would improve under the proposed BCA amendments — although this would need to be monitored or enforced following its implementation. Although the disclosure of the risks of using a private bushfire shelter is not specified as a requirement within the proposed BCA amendments, the recent corrective action taken by the Australian Competition and Consumer Commission (ACCC)[12] may indirectly ensure that product risk is disclosed, and misleading claims are limited. The accredited product currently available in Victoria provides a manual where the buyer is required to sign a statement to confirm that they acknowledge the private bushfire shelter is a measure of last resort. Whether all companies would similarly disclose the risk as a result of the proposed provisions or because of the threat of the ACCC is uncertain.

Quality assurance required beyond accreditation

Another significant risk to be addressed by States and Territories introducing regulation into the private bushfire shelter market is the potential that the standard of shelters is not maintained for each and every shelter. The accreditation process is expected to ensure that manufacturers are able to offer a product that meets the requisite performance outcomes, but would not guarantee the product quality is maintained. In the absence of systems to ensure manufacturers continue to use the specified processes and materials in their product, the quality of the shelters may reduce periodically or over time.

Where there is not an established requirement for private buildings to be independently assessed by an accredited authority, a mechanism would need to be introduced to ensure an equivalent outcome.

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12 In late 2009, the ACCC approached a number of manufacturers advertising compliance with Australian Standards for misleading claims. `

It is understood that it is not the role of the BCA to prescribe a regulatory framework — where the risk associated with quality assurance may most appropriately be addressed through States and Territory governments.

Business compliance costs

The costs to businesses to comply with the proposed regulation for the private bushfire shelter market are expected to be high, particularly relative to the expected size of the market (and relative profit margin). Reports from manufacturers have estimated the current accreditation process can costs up to $500 000 and take six months, depending on the number of times applications need to be adjusted or re-submitted. The potential compliance costs can be identified by considering the recent experience of manufacturers in Victoria seeking to have their shelter accredited under the interim provisions and may include:

- the additional costs paid for design and engineering services above what would have been paid in the unregulated market;
- the cost of additional infrastructure and/or equipment to enable testing of designs;
- the cost of engaging a third party to test the final product;
- the engineering and design costs to diagnose and rectify potential problems; and
- the cost of applying for accreditation or the risk of applying for a permit for an Alternative Solution.

The cost of entering the market for private bushfire shelters to comply with the regulation would be higher than in an unregulated market, the extent to which would be determined by the degree of specification in the regulation. There are two key factors that may influence the compliance cost:

- *the specification of the quality of the shelter* — where an increase in the standard of the performance outcomes may subsequently increase the cost of compliance for some manufacturers; and,
- *the specification of test methods or provision of DTS provisions* — where an increase in the detail of how the Performance Requirements are assessed may decrease the cost of compliance.

However, it is important to note that while increased specification in terms of quality and accreditation has the potential to increase the cost of production and compliance for businesses; it should not necessarily be considered to be a market barrier.

Where increased specification provides efficient increases to consumer benefits (that is, the additional compliance costs are more than outweighed by the additional protection benefits) the increase is efficient.

A more important factor affecting the cost of compliance is the level of certainty surrounding the assessment mechanism. Where there is currently no widespread consensus on a testing method through which a shelter can be accredited or assessed as providing an Alternate Solution to meeting the Performance Requirements, the compliance costs for businesses to enter the market are expected to be relatively high.

Preliminary industry consultation suggested that a greater level of specification within the standards would significantly reduce the cost of compliance. It is understood that establishing a test method would be a pre-requisite for developing DTS provisions. Should DTS provisions be developed, the regulators would effectively have outlined the design components of a minimally complying shelter. This is likely to allow manufacturers to have their products certified at a lower cost of compliance and would reduce the risk (and subsequent cost) for building surveyors who would otherwise be required to assess an Alternate Solution.

Greater specification may assist manufacturers to design a product that meets the acceptable standards without having to over-engineer their product. Whilst over-engineering a design is not considered to be prohibitively expensive in terms of the additional cost of entering the market, it may significantly increase the cost of an individual private bushfire shelter. Anecdotal evidence taken from the recent experience of manufacturers seeking to become accredited in Victoria suggests that some manufacturers may be over-engineering their product to increase the likelihood their product is accredited — and substantially increasing the cost of the product.

Assessment of competition impacts

It is expected that the introduction of regulation in the market for private bushfire shelters will reduce competition relative to the status quo. This would be expected given the increase in the costs of compliance and the initial reduction in the size of the market as consumers are made aware of the inherent risks associated with the shelters in the unregulated market. A sharp reduction in the number of suppliers of private bushfire shelters was observed in Victoria following the announcement of the introduction of interim regulations in 2009.

