



# Private Bushfire Shelters



2014

PERFORMANCE  
STANDARD



# **THE DESIGN AND CONSTRUCTION OF PRIVATE BUSHFIRE SHELTERS**

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PERFORMANCE STANDARD

**2014**



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## Preface

The 2009 Victorian Bushfires Royal Commission (VBRC) investigated the cause and responses to bushfires that swept through parts of Victoria in late January and February 2009. The VBRC delivered a first Interim Report in August 2009, a second interim report in November 2009 and a Final Report in July 2010.

The Interim Report of 24 November 2009 included recommendations for the future regulation of certain building related matters, including the regulation of private bushfire shelters.

In recognition of the absence of technical standards for private bushfire shelters within the BCA, the ABCBC announced on 24 September 2009 its intention to develop a national performance-based standard for the design and construction of private bushfire shelters.

In light of an international literature review undertaken during the initial stages of the project, it became evident that development of an appropriate technical standard would be an extensive exercise as no equivalent document had been prepared throughout the world.

The Standard has been developed as a performance-based document. Release of the document in early 2010 enabled State and Territory building regulators to use it as a basis for the regulation of private bushfire shelters prior to the inclusion of a new Performance Requirement in BCA 2011. In particular, the document enabled building designers and approval authorities to make informed professional judgments on the most appropriate means of mitigating life safety risk by the use of private bushfire shelters during a bushfire event.

It must be emphasized however that private bushfire shelters are not a stand-alone solution to mitigating life safety risk. Technical building standards are only one measure of a need for a comprehensive set of measures to counteract the effects of a bushfire event that include effective land-use planning, fuel management and emergency services strategies.

Therefore, it is not possible to guarantee that the installation of a private bushfire shelter built in accordance with the Design Requirements presented in this document will eliminate the risk of serious injury or fatality.

Based on evidence presented to the VBRC at the time, it concluded that it would appear that a well designed and constructed shelter can provide a level of protection from a



bushfire while the fire front passes. The VBRC indicated that it can be a useful 'Plan B' when efforts to defend a house have failed, or when for some reason it has not been possible to leave the property.

Nevertheless, fire can be unpredictable and assistance from fire defence resources may not be available to individual properties. As the VBRC heard, even well prepared community members lost their lives in some instances.

The VBRC indicated that the evidence presented to it suggested extreme caution should be taken in the use of bushfire bunkers as part of a household's bushfire fire safety plan.

It advised that misplaced reliance on a bushfire bunker can be life threatening.

It also noted that the design, siting and construction of a suitable bushfire bunker are neither simple nor inexpensive. The ABCB's work in preparing the Standard has confirmed this.<sup>1</sup>

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*1 Building in Bushfire Prone Areas – Interim Recommendations – Submissions of Counsel Assisting; 2009 Victorian Bushfires Royal Commission, 28 September 2009 - paragraphs 4, 13 and 31.*



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## 1 Design Standards

### 1.1 General

The BCA is a mandatory performance-based code for the design and construction of Class 1 to 10 buildings. At the time of preparation of the Standard the BCA did not contain specific provisions relating to the design of structures referred to as private bushfire shelters.

Accordingly, the Standard was developed to facilitate informed decision making by professional practitioners undertaking the design of private bushfire shelters as well as third party practitioners who must evaluate the designs. State and Territory Governments have determined private bushfire shelters to be Class 10c buildings for the purposes of building regulation.

Section 2 of the Standard contains a fundamental Performance Requirement that describes a level of performance required to be provided by a private bushfire shelter, i.e. to provide a tenable environment for occupants during the passage of untenable conditions arising from a bushfire event.

The Standard does not include a comprehensive 'Deemed-to-Satisfy' building solution for the design of private bushfire shelters. Instead, Section 2 provides a Table of Acceptance Criteria related to compliance with the Performance Requirement. Therefore, in all instances, designers are required to use professional judgment in order to develop designs intended to comply with the Performance Requirement. Appendices to the Standard provide important additional information on a range of considerations related to the design and construction of private bushfire shelters.



## **1.2 Scope**

The Standard presents a Performance Requirement, relevant Acceptance Criteria and important information related to the design of a private bushfire shelter.

The Standard is intended to be applied to meet the specific needs of able bodied property owners or occupiers of a dwelling, as well as the specific conditions of the site on which the private bushfire shelter is to be constructed.

The Standard is not intended to meet the broader needs of people with disabilities, respiratory or cardiovascular illnesses, children or the aged and it is strongly recommended that people in these categories are evacuated prior to potential exposure to a bushfire attack.

Specific needs of individuals and the circumstances of particular sites reinforce the value of setting a performance standard rather than presenting a 'one-size fits all' approach.

The Standard has been developed to address two alternative forms of construction of private bushfire shelters, being -

- an above-ground shelter separated from an associated dwelling;  
and
- an in-ground shelter separated from an associated dwelling.

Consideration was also given to the merits of addressing shelters formed by cellars under a dwelling or a 'safe' room within a dwelling. The ABCBC concluded that the risks involved in these forms of shelters were too great and recommends against their use as places of refuge in circumstances where the dwelling itself may be subjected to untenable conditions during bushfire attack.

The Standard is not suitable for use in the design of a Class 1a dwelling located in a designated bushfire-prone area.



### 1.3 The purpose and role of private bushfire shelters

The purpose of the Standard is to lower the risks of serious human injury or fatality based on the availability of technical data and the input and judgment of a broad representation of stakeholders.

It has been developed to ensure that a private bushfire shelter built in accordance with the Standard provides a measured degree of protection to people with nowhere else to go, such as occupants of dwellings in remote locations.

A private bushfire shelter must not be considered as a stand-alone solution to potential risks to life safety in a bushfire event, however in some instances a private bushfire shelter may be part of a broad package of measures that, in combination, form a robust 'Bushfire Risk Management Strategy'.

To provide a perspective of the role of private bushfire shelters as well as an understanding of where they may fit within a broader 'Bushfire Risk Management Strategy', use has been made of the National Fire Protection Association (NFPA) Fire Safety Concepts Tree<sup>2</sup>.

The concepts tree can also be used to analyse the potential impact of private bushfire shelters and to identify parameters that are critical in order for a private bushfire shelter to realise its life safety objectives.

Further information on the NFPA Fire Safety Concepts Tree is provided in Appendix D.

### 1.4 Risk mitigation

The 2009 Victorian Bushfires Royal Commission (VBRC) Interim Report 2 identified a critical need for property owners and occupiers to be made aware of the risks involved in deciding to stay and defend their property and potentially their lives when exposed to bushfire attack.

The ABCB endorses the view of the VBRC that "extreme caution should be taken in the use of bushfire bunkers as part of a household's fire plan. While a well designed and constructed bunker may provide a temporary place of refuge

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*2 NFPA 550 Guide to the Fire Safety Concepts Tree 2007 edition National Fire Protection Association. USA 2007*

during the passage of the fire front, bunkers are not a panacea. Misplaced reliance on a bunker can be life threatening."

In the context of life safety strategies, seeking protection in a private bushfire shelter is a form of risk mitigation, but the residual risk may still be high particularly on properties with extreme bushfire exposures e.g. classified as BAL FZ in AS 3959 (2009).

As mentioned previously, it is not possible to guarantee that the installation of a private bushfire shelter built according to the document will result in zero risk. This is because of the uncertainty, variability and indeterminacy of bushfire exposures.

It is strongly recommended that occupants of dwellings located in designated bushfire prone areas have bushfire safety plans developed and make themselves aware of the significant risks involved in occupying a private bushfire shelter during a bushfire event.

### **1.5 Performance-based standards**

The Standard is presented as a performance-based document. Private bushfire shelters must be designed to comply with the Performance Requirement in clause 2.3. The Performance Requirement lists various 'heads of consideration' that must be considered during the design process.

The Performance Requirement enables the design of a private bushfire shelter to be developed from first principles to maximise its potential to meet specific client needs for a specific site.

### **1.6 Acceptance Criteria**

Acceptance Criteria is presented in Section 2 Table 2.4 for nominated components of a sealed private bushfire shelter located on sites assessed in accordance with AS 3959 (2009) as BAL 40 or greater.

The Table may not address all components of a proposed private bushfire shelter and components that are not addressed must be designed from first principles.

### **1.7 Design pathways**

The Standard provides two pathways for the development of designs complying with the Performance Requirement. One pathway involves the application of fire engineering practice from first principles and requires designers to apply professional judgment on all design issues.

An alternative pathway involves the application of fire engineering practice in combination with appropriate operational and exposure design procedures that demonstrate compliance with Acceptance Criteria presented in clause 2.4.

### **1.8 Definition of terms**

Defined terms used within the text of the Standard are printed in italics. Definitions of terms used in the Standard may be different to similar terms used in AS 3959 (2009). For the purposes of the Standard the following definitions apply –

#### **1.8.1 Acceptance Criteria:**

Criteria that are considered acceptable to meet respective components of the Performance Requirement.

#### **1.8.2 Bunker:**

A structure of indefinite formation used for protection from bushfire.

Note - The term private bushfire shelter has generally been used in the Standard in lieu of the word bunker.

#### **1.8.3 Bushfire:**

An unplanned fire burning in vegetation.

#### **1.8.4 Bushfire attack:**

Includes burning embers, radiant heat, convective heat, flame, wind and smoke generated by a bushfire, which might result in ignition and subsequent damage or destruction of a building.

#### **1.8.5 Bushfire attack level (BAL):**

Has the same meaning as that within AS 3959 (2009).



**1.8.6 Bushfire intensity:**

The rate of release of calorific energy in watts from a bushfire determined either theoretically or empirically, as applicable.

**1.8.7 Bushfire event:**

The period of time during which the private bushfire shelter will be relied upon. Includes the period of bushfire attack plus a period of consequential fire events.

**1.8.8 Consequential fire event:**

Fires in adjacent structures or heavy fuels consequential to bushfire attack. With respect to a private bushfire shelter would include a structure fire in the associated Class 1 dwelling.

**1.8.9 Designated bushfire-prone area:**

Land that has been designated under a power in legislation as being subject, or likely to be subject, to bushfires.

**1.8.10 Fire-resistance level (FRL):**

The grading periods in minutes determined in accordance with BCA Volume One Specification A2.3, for the following criteria-

- (a) structural adequacy;
- (b) integrity; and
- (c) insulation

and expressed in that order.

Note - A dash means that there is no requirement for that criterion. For example, 90/-/- means there is no requirement for an FRL for integrity and insulation.

**1.8.11 Modified discomfort index (MDI):**

An index that increases with increases in either humidity or dry bulb temperature. It is expressed in units of temperature (°C).

**1.8.12 Performance Requirement:**

The Performance Requirement presented in Section 2.3, which states the level of performance that a proposed private bushfire shelter must achieve.

**1.8.13 Post bushfire event period:**

An ongoing period following a bushfire event when a heightened risk continues but does not present untenable conditions.



**1.8.14 Private bushfire shelter:**

A structure classified as a Class 10c building associated with a Class 1a dwelling that may, as a last resort, provide shelter for occupants from immediate life threatening effects of a bushfire event.

**1.8.15 Shelter:**

a private bushfire shelter.

**1.8.16 Tenable environment:**

The environment within a private bushfire shelter required to sustain human life during the passage of untenable conditions arising from bushfire event.

