

# ADDENDUM: APPENDIX 3

# planning for bush fire protection protection



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## Appendix 3

### Site Bush Fire Attack Assessment

#### A3.1 Introduction

This Appendix provides clarification on the use of AS3959-2009 as referenced in the Building Code of Australia (BCA) 2010.

Effective 1 May 2010, this document replaces Appendix 3 of *Planning for Bush Fire Protection 2006* (PBP) and is not to be used in isolation of the other components of PBP.

All development on bush fire prone land in NSW should comply with the requirements of this Appendix and other bush fire protection measures identified within PBP. Any reference in PBP to AS3959-1999 should be taken to be a reference to AS3959-2009. In addition, RFS documents that are provided as interpretations and clarification of issues related to PBP need to be considered as part of the application.

This Appendix forms an interim amendment to PBP to clarify the NSW development approval process in regards to bush fire protection and its relationship to AS3959-2009 as adopted in the BCA. A comprehensive review and revision of PBP will consider the findings of the Final Report of the 2009 Victorian Bushfires Royal Commission and any subsequent resulting changes to AS3959.

#### A3.2 Application

In NSW, the BCA bush fire protection provisions are applied to (via a NSW State variation to the BCA) Class 1, 2, 3 buildings, Class 4 parts of buildings, some Class 10 structures and Class 9 buildings that are Special Fire Protection Purposes (SFPPs).

The site assessment methodology covered in this Appendix applies for determining the construction requirements for buildings in a designated bush fire prone area. Appendix 2 of PBP addresses APZ requirements for subdividing land so that development flexibility is provided and future buildings can be built without theoretical exposure to potential flame contact. The APZ requirements for SFPP Developments are also covered in Appendix 2.

The methodology and criteria in this Appendix should not be applied in conjunction with the requirements found in Appendix 2 of PBP. The Asset Protection Zone (APZ) distances in Appendix 2 and the building construction requirements in this Appendix are separate processes and although complementary should be considered individually.

Generally, bush fire construction requirements do not apply under AS3959-2009 to buildings located more than 100 metres away from a bush fire hazard.

#### A3.3 PBP Compliance Approaches

Compliance with this Appendix is achieved on an Acceptable Solution (Deemed-to-satisfy (DTS)) or Alternative Solution basis by complying with the DTS provisions of the AS3959-2009 Tables 2.4.2, 2.4.3, and 2.4.4 or the methodology in section A3.4 as follows respectively.

In this regard any deviation from the requirements in AS3959-2009 Tables 2.4.2, 2.4.3, and 2.4.4 is considered an Alternative Solution in terms of PBP.

#### A3.4 Alternative Solution approach to site assessment: radiant heat flux and required separation distances

*There are a number of basic concepts underpinning the requirements of PBP. Each is briefly described below:*

##### (a) Radiant heat flux and fire intensity

*Fire intensity is the rate of heat release, per unit length of the fire front, measured in kilowatts per metre (kW/m). It is a function of the heat content and weight of the fuel and the rate of spread of the fire. Radiant heat flux is a measure of heat energy impacting on a surface (kW/m<sup>2</sup>).*

##### (b) Fuel loads

*Fuel is any organic matter available for ignition and combustible components include leaves, twigs, bark and residue (J. Gould, 2003). Fuel load is a measure (tonnes per hectare) of the accumulated vegetative matter available to a bush fire.*

*Fuel assessment methodology must be agreed to by the NSW Rural Fire Service (RFS). For the purposes of fuel assessment, the Natural Resources and Environment 'Overall Fuel Hazard Guide' (1999) is currently the methodology accepted by the RFS.*

*Determination of the protection measures required, is based on an estimation of the maximum hazard which, in turn, is based on maximum possible fuel loads likely to occur on and adjacent to the development site.*

## (c) Flame zone

The following definition shall supersede the definition in the dictionary section of PBP 2006 for the purposes of alternative solutions (page 73) in relation to this Appendix.

The distance from a bush fire at which it is calculated for the purposes of this document that there is significantly increased likelihood for flame contact to a building. Determined by the calculated distance at which the radiant heat received by the proposed building exceeds  $40\text{kW/m}^2$  or calculated by the point of potential flame contact, whichever occurs first.

Flame contact is the potential for intermittent impact of direct flame upon a surface and generally occurs at or above  $29\text{kW/m}^2$ .