It is difficult to assess efficiency of these competition impacts given the likelihood that there is information failure in the status quo, unregulated market. However, given that the proposed BCA amendments are targeted at increasing the level of information in the market, as well as providing a level of quality assurance that would not exist in an unregulated market, the expected reduction in the number of manufacturers may actually reflect an efficient and necessary market adjustment. The introduction of the regulation is intended to provide a standard of quality in the market — to provide transparency for consumers to assess the relative costs and benefits of purchasing and using a shelter.

Despite this potential for the provisions to both reduce competition and increase efficiency in the market, it is important that wherever possible, the cost of compliance incurred by manufacturers is minimised. This is to prevent the risk of an inefficient barrier to entry being developed, providing a form of monopoly protection. As previously outlined, the current uncertainty surrounding the assessment method may pose high costs (of compliance) to manufacturers and subsequently reduce market competition.

10 Consultation period

ABCB consultation protocol

The ABCB is committed to regularly reviewing the BCA and to amend and update it to ensure that it meets changing community standards. To facilitate this, the ABCB maintains regular and extensive consultative relationships with a wide range of stakeholders. In particular, a continuous feedback mechanism exists and is maintained through State and Territory building control administrations and industry, through the Building Codes Committee. These mechanisms ensure that opportunities for regulatory reform are identified and assessed for implementation in a timely manner.

All ABCB regulatory proposals are developed in a consultative framework in accordance with the Inter-Government Agreement. Key stakeholders are identified and approached for inclusion in relevant project specific committees and working groups. Thus, all proposals have widespread industry and government involvement.

The ABCB has also developed a Consultation Protocol, which includes provisions for a consultation process and consultation forums.[13] The Protocol explains the ABCB's philosophy of engaging constructively with the community and industry in key issues affecting buildings and describes the various consultation mechanisms available to ABCB stakeholders.

The ABCB's consultation processes include a range of programs that allow the ABCB to consult widely with stakeholders via:

- the proposal for change process;
- the release of BCA amendments for comments;
- regulatory impact assessments;
- impact assessment protocol;
- research consultations;

13 Available on http://www.abcb.gov.au/index.cfm?objectid=49960DC7-BD3E-5920-745CE09F1334889C.

- ABCB approval that reports directly to ministers responsible for buildings; and
- international collaboration.

The Protocol also ensures that the ABCB engages with their stakeholders via a range of events and information series through:

- the Building Codes Committee with representatives from a broad cross section of building professions and all levels of government;
- its consultation committees;
- public information seminars;
- its biennial National Conference;
- its technical magazine, the Australian Building Regulation Bulletin (ABRB);
- its online technical update, ABR Online;
- its 1300 service advisory line which provides information to clarify BCA technical matters and access technical advice about provisions; and
- the ABCB website.

Public consultation period

As highlighted through the Consultation RIS, there are a large number of issues that remain uncertain with respect to private bushfire shelters and their market. These stem from a range of factors, including scientific constraints on being able to replicate the effects of a bushfire, ability to control personal actions and decision making in the event of a fire, as well as issues related to the immature market, restricting the ability to observe demand and price effects over time.

Therefore, through the public consultation phase, the ABCB is seeking information on a number of key questions.

- **Understanding bushfires in Australia**
  - Is the profile of bushfire risk appropriately covered in the published literature as summarised here?
  - How is the nature of bushfire risk likely to change over the coming 50 years due to changing weather conditions and climate change?
  - Is there an increasing risk to life and property posed through increasing demand for dwellings on the urban-rural fringe?
  - What is the likelihood of intense bushfire events such as those of Black Saturday recurring in the near to medium term in Australia? In

particular, what is the likelihood of this occurring in semi-urban areas?

- **Private bushfire shelters**

  Market for private bushfire shelters:

  - What is the current level of demand for private bushfire shelters?
  - Has there been an increase in demand following 2009 fires?
    - ⋯ If so, is the demand increase concentrated in any particular regions?
    - ⋯ How big is the potential market for bushfire shelters?

  Performance of private bushfire shelters:

  - What is the expected increase in the quality of a shelter built to the proposed BCA amendments, in terms of the capacity to save lives?
  - What proportion of currently available shelters would not meet the proposed BCA amendments?

  Costs:

  - Is the assessment of the current market for bushfire shelters accurate? Including reference to two price levels?
  - Are the estimates of $10 000 per shelter under the non-mandatory guidelines and $15 000 per shelter under the proposed BCA amendments fair estimates of the expected average prices?