**1.8.17 Untenable conditions:**

Ambient external environmental conditions associated with a bushfire event in which human life is not sustainable.

**1.9 Limitations**

It is not practicable for the Standard to provide acceptable design solutions that have been tested and found to achieve compliance with the Performance Requirement. The Standard is not intended to –

- override or replace any legal rights, responsibilities or requirements;
- cover shared or community bushfire shelters or refuges; or
- address administrative requirements for private bushfire shelter.

**1.10 Informative Appendices**

Informative Appendices A – E provide explanatory information relating to the design and construction of private bushfire shelters.

## 2 Design Requirements

### 2.1 Objective

The objective of the Standard is to reduce the likelihood of fatalities arising from occupants of Class 1a dwellings not evacuating a property prior to exposure from a bushfire event.

### 2.2 Functional Statement

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

### 2.3 Performance Requirement

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 –
  - I. predominant vegetation;
  - II. adjacent buildings and structures;
  - III. allotment boundaries;
  - IV. other combustible materials.
- (b) occupancy of the private bushfire shelter;
- (c) bushfire intensity having regard for the bushfire attack level;
- (d) fire intensity from adjacent buildings and structures, allotment boundaries and other combustible materials;
- (e) ready access to the private bushfire shelter from the associated dwelling and occupant egress after the fire;
- (f) tenability within the private bushfire shelter for the estimated maximum period of occupancy;
- (g) generation of smoke, heat and toxic gases from materials used to construct the private bushfire shelter;
- (h) structural and fire loads and actions to which it may reasonably be subjected having regard to –
  - I. the topography between the private bushfire shelter and the predominant vegetation or other fire hazards;
  - II. the distance between the private bushfire shelter and the predominant vegetation or other fire hazards;
  - III. the size of the potential fire source and fire intensity;
  - IV. wind loading;
  - V. potential impact from debris such as falling tree limbs; and

- (i) degree of external signage identifying the location of the private bushfire shelter;
- (j) degree of internal signage identifying the design capacity and maximum period of occupancy;
- (k) degree of occupant awareness of outside environmental conditions; and  
*degree of essential maintenance.*

## 2.4 Acceptance Criteria

Table 2.4 provides Acceptance Criteria for nominated aspects of design for private bushfire shelters covered by the scope of the Standard. The scope of the Table is not purported to be comprehensive.

On sites assessed under AS 3959 (2009) as BAL 40 or greater, private bushfire shelters designed to comply with Acceptance Criteria in the Table must be sealed (refer to 3.4.2).

The Acceptance Criteria may also be used as conservative data for designs of private bushfire shelters on sites assessed as being below BAL 40.

**Table 2.4 – Acceptance Criteria**

COMPONENT OF DESIGN	ACCEPTANCE CRITERIA	INFORMATIVE COMMENT
<b>LOCATION</b>		
Distance between an associated dwelling and a shelter	Minimum of 6 m or 1.5 times the height of the dwelling, whichever is the greater.	Separation reduces interaction between the associated dwelling and a shelter.
Distance to an allotment boundary	Minimum of 6 m.	Separation reduces interaction between the shelter and the risks beyond an allotment boundary.

Distance to an adjacent structure	Minimum of 6 m or 1.5 times the adjacent structure height, whichever is the greater.	Adjacent structures include sheds, carports etc.
Distance to other fuel sources	Minimum of 6 m.	Fuel sources include wood piles, fences, cubby houses, vehicles, gas bottles, fuel or similar combustibles.
<b>ACCESS FROM THE DWELLING TO THE SHELTER</b>		
Travel distance between the associated dwelling and the shelter	Maximum 20 m.	
<b>ACCESS PATHWAYS BETWEEN THE DWELLING AND THE SHELTER</b>		
Surface of pathways	Must be non-combustible <sup>1</sup> .	Access pathways should be readily identifiable and have a relatively even surface.
Unobstructed width	Minimum clear width of 1 m.	Vegetation adjacent to a pathway should not be a hazard to travel.

PROVISION OF TENABLE CONDITIONS WITHIN A SHELTER		
Duration of occupancy	Minimum 60 minutes.	<p>The minimum period of occupation for which a tenable environment must be maintained.</p> <p>The minimum duration of occupancy is the period the shelter is required to be sealed in order to prevent occupant exposure to untenable conditions. It is assumed that occupants will not seal a shelter until exposure to untenable conditions is imminent. A shelter may be occupied for longer periods, either pre-bushfire attack or post-bushfire attack, in an unsealed state i.e. with doors or vents open (refer to 3.2.2).</p>
Ceiling height	Minimum 1.9 m.	Impacts the relationship between occupancy time and the number of occupants.
Floor area	Minimum 0.75 m <sup>2</sup> per person.	

Volume	Minimum 1.2 m <sup>3</sup> per person.	Minimum 'volume' criterion is intended to provide sufficient air for a maximum duration of 60 minutes. Design durations greater than 60 minutes will require a specific assessment of air supply.
<p>Interior air temperature</p> <p>OR</p> <p>Interior mean Modified discomfort index (MDI) for 60 minutes</p>	<p>Maximum 45°C (Patterson et al. 2010).</p> <p>Maximum mean 39°C (Patterson et al. 2010).</p>	A tenable environment within a shelter can be detrimentally affected by increased air temperature and relative humidity (refer to 3.4.4).
Interior surfaces temperature	Maximum 70°C for unguarded surfaces.	<p>Interior surface temperatures can be estimated by exposure to design fire conditions. Typical surfaces are those which an occupant of a shelter would be able to touch. Appropriate guarding or insulating of materials is acceptable.</p> <p>Internal surface temperatures will influence interior air temperatures.</p>

<p>Interior air toxicity</p>	<p>Construction materials forming part of the interior of a shelter that are likely to give off gas at temperatures exceeding 100°C must be tested to BS 6853 (1999) Appendix B2.</p> <p>Gases must be limited to -</p> <ul style="list-style-type: none"> <li>(a) carbon monoxide 30 ppm;</li> <li>(b) hydrogen chloride 1.0 ppm;</li> <li>(c) hydrogen bromide 0.5 ppm;</li> <li>(d) hydrogen fluoride 0.5 ppm;</li> <li>(e) hydrogen cyanide 1.0 ppm;</li> <li>(f) nitrogen dioxide 0.5 ppm; and</li> <li>(g) sulphur dioxide 2.5 ppm.</li> </ul>	<p>Materials used for construction of a shelter must not unduly influence the tenable environment during occupation.</p>
<p>Smoke sealing</p>	<p>Maximum leakage rate of 0.3 air changes per hour (when measured at an overpressure of 50 Pa), with ventilation system closed or not operating.</p>	<p>Shelters must minimise ingress of potentially untenable external air.</p>
<p>Ventilation</p>	<p>Natural ventilation must be provided by openings such as doors or other devices that, when open, have an aggregate open area of not less than 5% of the floor area of the shelter.</p>	<p>Sealed shelters may require ventilation to ensure a tenable environment is provided prior to occupation. Ventilation may also be used to supplement air supply provided external conditions are suitable.</p>

<b>EXTERNAL ENVELOPE</b>		
Construction materials	Concrete or solid masonry construction with FRL 60/60/60, except for viewing windows.	Evaluation of external envelope is to include elements and construction joints.
Structural design	The structural design of the shelter must be in accordance with Section B of Volume One of the BCA. All loads and actions to which a private bushfire shelter may reasonably be subjected must be considered, as necessary, for a building having an Importance Level of 4 as per Table B1.2a of Volume One of the BCA.	The external envelope is to be designed relevant to its above or below ground construction, including – <ul style="list-style-type: none"> <li>(a) topography of the site;</li> <li>(b) dead loads;</li> <li>(c) live loads;</li> <li>(d) impact loads (e.g. falling trees);</li> <li>(e) wind loads; and</li> <li>(f) imposed loads (e.g. vehicles).</li> </ul>
<b>ACCESS DOORS OR HATCHES</b>		
Size of opening	Unobstructed minimum width of 600mm and unobstructed minimum area of 0.36m <sup>2</sup> .	Access to a shelter is to be provided by a door or hatch opening that is of sufficient size to allow prompt access.

<p>Construction materials</p>	<p>(a) Except for seals to doors or hatches, must be non-combustible<sup>1</sup></p> <p>(b) When tested to the method described in AS 1530.8.2 shall comply with clause 13.8, except that –</p> <ul style="list-style-type: none"> <li>I. openings are not permitted;</li> <li>II. flaming is not permitted;</li> <li>III. radiant heat flux is limited to less than 2.5 kW/m<sup>2</sup> at 365mm; and</li> <li>IV. temperature rises must be appropriate to meet other criteria in this Table.</li> </ul> <p>(c) When tested to the method described in AS 1530.8.2, operable parts of a shelter such as door, sealable vents and operable ports, must fully operate at the conclusion of the test.</p>	<p>Access door materials need to maintain the design integrity of the shelter.</p> <p>When subjected to a design fire, access door materials, including insulation and door seals, must not release significant amounts of smoke or toxic fumes into the shelter.</p>
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<p>Operation of access door</p>	<p>(a) Must be able to be latched in both the open and closed positions.</p> <p>(b) Must be able to be unlocked from inside when locked from outside.</p> <p>(c) The temperature of operational components such as door handles, latches or locks must not exceed 55°C when measured 30 minutes after exposure testing to AS 1530.8.2 test.</p>	<p>An access door is a critical component of a shelter. It is required to maintain integrity for occupant protection through fire exposure. It is essential that it is able to operate as intended following exposure to a bushfire event.</p> <p>It is likely that an access door will be heavier than a solid core door. Therefore, the possibility of crush injuries needs to be minimised by providing latches.</p>
<p>Access ladders</p>	<p>Ladders used to provide access to or egress from a shelter must comply with AS 1657.</p>	<p>For subterranean shelters it is expected that access may be through some form of ladder or steps.</p>

<b>SIGNAGE</b>		
External signage	<p>(a) A permanent sign made from durable materials must be fixed adjacent to the main access roadway on the allotment on which a shelter is located.</p> <p>(b) The sign shall be headed “PRIVATE BUSHFIRE SHELTER” in red letters on a white background in letters at least 100 mm high.</p> <p>(c) The sign must include the following information in red letters at least 25 mm high –</p> <ul style="list-style-type: none"><li>I. the distance to the shelter on the allotment; and</li><li>II. the general direction in which the shelter is located (using words or a directional arrow).</li></ul>	

<p>Internal signage</p>	<p>(a) A permanent sign made from durable materials must be fixed inside a shelter adjacent to the main access door/hatch.</p> <p>(b) The sign shall be headed “PRIVATE BUSHFIRE SHELTER” in red letters at least 25 mm high on a white background.</p> <p>(c) The sign must include the following information in letters at least 5 mm high –</p> <ul style="list-style-type: none"> <li>I. the designed number of occupants;</li> <li>II. the designed duration of occupation;</li> <li>III. instructions for occupant access and egress;</li> <li>IV. instructions for the operation of installed equipment;</li> <li>V. information for contacting emergency services;</li> <li>VI. advice that increasing the designed number of occupants will decrease the maximum designed duration of occupation; and</li> <li>VII. information regarding the potential to open vents when external conditions are suitable.</li> </ul>	
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<b>CAPACITY TO ASSESS EXTERNAL CONDITIONS</b>		
Viewing window	<p>(a) Minimum size of 0.01 m<sup>2</sup>.</p> <p>(b) Maximum size of 150 mm x 150 mm.</p> <p>(c) Minimum FRL -/60/60 and glazing must remain clear after testing.s</p>	Prior to leaving a shelter occupants will need to visually assess external conditions and a viewing window or port is an appropriate mechanism.
<b>MAINTENANCE</b>		
Maintenance manual	<p>A maintenance manual must be located within a shelter and provide information relating to –</p> <ul style="list-style-type: none"> <li>I. general maintenance requirements;</li> <li>II. a maintenance schedule;</li> <li>III. special requirements to return a shelter to service following fire exposure to a bushfire event; and</li> <li>IV. any consumable items.</li> </ul>	<p>It is likely that a shelter may not be occupied for several years after it is constructed.</p> <p>Shelters will require regular maintenance to ensure effective operation.</p>

**Notes:**

1. 'Non-combustible' has the same meaning as defined in the BCA.
2. Nominated FRL to be determined in accordance with AS 1530.4



## 3 Informative Appendix A

### 3.1 Design Considerations

#### 3.1.1 Shelter location relative to fire hazards

The location of a private bushfire shelter will influence the outcome of a number of design and construction requirements.

This Standard has been developed to address two alternative forms of construction of private bushfire shelters, being –

- (a) an above-ground shelter separated from an associated dwelling;  
and
- (b) an in-ground shelter separated from an associated dwelling.

The proximity of a private bushfire shelter relative to potential hazards such as predominant vegetation, adjacent buildings and structures, allotment boundaries and other combustible materials should be established as a factor to determine the imposed fire exposure of the shelter or elements of construction that make up the shelter.

Notwithstanding the above it is prudent for private bushfire shelters to be located in an area that provides clearance from potential fuel sources, including vegetation. In addition, a private bushfire shelter should not be located within 6 m of a significant fire source such as a wood pile, another building on the same allotment or an allotment boundary. It is possible that exposure to a heat source such as a burning building on an adjoining allotment may be more of a risk than exposure to vegetation on the same allotment.

In the event of bushfire attack, an associated Class 1a dwelling and any other buildings or structures should be considered as potential fuel sources with respect to the private bushfire shelter.

If a shelter is designed as an underground structure or the bounding elements of construction are designed to resist the potential exposures it may be possible to provide a lesser separation distance from significant fire sources.

Consideration should also be given to the protection of an underground *shelter* from the long-term effects of ground water, flood and acid sulphate attack.



## 3.2 Occupancy of a shelter

### 3.2.1 General considerations

The potential occupancy of a *shelter* is a vital consideration in the design process. In the event of an emergency the designed occupancy and the actual occupancy may differ for the structure and may be several years old before it is required to be occupied in an emergency.

Therefore, it is critical to appreciate the limitations of the design and the impact that a varied occupancy may have on its performance.

Literature identifies that not all people may be fit for occupation in a private bushfire shelter, e.g. the very young, the elderly or people with disabilities, and alternative arrangements for protection from bushfire event, such as early evacuation, should be implemented wherever possible (Patterson et al. 2010; Taylor et al 2012))

In this context, it is essential to consider –

- (a) the characteristics of likely occupants i.e. age, people with a disability, people with a history of either cardiovascular<sup>3</sup> or respiratory illnesses;
- (b) the likely composition of occupants e.g. people and animals;
- (c) whether the safety of human occupants could be compromised by other occupants;
- (d) whether valuable possessions are intended to be placed in the shelter;
- (e) whether sufficient resources can be effectively provided to protect the occupants; and
- (f) whether the shelter is likely to be used for other than emergency occupation.

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<sup>3</sup> When exposed to a Modified Discomfort Index of 39°, particularly if entering the shelter when hot or tired, occupants must consider not just the thermal consequences, but also the possible impact upon cardiovascular health. These conditions will significantly increase cardiovascular strain, possibly leading to heat exhaustion in some individuals and perhaps even precipitating serious and life-threatening cardiovascular complications.

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### Duration of occupancy

A prediction of the expected duration of occupation of a private bushfire shelter may be derived from analysis of historic data of bushfires.

The design duration of occupancy should cover the period of untenable conditions and can be influenced by –

- (a) the numbers of occupants;
- (b) the predicted duration of exposure to bushfire attack mechanisms;
- (c) potential secondary (consequential) adjacent structure fires in the bushfire event; and
- (d) the capacity of resources/equipment provided.

The design duration of occupancy should be considered in relation to the following exposures –

- (a) Bushfire Attack – the period during direct *bushfire attack*; and
- (b) Consequential Fires – a period including exposure to other fire hazards such as adjacent structures (including the associated Class 1 dwelling) and other heavy fuel fires.

Design durations of occupancy for a typical *bushfire event* are –

- (a) Pre-event – 10 minutes.
- (b) Fire Front – 10 minutes.
- (c) Adjacent Fires - 30 minutes.
- (d) Safety margin - 10 minutes.
- (e) Total - 60 minutes.

The phases and design durations are represented in Figure 3.2.2.

### Figure 3.2.2 – Design durations of occupancy for a typical bushfire event

A sealed shelter must provide a tenable environment for occupants in its sealed state (refer to air supply requirements in 3.4.2). It is anticipated that in practice, the actual occupancy period may be longer than the duration of the sealed state; i.e. during either the pre-bushfire attack or post-bushfire attack periods. Occupants should be made aware that a private bushfire shelter designed to be sealed may be occupied in an unsealed state with doors or vents in the open



position provided external conditions are suitable. Signage advising of this potential outcome should be provided within a private bushfire shelter.

The design duration of occupation for a nominated number of occupants should be clearly identified on signage provided within a private bushfire shelter.

In shelters where a designed occupancy is for a limited time, a means for occupants to measure the duration should be addressed e.g. a reliable clock.

### **3.2.2 Number of occupants**

The number of occupants will influence the capacity of a private bushfire shelter to provide a tenable environment for occupants during a bushfire event.

## **3.3 Bushfire intensity**

### **3.3.1 General**

There are several products of a bushfire that may become catalysts for serious injury or death to humans and/or damage or destruction of property, including flames, radiant heat, embers, smoke and air pressure/wind.

Each of these products is capable of spreading fire, either in isolation or in combination, given a suitable environment and a source of fuel.

The period of a bushfire will generally involve a number of stages commencing with the ignition of fuel. If there is no form of intervention, a fire will generally develop and spread until the supply of fuel is depleted. A bushfire will 'travel' and the speed and distance it will travel can depend on factors such as the availability of fuel, the topography of bushland, the direction of wind etc. As the 'front' of the bushfire moves forward, heat from the flaming fuel preheats un-burnt fuel ahead of the fire front, which facilitates the rapid ignition of un-burnt fuel and the rapid spread of fire. Additionally, windblown sparks and embers can cause spot fires well in advance of the main fire front.

Some sites can be exposed to multiple fire fronts and increased impact from secondary fires. The likelihood of such outcomes occurring should be considered when designing a shelter to resist the overall bushfire attack and associated bushfire intensity.



It is important to predict the expected intensity of a bushfire and to predict the impact of heat flux on exposed materials in order to provide an appropriate level of protection to occupants of a private bushfire shelter.

The expected intensity of a bushfire can be determined by assessing the bushfire attack level (BAL), a measure of the heat released expressed in  $\text{kW/m}^2$ , for the proposed site. AS 3959 (2009) defines the intensity of radiant heat from a bushfire front in terms of an effective flame temperature, which is assumed to be 1090K maintained for a period of 2 minutes over a maximum fire front width of 100 m. It is considered reasonable to apply these values for the design of private bushfire shelters up to BAL 40. The localised effects of burning debris can be simulated by burning cribs as defined in AS 1530.8.1.

Within the 'flame-zone' (BAL FZ), AS 1530.8.2 applies a conservative approach by specifying 30 minutes of heating to the standard heating regime of AS 1530.4, rather than a transient high temperature exposure lasting a few minutes. Such an approach inherently allows for some residual burning of combustibles in close proximity to the structure. The fire intensity of adjacent structures and other combustible materials can be estimated based on information in fire engineering texts and experimental data.

### 3.3.2 Bushfire attack level

A predicted peak value of incident radiant heat flux ( $\text{kW/m}^2$ ) can be assessed by analysis of a specific site from first principles in accordance with Appendix B of AS 3959 (2009), or from the classification of the site in accordance with Section 2 of AS 3959 (2009) and the simplified method. The peak value is referred to as the bushfire attack level (BAL).

The requirements of AS 3959 (2009) relate to the design and construction of residential buildings located in a designated bushfire-prone area. The degree of life safety provided by the residential building is based on the predicted BAL. However, for the purposes of this Standard a BAL assessment must relate to the location of the private bushfire shelter and not the location of the associated dwelling.

Consequently, compliance with the Performance Requirement is expected to produce a shelter that will provide a reasonable level of life safety as compared with that provided by the associated dwelling.

It should be noted that the *shelter* will be subject to three phases of attack –



- (a) Pre-attack – exposure prior to flame.
- (b) Bushfire attack – exposure during flame immersion.
- (c) Consequential fires – exposure through heavy fuel loads or subsequent structural fire exposure (from adjacent dwellings or structures).



### 3.4 Tenable environment within a shelter

#### 3.4.1 General considerations

In order to provide a tenable environment for a specific number of occupants within a private bushfire shelter, there is a need to consider a number of contributing factors, including –

- (a) location factors including adjacent hazards and topography (refer to 3.1);
- (b) predicted duration of occupation (refer to 3.2.2);
- (c) floor area/volume of the *private bushfire shelter* based on the number of occupants (refer to 3.2.3 and 3.4.3);
- (d) applicable or relevant BAL for the specific site (refer to 3.3.2);
- (e) provision of a sealed or unsealed envelope (refer to 3.4.2);
- (f) air supply (refer to 3.4.3);
- (g) temperature (refer to 3.4.4); and
- (h) psychological temperament of occupants (refer to 3.4.5).

#### 3.4.2 Sealed and unsealed shelters

The provision and maintenance of a tenable environment within a private bushfire shelter exposed to a bushfire event will be influenced by the degree to which the envelope of the shelter is sealed or unsealed. Ambient air pressure will rise during a bushfire as ambient air temperature rises. External air pressure would be expected to be greater than the pressure inside a private bushfire shelter.

Therefore, it is likely that external smoke will enter a shelter unless there is an adequate seal around typical openings such as doorways, glazed panels and possible service penetrations. Such openings should be sealed sufficiently to minimise the entry of smoke.

Sealing the envelope of a shelter will mitigate the effects of potential smoke infiltration and flame impingement within the shelter. However, sealing can also introduce a range of issues requiring consideration including –

- (a) potentially limited air supply while seals remain in place;
- (b) oxygen depletion;
- (c) carbon dioxide build-up of (potentially more significant than oxygen depletion);
- (d) elevation of internal temperatures from external heat sources; and
- (e) elevation of internal temperatures from human occupation.



The method of sealing the envelope should be carefully considered. Door and vent seals will need to withstand anticipated exposure temperatures during a *bushfire event*. Common sealants used in passive fire protection (e.g. intumescent materials) can give off toxic or noxious gases when exposed to high temperatures and some may change their composition and prevent doors from being readily opened.