- **Proposed changes to the BCA**

  - Are there likely to be discernable differences in shelter quality between the implementation of proposed BCA amendments and the non-mandatory guidelines?
  - What is the likelihood that local councils in higher risk areas will include mandatory construction requirements for private bushfire shelters in new house constructions?
  - How would other fire mitigation alternatives, including vegetation clearing, fuel management and emergency services interact with the proposed BCA amendments?
  - Are there areas in which these mitigation policies, if properly implemented, would be able to negate the need for a shelter all together?
  - Would other mitigation policies provide a viable alternative to the proposed BCA amendments for private bushfire shelters?

Framework for analysis

- What is the expected probability of survival without a private bushfire shelter?
  - That is, where only a house or other building is available.
  - What was the Black Saturday experience?
- What is the expected probability of survival in a shelter:
  - where there are no mandatory standards?
  - with the proposed BCA amendments?
- What is the expected rate of uptake of shelters under each implementation option?
  - For example, would more residents be likely to construct a shelter if the proposed BCA amendments were implemented compared to information and guidelines only?
- How would the decision to stay or go be altered by the different implementation options, including:
  - those that would leave irrespective of the availability of any shelter;
  - those that would decide to stay if an unaccredited shelter is available;
  - those that would decide to stay only if an accredited shelter is available; and
  - those that would be required to construct a shelter (by local councils) and still leave.
- What would be the public (non-private) impacts during a bushfire event:
  - *congestion effects* on roads in a fire event in which the number of people evacuating an area may be reduced;
  - *changes in response requirements* of emergency services personnel where demand for protection may be reduced due to the availability of private bushfire shelters; and
  - *potential scrambling effects* where people attempt to utilise the fire shelters of neighbours, potentially increasing the risks associated with using the shelter.

11 Conclusion

The Black Saturday bushfires of 7 February 2009 resulted in significant loss of life and property and were considered to be in many ways to be 'uncharacteristic' of bushfires in Australia's past. The uncertainty of whether these bushfires are an anomaly or signal increasing bushfire risk in Australia is a central issue to the question of whether past bushfire response mechanisms, policies and attitudes are appropriate for the future.

Where public safety issues are involved, it is important that either through market mechanisms or regulatory measures individuals are provided with the information to be able to optimally measure and assess their private risk profiles, risk preferences and financial resources and be able to make decisions accordingly. Hearings and research conducted through the Victorian Bushfire Royal Commission (VBRC) have indicated that there are failures in the market for private bushfire shelters, impeding the ability of individuals to make efficient decisions.

The VBRC has also highlighted the changing market for private bushfire shelters immediately after the Black Saturday fires, where a strong increase in interest and demand may be suggestive of an underlying change in risk preferences or attitudes of Australians. This possibility has provoked questioning of the desirability of increasing demand for shelters in light of the indicated market failures.

The information based market failure considered to exist for private bushfire shelters is likely to be imposing two costs. Firstly, where consumers do not have the correct information on the average quality of a shelter and its ability to protect lives, this may be inflating the number of shelters purchased in the market — where the actual benefits that may be received are well below those that are perceived. Secondly, where consumers do not fully understand the limitations of private bushfire shelters to protect life, they may also be putting their lives in danger by relying on these shelters in the event of a bushfire.

This Consultation RIS has conducted preliminary analysis into the proposal to include BCA amendments for private bushfire shelters into the BCA.

The central question examined is the potential net benefits that may be expected to be achieved following the introduction of the proposed BCA amendments compared to non-mandatory guidelines or maintenance of the status quo market position.

The framework used to assess the relative costs and benefits of each implementation option in this Consultation RIS has involved a qualitative framework, in conjunction with an illustrative quantitative model. The analysis suggests that, provided residents are able to understand and act on it, the provision of information is likely to result in a net benefit to each individual that may consider constructing or using a private bushfire shelter. That is, where information only guidelines provide additional information to the status quo, this results in a reduction in inefficiencies. Further, the implementation of the proposed BCA amendment provides even more information, resulting in the highest average net present value of the implementation options, and the lowest level of market inefficiencies.

Under the status quo, it is assumed that there is minimal information available to consumers, as well as a prevalence of lower quality shelters. These factors restrict the ability of consumers to make reasonable judgements on the risk of bushfire shelters. The cost benefit ratio in the status quo is expected to be approximately 1.44, with an average net present value of $2220.