#### 3.4.2.1 *Sealed shelters*

Generally, all openings and penetrations through the envelope of a private bushfire shelter required to be designed to BAL 40 or greater should be sealed. In sealed shelters consideration should be given to airflow through the shelter during dormant periods. In such cases, openable vents fitted with wire mesh screens or similar devices that restrict the ingress of windblown debris may be appropriate.

Special consideration should be given to the sealing of doors (refer to 3.6.3).

#### 3.4.2.2 *Unsealed shelters*

A private bushfire shelter designed to below BAL 40 may not need to be sealed because potential toxic gases in the external environment would not be expected to facilitate untenable conditions within an appropriately designed shelter. On a site with a design below BAL 40 the primary concern is likely to be exposure to heat and appropriate protection may be provided without sealing the envelope of a private bushfire shelter.

When reviewing unsealed options, the potential hazards of toxic smoke from fires in adjacent dwellings, outbuildings, vehicles and the like should be considered.

Special consideration should be given to the suitability of an unsealed private bushfire shelter for use by occupants with respiratory problems.

### 3.4.3 **Air supply**

The pressure differential across an element of construction would be expected to be dominated by wind effects and there is potential for a positive pressure between the outside and inside of the private bushfire shelter, potentially permitting toxic gases to flow through any small openings.

Therefore, there is potential for external smoke to enter the shelter unless there is an adequate seal around typical openings such as doorways, glazed panels



and service penetrations. In sealed shelters such openings need to be sealed sufficiently to minimise the entry of smoke.

Designs with combinations of doors with a short corridor (i.e. an air lock) may be particularly effective where the first door resists the majority of the heat and the second door is fitted with smoke seals.

The potential toxicity of combustible materials in the vicinity of the private bushfire shelter must be considered. Typical combustible materials near a private bushfire shelter could include –

- (a) the associated Class 1a dwelling;
- (b) vehicles and farm equipment;
- (c) associated sheds and outbuildings and their contents (farm chemicals, fertilisers, fuels);
- (d) garden furniture (plastics);
- (e) water tanks (plastics);
- (f) vegetation; and
- (g) treated timber.

Sealed private bushfire shelters must have sufficient air supply to provide a tenable environment for the required period of occupation. In the design process it is critical to specify the scope of potential inclusions in a shelter because additional inclusions to those addressed at the design stage will reduce the volume of air available to occupants during an emergency.

High carbon dioxide levels (hypercapnia) can be potentially fatal and are generally caused by exposure to environments containing abnormally high concentrations of carbon dioxide, which can occur by re-breathing exhaled carbon dioxide in an enclosed space. Carbon dioxide scrubbing systems, which include filters to remove harmful gases and toxins from within a private bushfire shelter (e.g. pre-filled absorber chemical cartridges) may be suitable.

Table 3.4.3 provides information regarding the predicted toxicity of a carbon dioxide environment by relating a 'minimum volume' and a 'number of occupants' to a 'maximum duration' in a sealed environment. This information is based on an average 70 kg person and CO<sub>2</sub> output under normal conditions. This does not take into consideration increased temperature or emotional stress, however emotional stress does not have a large effect on CO<sub>2</sub> production as it is increased by metabolic activity. Due to the increased heat



and possible physical activity prior to entering the shelter, a factor of safety of 50% should be applied to the tabulated values, i.e. value x 0.50.

The minimum required volumes presented in Table 3.4.3 may not be sufficient to address other influences on the provision of a tenable environment within a private bushfire shelter.

Table 3.4.3 – Theoretical Duration of Occupancy

Theoretical maximum duration of occupancy for a complying shelter (hours)										
Volume of private bushfire shelter (m <sup>3</sup> )	Number of occupants									
	1	2	3	4	5	6	7	8	9	10
7.5	24.8	12.4	8.3	6.2	5.0	4.1	3.5	3.1	2.8	2.5
10.0	33.1	16.6	11.0	8.3	6.6	5.5	4.7	4.1	3.7	3.3
12.5	41.4	20.7	13.8	10.4	8.3	6.9	5.9	5.2	4.6	4.1
15.0	49.7	24.8	16.6	12.4	9.9	8.3	7.1	6.2	5.5	5.0
17.5	58.0	29.0	19.3	14.5	11.6	9.7	8.3	7.2	6.4	5.8
20.0	66.2	33.1	22.1	16.6	13.2	11.0	9.5	8.3	7.4	6.6
22.5	74.5	37.3	24.8	18.6	14.9	12.4	10.6	9.3	8.3	7.5
25.0	82.8	41.4	27.6	20.7	16.6	13.8	11.8	10.4	9.2	8.3
27.5	91.1	45.5	30.4	22.8	18.2	15.2	13.0	11.4	10.1	9.1
30.0	99.4	49.7	33.1	24.8	19.9	16.6	14.2	12.4	11.0	9.9
35.0	115.9	58.0	38.6	29.0	23.2	19.3	16.6	14.5	12.9	11.6
40.0	132.5	66.2	44.2	33.1	26.5	22.1	18.9	16.6	14.7	13.2
45.0	149.1	74.5	49.7	37.3	29.8	24.8	21.3	18.6	16.6	14.9

Source - Simon Hill Professional Engineering Solutions Pty Ltd based on study by Nigel J. Langford, "Carbon Dioxide Poisoning (2005)"



Air supply within a sealed private bushfire shelter may be supplemented by providing a sealed ventilation system that may be readily opened after a fire front has passed and when external air is of sufficient quality to not endanger occupants.

Literature dismisses the possibility of suffocation inside an unsealed private bushfire shelter due to bushfire derived oxygen deficiency reasoning that humans can survive at atmospheric oxygen concentrations below the flammability limit. This is supported by research that demonstrates flaming combustion ceases at atmospheric oxygen concentrations less than 11% (Butler & Putnam 2001).

As air is approximately 21% oxygen<sup>4</sup> the use of pure oxygen should not be considered as a means of supplementing air supply because it is a significant fire accelerant due to its enhancement of the burning process. A preferred means of supplementation would be the use of compressed air.

### 3.4.4 Temperature

#### 3.4.4.1 General

Design parameters including construction materials and methods, shelter size, and ventilation can influence the internal temperature of a private bushfire shelter.

The effect of temperature on occupants is an important consideration in the construction and use of private bushfire shelters. This design issue can be exacerbated by typically elevated temperatures on days of higher bushfire risk. The interior of an above ground shelter may reach the maximum outside ambient temperature during extended heat waves. These temperatures commonly reach the high forties. As such, maintaining the interior air temperature below a designed maximum within above-ground shelters may prove problematic without active climate controls (Patterson et al. 2010).

During the period of occupation of a private bushfire shelter the temperature within a sealed shelter would be expected to increase due to the influence of

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<sup>4</sup> Dry air is primarily made up of nitrogen (79.09%) and oxygen (20.95%). The remaining 1% is made up of argon (0.93%), carbon dioxide (0.03%) and other trace gases (0.003%). Water vapor (water in its gaseous state) is also present in air in varying amounts.



factors including exposure to external radiation and metabolic body heat of occupants.

The relative humidity of air in a sealed shelter is also a critical factor to the provision of a tenable internal environment. The relationship between internal temperature and internal relative humidity can influence the duration of occupation. Literature relating temperature and relative humidity is available (Kenney et al. 2004; Patterson et al. 2010).

### **3.4.5 Fire-resistance level**

#### **3.4.5.1 General**

A private bushfire shelter should be designed to protect occupants from one or more of the following exposures that may occur during a bushfire event, depending upon the proximity to the bushfire front, other potential fire sources and the prevailing conditions—

- (a) Direct flame contact.
- (b) Radiant heat.
- (c) Burning debris.
- (d) Embers.
- (e) Smoke.

The level of protection should be such that a tenable environment should be maintained in the shelter for the required period of occupation.

In order to verify the performance of a private bushfire shelter design, it is necessary to nominate design actions and acceptance criteria. These are discussed in more detail below.

### **3.4.6 Design Exposure Conditions**

There is a continuum of potential exposure conditions that could occur from a *bushfire*. Since it is impractical to evaluate the performance of a large number of exposure conditions, consistent with normal engineering practice, it is appropriate to specify design actions that have sufficient conservatism to include most credible exposure conditions, and that are capable of being replicated as part of a standard test procedure. The test procedure can then form part of a verification method.



Such an approach was adopted during the development of AS 1530.8.1 and AS 1530.8.2, which are prescribed by AS 3959 (2009) for construction of buildings in *designated bushfire-prone areas*.

AS 1530.8.1 applies to structures that are unlikely to be exposed to large flaming sources and should only be applied to specific sites.

AS 1530.8.2 was developed to assess the performance of elements of construction that may be exposed directly to flames from a fire front or from other fire sources such as adjacent buildings and is therefore more appropriate for approval of a private bushfire shelter for general applications.

AS 1530.8.2 adopts the standard fire resistance test heating regime of AS 1530.4 (2005) and ISO 834-1 (1999) and specifies an exposure period of 30 minutes. Heating regimes on which AS 1530.4 (2005) is based have been in use for over half a century and have been used to regulate the performance of elements of construction exposed to fully developed internal fires as well as external fires from adjacent buildings.

Internal building fires can have similar profiles to direct flame exposure from a bushfire front with a rapid temperature rise to in excess of 1090K with the duration of high temperatures relating to, amongst other things, the fuel load.

Whilst the AS 1530.4 heating regime does include an initially rapid temperature rise, this rate of rise could be exceeded under certain circumstances. The substantial experience with the use of the standard heating regime has shown that it is unusual for these variations in heating rate to significantly affect the ranking of elements of construction and methods such as the normalised heat load concept or a variant using the lumped thermal mass approach can be used to transpose an actual exposure to an equivalent fire resistance period. Using such an approach it can be shown that a 30 minute exposure to the standard heating regime would be sufficient to be equivalent to exposure from a bushfire front with a reasonable margin of safety.

Therefore it is considered that the heating regime of AS 1530.8.2 can be reasonably applied to private bushfire shelters.



This approach is also consistent with the accepted exposure for other buildings in designated bushfire-prone areas since AS 1530.8.2 is specified in AS 3959 (2009).

It should also be noted that AS 1530.4 is referenced in the BCA in relation to minimising the risk of fire spread between buildings, which is a fire spread mechanism that can also occur during bushfires.

In addition to specification of heating AS 1530.8.2 and AS 1530.4 also require a positive pressure to be applied to elements of construction. This can be important since leakage of hot gases through door seals, joints and other openings/penetrations can influence a tenable environment and the test conditions of AS 1530.8.2 can evaluate these effects to some extent.

### **3.4.7 Acceptance Criteria**

AS 1530.8.1 and AS 1530.8.2 provide test methods for evaluation of elements of construction exposed to various levels of bushfire event and have more stringent performance criteria than AS 1530.4, which is used to determine a fire-resistance level (FRL). The increased stringency was introduced to address mechanisms of fire spread during bushfires, the limited fire fighting resources that may be able to be employed promptly and to facilitate evacuation from a building if it is ignited.

Care needs to be taken when applying the results of AS 1530.4 and AS 1530.8 since the performance criteria were not derived for private bushfire shelters which have a much smaller volume than normal housing stock and the occupants may not have the opportunity to evacuate directly after the bushfire attack has passed.

Therefore, Acceptance Criteria for a private bushfire shelter needs to be more stringent than AS 1530.4 and AS 1530.8.2 performance criteria as noted below. In many instances it is possible to expose all or part of a shelter and monitor internal conditions within the enclosure. Under these circumstances acceptance and performance criteria can be based on –

- (a) limiting air temperature rises measured within the enclosure to ensure tenability criteria for moist air are not exceeded (refer Table 2.4); and



- (b) surface temperatures with a maximum of 70°C from unguarded surfaces (refer Table 2.4) are not exceeded.

Other important issues include -

- (a) Fire doors - typical performance criteria for fire doors require substantial modifications since large gaps around the perimeter are permitted particularly by AS 1530.4 and the insulation criteria is less stringent to walls since it applies for only 30 minutes. In addition opening forces after fire exposure need to be specified to enable occupants to leave the shelter unassisted; and
- (b) Penetration seals – AS 1530.4 or AS 1530.8 do not measure the production of toxic gases from the non fire exposed side. This could be addressed by limiting temperature rises on the non fire side to a temperature below which materials will not break-down.

A credible specification for a design fire that may be used for design modeling, tenability modeling or test protocol design is provided below -

- (a) 5 kW/m<sup>2</sup> for 3 minutes;
- (b) 10 kW/m<sup>2</sup> for 2 minutes;
- (c) 30 kW/m<sup>2</sup> for 2 minutes;
- (d) Flame immersion at 935°C for 50 seconds;
- (e) 5 kW/m<sup>2</sup> for 2 minutes; and
- (f) 10.6 kW/m<sup>2</sup> for 30 minutes (as a 120 kW/m<sup>2</sup> structure fire at 10 m separation from the shelter).

### **3.4.8 Psychological considerations**

An occupant's ability to act and make optimal choices during a bushfire event will be influenced by their mental preparation, the availability of information for decision making, their perception of a real threat and their considered response.

In this context, an occupant may experience heightened anxiety due to their involvement in a bushfire event and their potential confinement within a private bushfire shelter, which may influence body temperature and oxygen consumption. Therefore, it is essential that occupants become familiar with the operation of a private bushfire shelter and the likely duration of confinement, particularly occupants with claustrophobic or associated tendencies.



### 3.5 Loads and actions

#### 3.5.1 General

The structural design of a *shelter* should be in accordance with Section B of Volume One of the BCA. All loads and actions to which a *private bushfire shelter* may reasonably be subjected should be considered, as necessary, for a building having an Importance Level of 4 as per Table B1.2a of Volume One of the BCA.

The location of the shelter and its immediate surrounds will determine the loads that it will be subjected to. Wind loads in particular will be influenced by the surrounding topography and any shielding. Existing site conditions may indicate whether bushfire attack from a particular direction is likely to be more severe than from other directions.

For below-ground shelters the type of soil will determine earth pressures that the shelter will need to resist. The likelihood of below-ground shelters being subjected to vehicular loads will be dependent on the location and any obstacles that would impede or prevent vehicles driving over the structure. The potential for ground movement may also be relevant.

Likely future site conditions have the potential to significantly alter the direction and severity of bushfire attack and the potential impact of this on the design of the shelter also requires consideration. The predicted bushfire intensity and predicted duration of the bushfire event can impact on the structural integrity of the shelter.

#### 3.5.2 Dead loads

Refer to Section B of Volume One of the BCA.

#### 3.5.3 Live loads

A private bushfire shelter should be designed and constructed to withstand the impact of windblown objects and falling trees and, in the case of in-ground private bushfire shelters, the possibility of vehicles driving over the private bushfire shelter<sup>5</sup>.

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<sup>5</sup> *Building in Bushfire Prone Areas – Interim Recommendations – Submissions of Counsel Assisting; 2009 Victorian Bushfires Royal Commission, 28 September 2009 - paragraphs 4, 13 and 31.*



A private bushfire shelter should be designed and constructed to withstand the high winds that are a feature of extreme fire weather<sup>6</sup>.

A private bushfire shelter would be a building having an Importance Level of 4 for the purposes of BCA Volume One Table B1.2a and wind loads should be determined for an Annual Probability of Exceedance of 1:2000<sup>7</sup>.

### 3.5.4 Effects of bushfire attack on structural elements

Levels of radiant heat expected during *bushfire attack*, as well as possible fire in adjacent dwellings and other structures (in the *post bushfire attack period*), may reduce the load carrying capability of structural elements. This potential reduction in structural capacity needs to be considered in the design of *private bushfire shelters*.

## 3.6 Materials and construction

### 3.6.1 Selection of materials

Satisfactory performance of elements of construction is critical to the overall performance of a private bushfire shelter. The performance of elements of construction exposed to bushfire event may be assessed by testing in accordance with AS 1530.8.1 and AS 1530.8.2.

AS 1530.8.1 addresses testing of elements exposed to radiant heat, burning embers and burning debris (BAL 12.5 up to BAL 40).

AS 1530.8.2 addresses testing of elements exposed to large flaming sources (BAL FZ – Flame Zone).

For the purposes of the Standard, materials must be suitable for use when exposed to the BAL required under 3.3.2.

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<sup>6</sup> *Ibid*

<sup>7</sup> *During the Victorian bushfires wind gust of 90 -115 kilometers per hour were recorded. Some estimates of wind speeds were developed. It is known that for wind speeds above about 50 kilometers per hour the nature of a bushfire changes significantly.*



Building material manufacturers that have products tested to AS 1530.8.1 or AS 1530.8.2 may be able to provide information and assistance to designers of private bushfire shelters.

Guidance on the selection of appropriate building materials and building products may also be provided by AS 3959 (2009).

### 3.6.2 Construction gaps

During the course of construction of a *private bushfire shelter* it is critical that no significant gaps occur between elements of construction. Gaps may allow products of *bushfire*, i.e. flames, embers and smoke, to enter the *private bushfire shelter*. Any gaps that do occur should be filled with a fire-resistant material.

### 3.6.3 Doors

#### 3.6.3.1 Location of door/hatch openings

To reduce the potential for egress to be compromised, alternative means of exiting a private bushfire shelter is preferable in private bushfire shelters on sites with substantial vegetation. Alternative means of egress should not be located within close proximity of each other.

A door/hatch opening in the external envelope of a private bushfire shelter will present a 'weak spot' in the capacity of the envelope to resist the impact of external sources of heat. In sealed shelters, the door/hatch is a likely failure point for smoke seals. Therefore, wherever practicable, doors/hatches should be located/orientated so that they are not exposed to major sources of radiant heat, such as a dwelling on the same allotment or an allotment boundary in close proximity to the shelter.

As an opening in the external envelope will be a 'weak spot' the size of a door/hatch opening should be sufficient to provide appropriate access or egress without being excessive.

In private bushfire shelters required to be designed to BAL 40 or greater, consideration may be given to the provision of two doorways separated by an air lock or similar. In such a layout the outer door would be used as a means of protecting the inner 'smoke door'. Physical heat shielding of a single access door by fire-resisting construction such as an entry tunnel may also be appropriate.



In private bushfire shelters designed to below BAL 40, suitable protection of a doorway may be provided by a non-combustible barrier located in front of the door opening to protect the doorway from exposure to significant radiant heat.

The design of the door/hatch should also consider the internal face temperature of the door during exposure.

### 3.6.3.2 *Type of doors*

Doors used in buildings to act as a barrier to the spread of fire, commonly referred to as 'fire doors' may not be suitable for installation in a private bushfire shelter in all instances.

Fire doors in buildings are not expected to be opened by occupants once they are exposed to significant burning. In such instances, the exposed surface of a fire door may ignite and it may buckle or bend, however it will remain generally in place and act as a suitable barrier.

When a door to a private bushfire shelter is the only door in and out of the shelter it will be necessary to open it in order for occupants to egress. During the passage of a bushfire, the external lining of the door may ignite and egress could be significantly hindered if the door is burning or buckled, perhaps to the degree that it is not able to be opened at the time.

To reduce the potential for a door to ignite, a non-combustible door should be installed, or a fire-rated door with an external non-combustible lining may be installed. The door should be tested to AS 1530.8.2 to achieve the period of occupancy and tested to be openable after the conclusion of the test. The result of this test should also be used as inputs to the calculation for heat load within the structure (i.e. temperature rise across the door). In some instances, the use of a horizontal hinged hatch or similar device may provide a more suitable means of access and egress than a typical door opening.

The appropriate type of external door (solid core or glazed) for the varying levels of exposure during bushfire attack is proposed to be researched by Standards Australia<sup>8</sup>.

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<sup>8</sup> AS3959 2009 – Construction of Buildings in Bushfire Prone Areas – page 3



### 3.6.3.3 *Direction of swing and latching*

The direction of door swing should be the most appropriate to facilitate safe access and egress for occupants in consideration of factors that may restrict occupants ability/capacity to readily open the door when required. Such factors include –

- (a) an outward swinging door may be blocked by debris;
- (b) an inward swinging door may be blocked by occupants or contents, and
- (c) a pressure differential or strong wind may restrict closing or opening of a door.

Doors should be able to be unlocked/unlatched from both inside and outside the private bushfire shelter after exposure to the bushfire front or other critical exposure<sup>9</sup>. This will reduce the potential for occupants to become trapped inside and also facilitate external intervention by emergency services personnel. Where a door is lockable from the outside, it needs to be openable from the inside at all times, even when locked from outside.

In some instances, it may be necessary to install roll-cages or similar structures over a door opening in order to reduce the potential for a doorway to become blocked by falling debris during occupation.

### 3.6.3.4 *Sealing of door/hatch openings*

Leakage from an unsealed door may be greater than 200 m<sup>3</sup>/hour at low pressure differentials, and leakage from a poorly sealed door may be in excess of 80m<sup>3</sup>/hour when exposed to 200°C. Data on the performance of door/seal combinations at 200°C can be obtained from tests performed in accordance with AS 1530.7.

Gaps between the base of an unsealed door and the floor of the private bushfire shelter should perform to a higher standard if fitted with a draught excluder that is non-combustible.

The actual method of sealing a door should also be considered because an activated intumescent seal may create a bond between the intumescent

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<sup>9</sup> *Building in Bushfire Prone Areas – Interim Recommendations – Submissions of Counsel Assisting; 2009 Victorian Bushfires Royal Commission, 28 September 2009 – paragraphs 4, 13 and 31.*



material and the door and restrict an occupant's capacity to open a door when preparing to leave.

#### 3.6.3.5 *Door hardware*

Mechanisms that open a door/hatch, such as a door handle, should be of a suitable material that will not retain heat for long periods as metal fittings exposed to the external environment could become extremely hot during the passing of a *bushfire* front. Door hardware should be in accordance with that fitted to the respective tested door.

Due to the potential for doors to bend or buckle when exposed to differential heat on opposing surfaces, sealing a door may not provide sufficient protection from the external environment unless an airlock system or positive pressure system is utilised.

### 3.6.4 **Signage**

#### 3.6.4.1 *Signage to identify the location of a shelter*

A non-combustible sign should be provided adjacent to the main entrance to the site to enable emergency services personnel or other rescuers to readily identify a site that contains a private bushfire shelter.