Following the provision of information based construction guidelines on private bushfire shelters, consumers are likely to become more informed about the risks with the average quality of a private bushfire shelter increasing accordingly. Such improvements in both quality and information will reduce the inefficiencies compared to the status quo. The estimated cost benefit ratio is approximately 1.64, with an average net present value of $6430.

Through the implementation of the proposed BCA amendments, consumers will be made fully aware of the construction requirements and the associated risks of using shelters. In this case, the market information issues are minimised, and most likely removed. This is likely to be the most efficient implementation option and has a positive cost benefit ratio of 2.17 and an expected net present value per shelter of $17 500. That is, the net present value of a shelter under the proposed amendments is eight times greater than under the status quo.

These results for the average net present value of an individual shelter are presented in table 11.1.

11.1 Summary output table — illustrative quantitative model

	Status quo	*Non-mandatory guidelines*	*Proposed BCA amendments*
Mis-judged cost of lives lost	$43 380	$26 870	$-
Net present value	$2 220	$6 430	$17 500

Data source: TheCIE 2010.

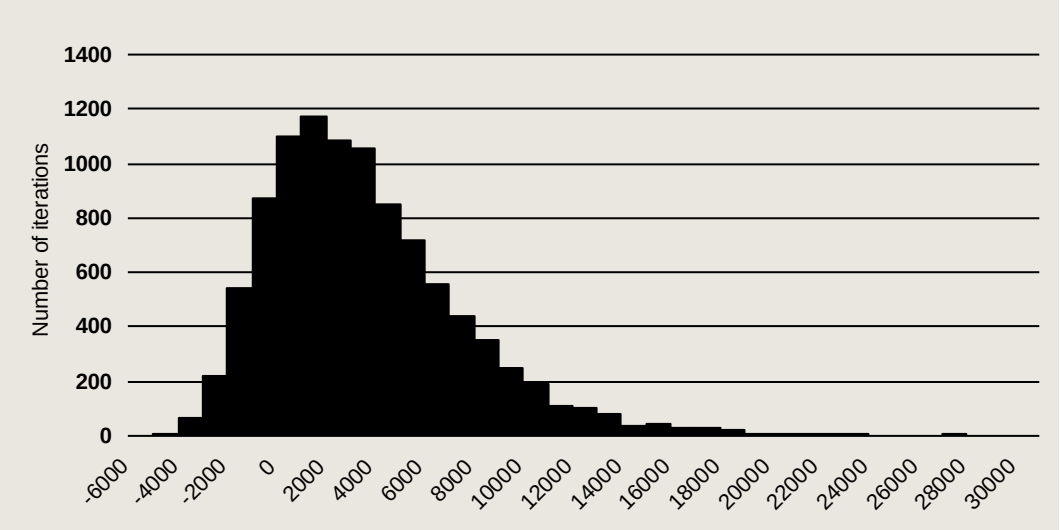
Table 11.1 also includes for comparison the cost of lives that are under-estimated in each option due to mis-informed consumers. In the case of the status quo and non-mandatory guidelines, this difference is considered to be significant.

The sensitivity of these net present values to a variation in the input parameters has been tested through both a scenario and Monte Carlo based sensitivity analysis. Combined, these analyses show that relative results across the implementation options are fairly robust to uncertainty in the parameters.

The Monte Carlo analysis tests the combined effects of varying input parameters on the costs and benefits of each implementation option. Five thousand simulations for each implementation option were generated to test the impact of such variability on the estimated benefit cost ratios.

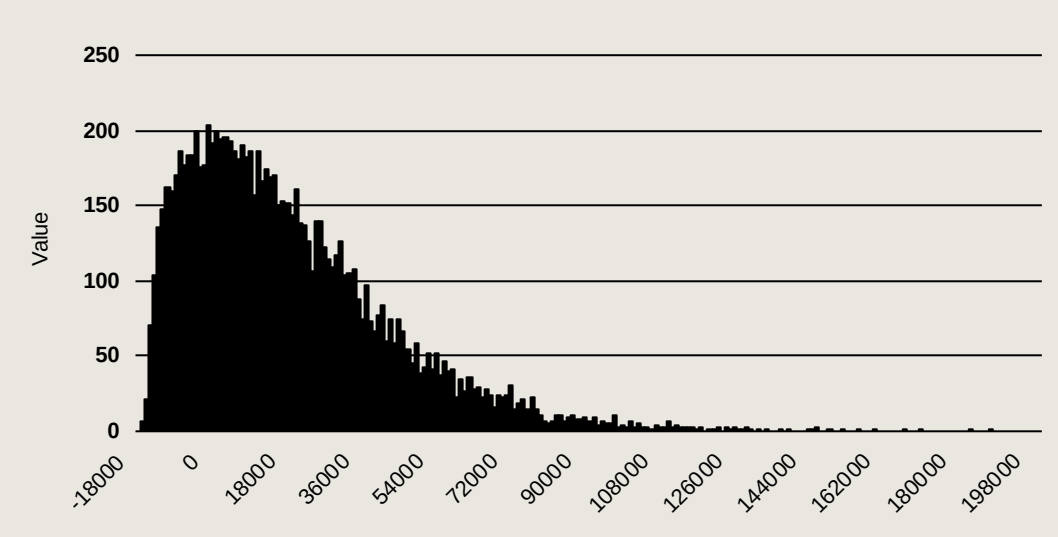
Charts 11.2 and 11.3 present the frequency of iterations for the net present values in the status quo and proposed BCA amendment scenarios.