Additionally, in order to reduce the potential for vehicles to inadvertently drive over the top of an underground shelter, a substantial non-combustible sign identifying the location of an underground private bushfire shelter should be located directly adjacent to its entrance.

The location and content of both signs required under this clause should not imply that a private bushfire shelter is available for public use.

#### 3.6.4.2 *Signage within a shelter*

A sign should be located within a shelter to advise occupants of the designed capacity of the shelter with regard to the number of occupants and the maximum period of occupation in its sealed state, i.e. with the entrance door and other openings closed and sealed.

The sign should also convey information relating to the safe use of the shelter and the operation of any critical equipment, including door latches.



### 3.6.5 Communication with external environment

#### 3.6.5.1 Verbal communication systems

A suitable form of verbal emergency communication may provide assistance to occupants of a private bushfire shelter. The application and performance of available systems may vary depending on site specific conditions or the accessibility of local communication networks.

#### 3.6.5.2 Visual communication systems

A glazed window or similar device should be provided in the external envelope of the private bushfire shelter to allow occupants to periodically observe the passing of the bushfire front and also to visually evaluate the tenability of external conditions. This is also important for occupants to be able to be alerted when other people, such as rescuers, are approaching the private bushfire shelter.

A window or similar device will need to withstand the heat and forces generated by a bushfire event and it is likely that a fire-rated window will be required. Fire-rated windows with duration ratings ranging from 30 to 120 minutes are available.

If a non-rated window is used the glazing in the frame may break, which may create an opening in the external envelope of the private bushfire shelter and allow radiant heat and smoke to enter.

While some protection or shielding from radiant heat may be available within the private bushfire shelter, smoke contains toxic gases and will significantly impact on indoor air quality if sufficient smoke finds its way into the shelter.

An alternative means of protection may be provided by a fire-rated shutter that can be used to cover and protect a non-fire rated window. In extreme conditions, such as sites beyond the bushfire attack level criteria in AS 3959 (2009), it may be necessary to install both a fire-rated window and a fire-rated shutter. The size of the opening should be considered carefully as it may have an impact on the internal temperature of the shelter.



### **3.7 Level of essential maintenance**

#### **3.7.1 General**

Like all other buildings a private bushfire shelter will require regular maintenance if it is to act as an effective form of protection when required, which may be several years after its initial construction.

A property specific bushfire safety plan should address the maintenance of all bushfire protection measures prior to the start of the bushfire season, including maintenance of a private bushfire shelter.

Individual State and Territory Governments hold legislative responsibility for building control matters, including the maintenance of a building during its operational life. Therefore, legislative requirements for maintenance are addressed, to the extent necessary, within each jurisdiction's legislative system.

Provisions identifying the scope of 'safety installations' required to be maintained are contained in the BCA. The objective for these provisions states; "Equipment, installations and components critical to the safety of the building or the occupants must be adequately maintained in such condition that will enable their proper performance."

However, the BCA does not prescribe a building solution to achieve a 'requirement' for maintenance. The primary reason for this outcome is that maintenance of buildings is an administrative matter, rather than a technical matter for regulation by the BCA.

The general objective of maintenance provisions is to ensure that safety measures in buildings, which perform satisfactorily at the time of initial construction and occupation of a building, continue to perform to at least the same standard throughout the life of the building. This objective applies equally to the construction of a private bushfire shelter as it does to any other building.

In essence, there are a number of fundamental issues that should be included within a comprehensive maintenance regime for private bushfire shelters, including those contained in 3.7.2 to 3.7.6.

#### **3.7.2 Management of the physical environment**

It is critical that the condition of the physical environment on which the design of a shelter has been based is not changed in a manner that could compromise



the capacity of a shelter to perform as required for the life of the structure. Factors such as vegetation and topography in the immediate area of the associated dwelling, access pathways and the shelter itself should be managed to ensure this outcome. Where possible, implementation of a hazard reduction strategy that includes removal of existing hazards may enhance the performance of a shelter in a bushfire event.

### **3.7.3 Use of a shelter**

Generally, a private bushfire shelter should not be used for other purposes as these may render the private bushfire shelter unusable in the event of an emergency.

### **3.7.4 Periodic trial occupations**

Likely occupants of the private bushfire shelter should be encouraged to participate in periodic trial occupations to ensure –

- (a) they become familiar with any pre-occupation activities they may be required to undertake; and
- (b) the *private bushfire shelter* is capable for performing its intended function in the event of an emergency.

### **3.7.5 Maintenance of active systems**

Active fire safety systems, such as mechanical ventilation systems or water spray systems should be expected to require significant ongoing maintenance in order to ensure that they perform effectively in the event of an emergency.

### **3.7.6 State and Territory legislative requirements**

Specific information relating to the maintenance of *private bushfire shelters* should be sought from the relevant Government agency. An outline of individual jurisdictions requirements is provided in Appendix E.



## **4 Informative Appendix B**

### **4.1 Ancillary Information**

#### **4.1.1 Provision of safe access and egress**

Reference to the NFPA fire safety concepts tree (Appendix D) shows that in addition to providing a safe destination it is necessary to "provide movement means" and "cause movement of exposed".

Whilst these considerations may lie outside the typical scope of the BCA they may contribute to achievement of the objective of provision of a private bushfire shelter.

To facilitate safe movement of people into a private bushfire shelter, adequate training should be provided so that occupants can evaluate a need to move, communicate that need to others and provide instructions to proceed to a shelter before the fire front arrives. Paths of travel to a shelter should –

- (a) provide a safe route from buildings on the site and the allotment boundary entry;
- (b) be sufficiently wide to allow movement in a timely manner; and
- (c) have sufficient clearance to vegetation and other combustible materials or shielding such that if a spot fire is ignited prior to arrival of the fire front the path of travel will remain trafficable.

#### **4.1.2 Access to a shelter**

Occupant movement into a shelter should be initiated in accordance with the occupants respective 'bushfire safety plan'.

Adequate means of access and egress should be provided for all intended occupants and have dimensions and characteristics, such as surfaces and slope, suitable for a person with an ambulant disability to access the shelter when necessary, with a maximum slope of 1:14 preferred.

Consideration should also be given to the need to access the shelter when visibility could be poor, such as at night or when exposed to thick smoke, particularly as local electricity supply systems may be disabled by bushfire.

The timing of entry to a shelter is critical to the safety of occupants. A shelter should be occupied and closed to the outside when untenable conditions become evident in the proximity of the site.



The door to the shelter need not be closed at the initial time of entry if the external environment is not threatening. Closing the door too early may compromise the available air supply.

Depending on the direction a fire front is moving, a shelter located upslope from the associated dwelling could be difficult to access if it is a substantial distance from the associated dwelling. A fast moving fire front may travel rapidly up a slope and could become a hazard to people trying to access the shelter, particularly if they are carrying or assisting children or family members with an ambulant disability.

Unobstructed and safe access to a private bushfire shelter should be provided and maintained. At the time when residents need to access a shelter it is possible that components of the associated dwelling may have ignited and vegetation in the vicinity of the shelter may have also ignited. Clearing of vegetation around either side of the path of travel to the private bushfire shelter is important.

The distance between the associated building and a private bushfire shelter should be such that potential exposure to untenable conditions is minimised. It is critical that occupants are not exposed to radiant heat flux during their journey to a private bushfire shelter because even a short period of exposure to low levels of radiant heat can cause significant burning; an outcome that may not be able to be treated for a substantial period of time during occupation of the shelter. As described in 3.1, generally a private bushfire shelter should not be located within 6m of the associated dwelling. However; to enable ready access it should also not be more than 20m from the associated dwelling.

The potential for vehicular access to the property and the shelter during a bushfire event should also be assessed. Poor access in conditions of fire and heavy smoke with low visibility may limit a person's ability to leave a property and also may prevent fire fighters from assisting. Evidence given to the VBRC advised that fire fighters were unable to gain vehicular access to a particular property because trees had fallen across the entrance road. Therefore, alternative means of vehicular access/egress should be considered.

#### **4.1.3 Mobility of occupants**

The mobility of occupants will need to be considered with regard to providing sufficient time to access a shelter once a decision to use a shelter is made. The



time available for access can be rapidly diminished by the spread of a bushfire and the radiant heat generated by the fire front.

#### **4.1.4 Egress from a shelter**

During a bushfire event the influence of various forces and actions may result in effective egress from an occupied private bushfire shelter being compromised.

When occupants leave a private bushfire shelter they must remain aware of changes to environmental conditions. As an example, a change to the direction of wind could change the direction of the movement of a fire front.

Evidence provided to the VBRC described people who had exited a private bushfire shelter to control spot fires later becoming exposed to a second fire front as a result of a change in wind direction.

If the private bushfire shelter is to be re-entered care must be taken as to the change in environment within the private bushfire shelter due to the possibility of smoke or burning embers entering it while it was not occupied.

Vegetation should be cleared to the extent that if a spot-fire occurs there should be sufficient separation to allow occupants to either access or egress the shelter.

#### **4.1.5 Sanitary facilities**

The Performance Requirement does not specifically require the provision of sanitary facilities. However, it does require consideration of the duration of occupancy.

The designed duration of occupancy may be of such magnitude that some form of sanitary facility would reduce the temptation or perceived need for occupants to prematurely leave the shelter.

#### **4.1.6 Potable water**

The Performance Requirement does not specifically require the provision of potable water. However, it does require consideration of the duration of occupancy.

The predicted duration of occupancy may be of such magnitude that a quantity of potable water would reduce the need for occupants to prematurely leave the shelter.



#### **4.1.7 Lighting**

Lighting may play a role in reducing stress in shelter occupants.

The Performance Requirement does not specifically require the provision of internal lighting; however it does require consideration of the duration of occupancy.

The predicted duration of occupancy and changes to the external environment may be of such magnitude that a form of temporary lighting, such as a torch, would reduce the potential for occupants to prematurely leave the shelter.

Combustion-based forms of lighting, such as fuel lamps or candles, should be avoided because they increase the risk of ignition of other fuels within the shelter and also consume oxygen.

#### **4.1.8 General safety**

Before deciding whether it is safe to leave a private bushfire shelter, the condition of the surrounding environment needs to be carefully assessed for potential hazards.

Large trees will continue to burn for some time, even days, after the event particularly if they are hollow. This means that the external environment may be susceptible to falling branches or trees for quite some time.

Burning buildings can contain potentially explosive items such as gas bottles. Fuel tanks, either bulk storage or in vehicles that are on fire can also be a significant unpredictable explosion risk.

Seemingly insignificant items including children's play equipment and outdoor furniture can present sources of potentially toxic smoke following bushfire exposure.

All potential hazards will need to be considered and avoided wherever possible.

#### **4.1.9 Durability**

While bushfire events are common occurrences in Australia, recurrent exposure of individual sites is not as common. It may potentially be many years before a constructed shelter is required in an emergency. Accordingly, the durability of the structure, materials and active systems should be considered in the design.



#### **4.1.10 Clothing**

Occupants exposed to the effects of a bushfire should be protected with suitable clothing when leaving a shelter after the fire front has passed. Clothing including gloves should be able to withstand likely temperatures of door hardware and the like.

Calculations based on the Society of Fire Protection Engineers (SFPE) Engineering Guide, Predicting 1st and 2nd Degree Skin Burns from Thermal Radiation, indicate that occupants without any significant protection from clothing would experience pain after approximately 18 seconds of exposure to a radiant heat flux of 4 kW/m<sup>2</sup>.

#### **4.1.11 Secondary usage of a shelter**

Using a private bushfire shelter for a secondary purpose, such as a storeroom or a wine cellar, may help validate the initial cost of construction, however a secondary use may also compromise its primary use when it is most needed, i.e. at the time an emergency arises. A secondary use may introduce unintended safety hazards that jeopardize its primary use and should be avoided.

#### **4.1.12 Personal bushfire safety plans**

The development of a personal bushfire safety plan may help property owners or occupants determine whether the option of staying and defending a property is viable.

It will also assist a transition to occupying a private bushfire shelter if circumstances dictate such an outcome.

Local fire authorities may be able to assist with the preparation of a personal fire plan and provide authoritative advice on the capacity to defend individual properties.

#### **4.1.13 Equipment for inclusion in a shelter**

Consideration should be given to meeting the essential needs of occupants during and immediately after a bushfire event. The following items may be of considerable value -

- (a) Radio may provide a means of receiving news of the fire situation;



- (b) Mobile phone may provide a means of contacting emergency services;
- (c) First Aid Kit may enable treatment of minor cuts and burns as well as possible heat stress;
- (d) Torch can provide short periods of light both inside the *shelter* and also externally at night and poor visibility;
- (e) Potable water may be essential as air temperature is likely to be high and dehydration can occur very quickly. Water can also be used to wet towels and blankets to provide protection from heat;
- (f) Spare clothing, including gloves; and
- (g) Portable sanitary facilities may be of benefit if a *shelter* is to be occupied for a considerable period of time.

#### 4.2 Additional State or Territory requirements

State or Territory agencies may have a range of requirements for the construction, use and maintenance of private bushfire shelters. It is necessary to determine whether legislation requires –

- (a) approval for construction; or
- (b) registration and signage; or
- (c) regular maintenance programs; for private bushfire shelters.

Appendix E presents an outline of requirements in each State and Territory.

#### 4.3 Publications

Various publications containing information that may be assistance to designers or relevant authorities are listed below -

- Victorian Building Commission - Bushfire Bunker Information Sheet
- Government of South Australia - Cautionary Note. Bunkers/Shelters
- Literature Review of Bushfire Construction Materials and Proposed Test Protocol for performance Assessment – Warrington Laboratories 2002
- Bushfire Impact from a House's Perspective - A background support document for ongoing work in the Bushfire CRC J.E. Leonard, R. Bianchi, P.A. Bowditch. CSIRO
- International Fire Engineering Guidelines Edition 2005. ISBN 1741 614 562
- Wood Products Victoria Ltd - Timber framed housing in bushfire prone areas
- Standards Australia's Handbook HB 330



- The Complete Bushfire Safety Book 3rd edition, Joan Webster 2000.

Various references to relevant literature are also made throughout the text of the Standard.



## 5 Informative Appendix C

### 5.1 Model Design Process

An optional model design process is presented below. The model process is offered as a simple checklist of components of a possible design process and may not be sufficiently comprehensive for complex designs.

The concepts and provisions outlined in this model design process are not intended to be used for the design of Class 1a dwellings located in designated bushfire-prone areas.

#### **Step One – Selection of bushfire attack level (BAL)**

An assessment of the bushfire attack level (BAL) is undertaken in accordance with Section 2 of AS 3959 (2009). This assessment will determine two critical factors relating to the design of a private bushfire shelter, i.e. the expected duration of the bushfire and the bushfire intensity.

#### **Step Two – Determine duration of occupation**

The time for occupation is made up of a number of factors –

- (a) the pre-bushfire attack time when people access the private bushfire shelter; prepare themselves and wait for the bushfire;
- (b) the duration of the bushfire attack; and
- (c) the period of consequential fire events from other sources (structures and the like) and when people assess conditions outside and determine an appropriate time to safely leave the private bushfire shelter.

#### **Step Three - Determine requirements for tenability**

Having determined the time for occupation and knowing the design number of occupants, the requirements to maintain tenable conditions can be determined depending on the following –

- (a) temperature rise, this will be a combination of –
  - I. heat from the fire entering the private bushfire shelter (largely determined by the level of insulation provided by the construction materials);
  - II. heat build-up from the occupants themselves; and
- (b) air supply – the volume of air required in the private bushfire shelter for the design number of occupants;



- (c) smoke – the private bushfire shelter should be sufficiently sealed against the entry of smoke in order to minimise air contamination and maintain reasonable visibility; and
- (d) thermal mass of the shelter.

#### **Step Four – Determine other design requirements**

Depending on the location of the private bushfire shelter it may be required to resist the following structural actions –

- (a) earth pressure;
- (b) wind loads for an Annual Probability of Exceedance of 1:2000;
- (c) vehicular loads where appropriate;
- (d) impact resistance to falling debris (branches, building elements); and
- (e) aerial water bombing.

#### **Step Five – Determine construction materials**

Construction materials can now be selected on the basis of –

- (a) fire-resistance level (FRL); or
- (b) resistance to structural loads; or
- (c) testing to AS 1530.8.1; or
- (d) testing to AS 1530.8.2; and
- (e) low toxicity emission materials.

#### **Step Six – Determine appropriate design details**

Once the basic construction has been determined, a number of design details need to be considered –

- (a) visibility – e.g. a small view window to allow assessment of external condition;
- (b) smoke seals on doors, service penetrations and other such openings;
- (c) lighting and communication; and
- (d) drainage.



## 6 Informative Appendix D

### 6.1 NFPA Fire Safety Concepts Tree

To provide a perspective of the role of private bushfire shelters and to provide an understanding of where they may fit within a broader 'Bushfire Risk Management Strategy', use has been made of the National Fire Protection Association (NFPA) Fire Safety Concepts Tree<sup>10</sup>. The concepts tree can also be used to analyse the potential impact of private bushfire shelters and to identify parameters that are critical in order for a shelter to realise its life safety objectives.

The Fire Safety Concepts Tree includes a series of logic gates i.e. "or" and "and" gates.

An "or" gate indicates that any one of the concepts below will cause, or have as an outcome, the concept above it. Therefore, only one concept below the gate would need to be implemented to achieve the desired outcome if the system was 100% reliable. However in practice no systems are 100% reliable and in a robust design a number of concepts below an "or" gate will be implemented to improve the holistic reliability of the strategy.

An "and" gate indicates that all the concepts below are needed to achieve the concept above it. This means that if one of the concepts below the gate is not achieved the concept above would not be met. Therefore, it is critical to maximise the reliability in achieving all the concepts below an "and" gate.

Figure 1 shows the upper part of the Fire Safety Concepts Tree. The dark blue boxes indicate concepts that relate to private bushfire shelters. The objective of private bushfire shelters considered in the Standard is the life safety of occupants.

As Figure 1 shows the objective of life safety (primary concept) can be achieved by either preventing ignition or managing the impact of the fire. The concept of preventing ignition relates predominately to land management/planning, education and policing since a significant number of ignitions are caused by some form of human action or involvement. This branch of the fire safety

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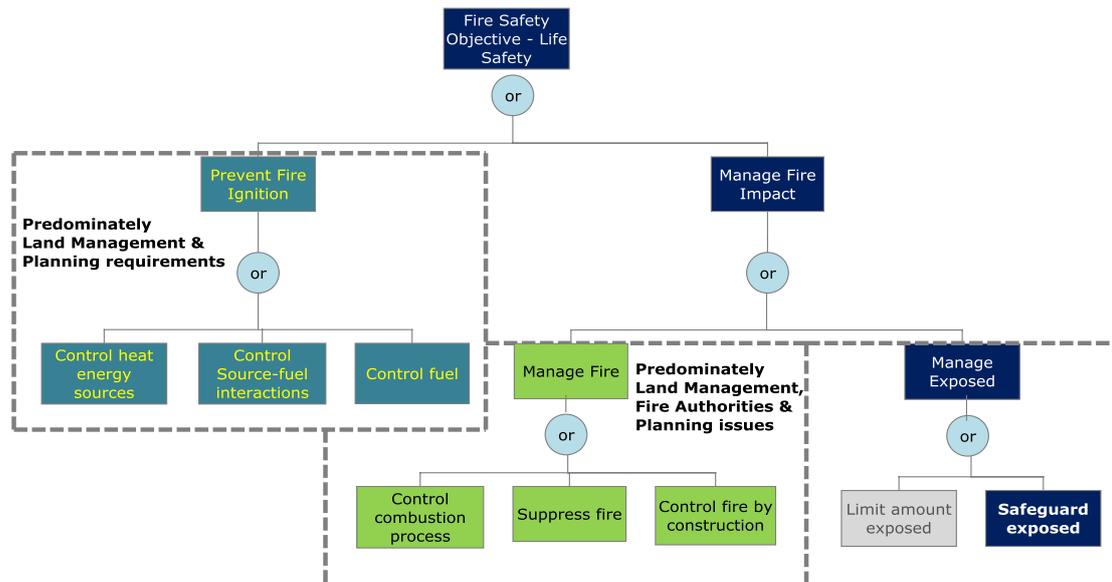
<sup>10</sup> NFPA 550 Guide to the Fire Safety Concepts Tree 2007 edition National Fire Protection Association. USA 2007

concepts tree has not been expanded further since it does not relate to the design and construction of private bushfire shelters.

The impact of a fire can be managed by either 'managing the fire' or 'managing the exposed'. The 'manage fire' branch again relates to land management/planning issues and fire fighting operations.

The control of fire by construction concept in the context of this branch generally refers to barrier systems within buildings to limit fire spread within a building and therefore has little direct relevance to bushfires. The 'manage fire' branch of the Fire Safety Concepts Tree has therefore not been expanded but it should be noted that local management of fire by for example vegetation management on an allotment could and should be a consideration with respect to the potential exposure of a private bushfire shelter and paths of travel to a shelter.

**Figure 1 Upper Branches of the Fire Safety Concepts Tree**



There are two options to satisfy the concept of 'managing the exposed', i.e. 'safeguard the exposed' or 'limit the amount exposed'. Limiting the amount of people exposed relates to planning restrictions (limiting development in high risk areas) and preventing access to high risk areas during a bushfire emergency and is not relevant to the construction of private bushfire shelters.