11.2 Results for Monte Carlo analysis in status quo



Data source: TheCIE 2010.

11.3 Results for Monte Carlo analysis for proposed BCA amendments



Data source: TheCIE 2010.

Under the status quo, the average net present value of a private bushfire shelter is estimated at $2500 per shelter. The results have a relatively low level of variation, where 90 per cent of iterations have a net benefit of between -$2500 and $10 000. Overall, there is a relatively high probability of a positive average net return — 71 per cent.

Under the proposed BCA amendments scenario, the average net present value of a private bushfire shelter is estimated at $17 700 per shelter. The results have a higher level of variation than the status quo. There were 90 per cent of iterations with a net benefit of between -$11 900 and $65 700. Overall, there is a relatively high probability of a positive average net return — 73 per cent.

- The higher level of variability of results under the proposed BCA amendments is due firstly to a higher level of costs per shelter ($15 000 compared to $5000) and a higher ability to save lives (90 per cent compared to 10 per cent).

The final option that has been considered in the Consultation RIS is the potential for local councils or other governing authorities to require a private bushfire shelter to be constructed with a new Class 1a dwelling. Should such actions be taken, it would be expected to reduce market efficiency. There are two forms of inefficiencies likely to be generated above the proposed BCA amendments outcome.

- Consumers who assess that their private benefits are lower than their private costs and are still forced into constructing a shelter.

- Existing residents that incorrectly alter their risk perceptions of shelters, based on the actions of councils, subsequently deciding to inefficiently purchase a private bushfire shelter. At this point, the change in risk perceptions has imposed a cost, through the inefficient purchase of a shelter, and may endanger lives where the shelter is relied upon instead of an alternate bushfire plan.

The net present value of a shelter constructed for either of the above reasons depends heavily on the probability of it ever being used. Where a resident is unlikely to use it ever (for example, they are only ever residing in the area in the off fire season) they could incur a maximum net cost of $15 000 — the purchase price of the shelter. With a 1 per cent probability of having to use the shelter in the next 40 years, the net cost of the shelter is approximately $1500.

A sensitivity analysis has not been undertaken for the mandatory construction requirement as by definition there is no potential for a benefit cost ratio above 1 to be achieved, and the results are a direct function of the probability of use.

These estimated incremental benefits of the proposed BCA amendments would accumulate to an overall net benefit for the community. However, an implicit point within this analysis is that there remains the potential for consumers to construct buildings that in the event of a bushfire may also be used as a last resort for protection. This factor is important where the introduction of the proposed BCA amendments is likely to raise the market price of a shelter, it would be important not to preclude individuals whose net benefit of an alternate building — such as a wine cellar or document store - would be positive at a lower cost (that is not built to the Performance Requirements). While it is not possible to quantitatively analyse this parallel market, due to the existence of a mandatory Performance Requirement, these individuals are assumed to be making informed decisions following the provision of information — that is, increasing their capacity to understand the risk elements of shelters and risks associated with using a shelter, as well as the risks of using an over-specified wine cellar.

In summary, the adoption of the proposed BCA amendments is expected to generate greater net benefits to the community than the status quo or alternate non-mandatory guideline implementation options. Relative to the status quo arrangements, inclusion of the proposed BCA amendments is expected to produce an eight-fold increase in the estimated net present value of an average shelter.

In order to ensure this outcome is achieved, the surrounding implementation framework including any associated assessment criteria and other approval regulations would need to ensure the quality of shelters remains high over time, in terms of the ability of a shelter to save a life, and the risks and uncertainties associated with using a private bushfire shelter are adequately communicated to the public.

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