The 'Safeguard Exposed' branch relates directly to private bushfire shelters and has been expanded in Figure 2. Since private bushfire shelters may not be part

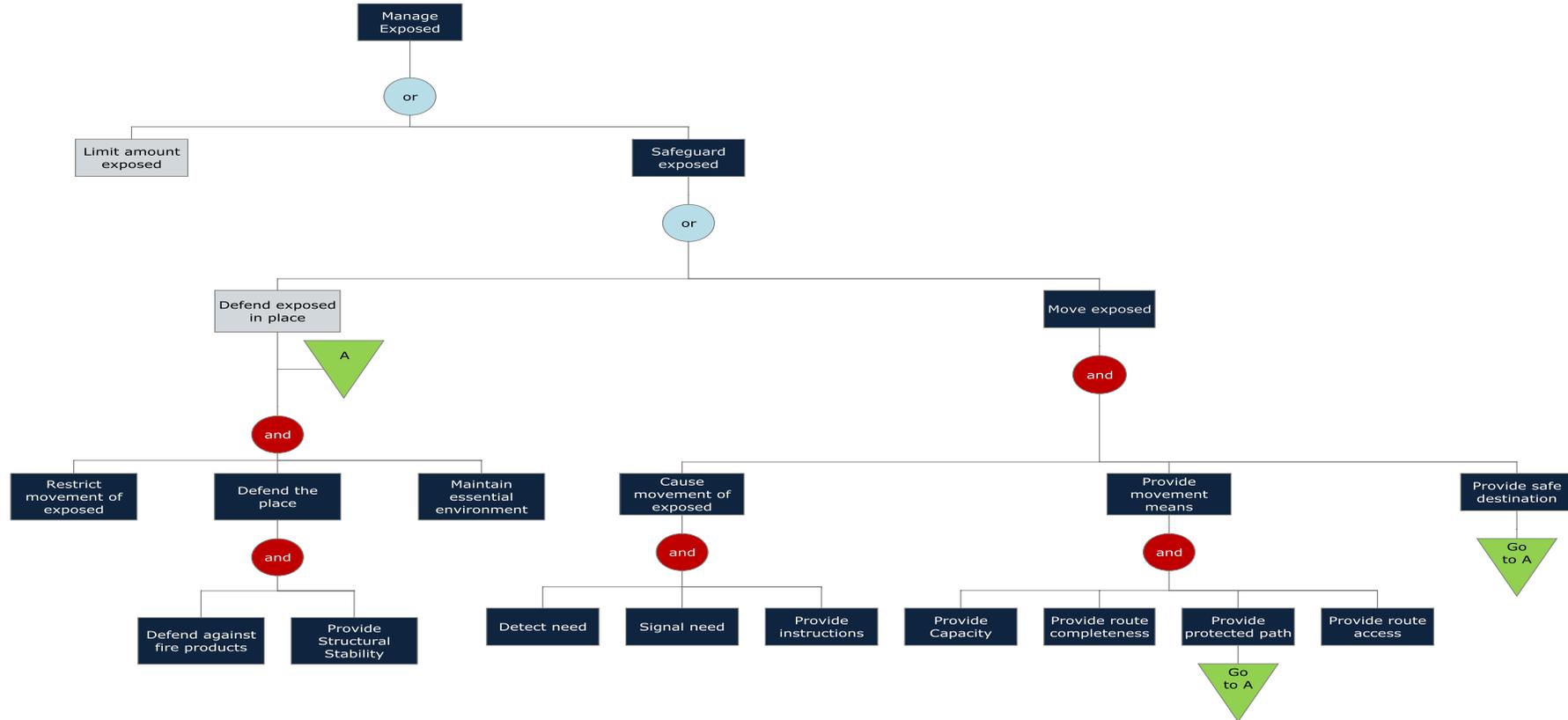


of a building the 'Move Exposed' branch is the most relevant with the private bushfire shelter intended to satisfy the concept of the provision of a safe destination. The safe destination requires the same concepts to be considered as a 'defend in place strategy' but in addition it is necessary to satisfy both the "Cause movement of exposed" and "Provide movement means" concepts.

The 'move exposed' branch can also be applied to the concept of community shelters/safe places and the 'evacuate early' strategies, which lie outside the scope of this standard.



Figure 2 - Expansion of the Manage Exposed branch of the Fire Safety Concepts





## **7 Informative Appendix E**

### **7.1 Summary of State and Territory Advice**

#### **7.1.1 Introduction**

This Appendix presents an outline of State and Territory advice on requirements for the design and construction of private bushfire shelters in the respective jurisdictions. It is recommended that confirmation of this advice is sought from relevant authorities prior to commencement of the design process.

#### **7.1.2 Australian Capital Territory**

In the ACT construction of bunkers or shelters is regulated primarily under the Building Act 2004, and the Planning and Development Act 2007. Those Acts are ACT laws, but they also apply in Jervis Bay Territory. Other ACT laws and Commonwealth laws might also apply in addition to, or instead of, ACT laws.

Under the Building Act 2004, certain building work, including bunker or shelter construction, alteration or demolition, must only be done in accordance with the statutory approval process set out in that Act, which includes requirements for compliance with the BCA. Under that Act it is unlawful to occupy or use certain buildings, including certain bunkers and shelters, unless a relevant certificate permitting that occupancy or use has been issued under that Act, for the bunker or shelter. However, regulations made under the Building Act prescribe when all or part of a building, or building work, is exempt from that Act in whole or in part. Certain, but not all, class 10 buildings are included in those exemptions, subject to the prescribed parameters and limitations of the exemption provisions.

Under the Planning and Development Act 2007, certain development of land, including bunker or shelter construction, alteration or demolition, must only be done in accordance with the development approval process set out in that Act. The process covers design, siting, land use, lease, heritage, tree protection, urban planning, environmental impact, neighbourhood impact and other matters. However, regulations made under the Planning and Development Act prescribe when all or part of a development is exempt from that Act, in whole or in part. Certain, but not all, class 10 buildings are included in those exemptions, subject to the prescribed parameters and limitations of the exemption provisions.



If a proposed bunker or shelter does not meet the relevant exemption parameters and limitations, construction, alteration, demolition, occupation and use must comply with all relevant provisions of the above-mentioned laws.

ACT laws are available at: [www.legislation.act.gov.au](http://www.legislation.act.gov.au). Further advice on building in the ACT is available from [www.actpla.act.gov.au](http://www.actpla.act.gov.au). The above information is subject to change.

### 7.1.3 New South Wales

#### 7.1.3.1 *Overview of legislation in NSW - application of the BCA*

The Environmental Planning and Assessment (EP&A) Act 1979 and EP&A Regulation 2000 reference the Building Code of Australia (BCA) as the technical standard for the design and construction of new buildings and new building work. The application of the BCA is to work that requires a development application (DA) or a complying development certificate (CDC). Under State Environmental Planning Policy (SEPP) Exempt and Complying Development Codes 2008 (the 'Codes SEPP'), work that is categorised as exempt development must also comply with the BCA.

The version of the BCA that is applicable to any building work is the one in force at the time the construction certificate (CC) or CDC is applied for. (See EP&A Regulation 2000 clauses 136A and 145).

#### 7.1.3.2 *Developments on bushfire prone land*

Before granting consent for development on bushfire prone land (other than certain subdivisions), section 79BA of the EP&A Act requires a consent authority to –

- (a) be satisfied that the development conforms with Planning for Bushfire Protection, produced by the NSW Rural Fire Service; or
- (b) consult with the Commissioner of the NSW Rural Fire Service, concerning measures to be taken to protect from the dangers of bush fire.

In addition, a bushfire safety authority issued under Section 100B of the Rural Fires Act 1997 must be obtained for subdivision of bush fire prone land that could lawfully be used for residential or rural residential purposes, or development of bush fire prone land for a special fire protection purpose.



Currently, the option of complying development on bushfire prone land is excluded under the following provisions:

- (a) The Codes SEPP, Clause 1.19(5) specifies land exemptions for the General Housing Code - clause 1.19(5)(e) states that to be complying development, it must not be carried out on land that is bush fire prone land; and
- (b) Section 100B of the Rural Fires Act states that development under that section is not complying development for the purposes of the EP&A Act.

Note: A policy amendment to permit some complying development on some bushfire prone land is being developed for a staged implementation, the first in the middle of 2010 and the second towards the end of 2010. Check the Department of Planning's website for further information on the Codes SEPP regarding this matter - [www.planning.nsw.gov.au/housingcode](http://www.planning.nsw.gov.au/housingcode)

The construction or installation of a private bushfire shelter on bushfire prone land must comply with the relevant processes described above and any other requirements under the applicable environmental planning instrument.

A private bushfire shelter is likely to require a DA and compliance with section 79BA of the EP&A Act.

For the full text of above mentioned legislation, refer to [www.legislation.nsw.gov.au](http://www.legislation.nsw.gov.au)

#### **7.1.4 Northern Territory**

Northern Territory has no legislation that regulates the use of or requires maintenance of private bushfire shelters.

#### **7.1.5 Queensland**

The Building Act 1975 (BA) and Sustainable Planning Act 2009 (SPA) are the two principal Acts under which most building work in Queensland is controlled. The construction of a private bushfire shelter is defined as building work under the BA. Under the BA, all building work is assessable unless it is prescribed under schedules 1 or 2 of the Building Regulation 2006 (BR) as self-assessable or exempt.

All assessable building work must be assessed for compliance with the relevant regulations, codes and standards referenced in the BA, and approved by either a local government or private building certifier. The construction of a private



bushfire shelter would generally be assessable, and therefore require assessment and approval under the provisions of the BA. However, if the work is of a size and configuration set out schedules 1 or 2 of the BR, it may be self-assessable or exempt.

Self-assessable building work must still comply with all relevant regulations, codes and standards referenced under the BA, but do not require a building development approval from a local government or private building certifier. If the building work is exempt, there are no requirements for it to be approved or constructed in accordance with any regulations, codes or standards.

#### **7.1.6 South Australia**

Council development plans under the Development Act 1993 identify Bushfire Protection Areas as having either a General, Medium or High risk. Some townships are also identified as “excluded”.

The applicable planning and building assessment processes that are determined by the level of risk for the particular site of the proposed development work.

Applications for Development Plan Consent are assessed against the planning policies contained in the Development Plan for the relevant Council, or may be complying development under the Development Regulations 2008. In High risk areas an application must be referred to the Country Fire Service (CFS) for comment and the CFS have the power to issue directions to the council on how the application is to be dealt with.

Applications for Building Rules Consent are assessed against the technical requirements of the Building Rules.

The technical requirements for Bushfire Protection Areas are contained in the Building Code of Australia (SA variation), the South Australian Housing Code and Minister’s Specification SA 78.

A site assessment to AS 3959-2009 is not required in General and Medium risk areas but is required in High risk areas for determining the Bushfire Attack Level and construction requirements.

#### **7.1.7 Tasmania**

Private bushfire shelters are Class 10 buildings and require a building permit.



### **7.1.8 Victoria**

Victoria has regulated for the construction of private bushfire shelters through amendment to the Building Regulations 2006. The Building Amendment (Private Bushfire Shelter Construction) Interim Regulations 2009 came into operation on 11 November 2009. The Regulations amend the Building Code of Australia 2009 as it applies in Victoria.

The amending Regulations classify a private bushfire shelter as a Class 10c building; introduce a Functional Statement (F2.3.4A) and a Performance Requirement (P2.3.4A). The Regulations also limit the circumstances where a relevant building surveyor can issue a building permit for the construction of a Class 10c building. These are where a Class 10c building design has received an accreditation from the Building Regulations Advisory Committee or CodeMark, a performance determination from the Building Appeals Board, or the design has been certified by a registered fire safety engineer who did not prepare the design.

### **7.1.9 Western Australia**

Western Australia has no legislation that regulates the use of or requires maintenance of private bushfire shelters.

The Building Regulations 1989 require every builder intending to construct a building (including a private bushfire shelter), to submit an application to the local government for a building license.

Applications should be accompanied by detailed drawings and specifications so that the compliance with relevant building regulation can be assessed. The Regulations give the building surveyor the power to require any other information necessary to establish compliance.

When determining compliance, a building surveyor will rely upon certification by a competent person that certain aspects of the private bushfire shelter comply with relevant standards.



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