Flame length will vary (short/long) depending on vegetation type, wind and slope. Minimum defensible space and APZ requirements reflect flame length/ zone calculations.

Given the significant risk associated with developments in the flame zone and the complexity of the protection measures required, the RFS for the purposes of life safety, cannot support a 'one-size-fits-all' deemed-to-satisfy solution for buildings in the flame zone. To support this, the BCA has established a NSW variation that excludes AS3959 Section 9 Construction for Bushfire Attack Level FZ (BAL-FZ).

Class 1, 2, 3 or 4 (part) buildings not being a Special Fire Protection Purpose subject to BAL-FZ require an Alternative Solution and referral to the RFS for consideration under section 79BA of the Environmental Planning & Assessment Act 1979. Some class 10 buildings may also be referred under these provisions.

## (d) Determining appropriate hazard parameters

A robust hazard assessment for habitable building development must quantify, for different vegetation types, the parameters of fire attack (embers, radiant heat, flame contact and wind) that damage or destroy buildings. This system must relate these parameters to threshold values of vulnerable components of buildings (CSIRO, 2000).

Determining appropriate hazard parameters requires measurements or models to describe:

- components of structures, the threshold values for radiant heat flux and their duration;
- the flame characteristics of temperature, emissivity and hence radiant heat flux at the flame;
- different vegetation types, the flame height and width of flame-front and flame duration

for high intensity bush fires as they reach the edge of vegetation; and

- the value for radiant heat flux as a function of distance from walls of flame of different dimensions. (see CSIRO, 2000)

In 2004, the RFS developed a model which related hazard parameters to various building components. This model has been used as a basis for developing the following methodology. Table A3.4.2 of this Appendix can and should be used for determining the likely radiant heat flux on a building and hence which bushfire attack level from AS3959-2009 is appropriate in the particular circumstance.

The methodology is based on radiant heat flux derived for 12 vegetation formations (10 sub-formations), six slope classes and appropriate regional weather conditions and applied to different construction standards.

For building elements subject to radiant heat flux of greater than  $29\text{kW/m}^2$ , the use of exposed timber is generally not suitable without specific testing in accordance with suitable protocols.

The distances below can be considered on the basis of the various elements of a building when subject to heat, flames and ember attack. Extensive ember attack can occur beyond 100 metres ahead of a bush fire, however, distances are limited to a maximum of 100 metres for class 1, 2, 3 and Class 4 parts of buildings, some Class 10 structures and Class 9 buildings that are SFPP.

Figure A3.4.1 and Table A3.4.1 summarise the relationship between radiant heat flux and required separation (APZ) distances.

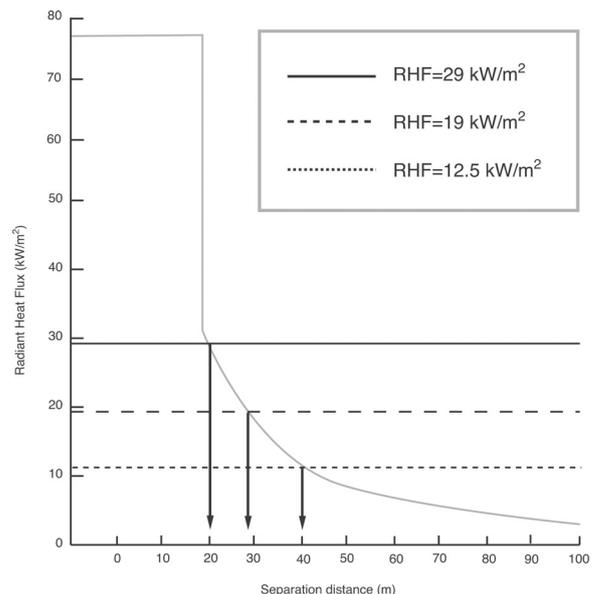


Figure A3.4.1 Sample illustration of radiant heat dynamics. Distance graph of forest for FDI = 100 ( $0^\circ$  Slope).

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Table A3.4.1 Radiant heat flux and effects on buildings and people for a modeled forest fire (FDI 100 on flat ground)

Radiant Heat Flux	Likely Effects	Approx. Distances
2.1 kW/m <sup>2</sup>	Unprotected person will suffer pain after 1 minute exposure – non fatal.	140 metres
3 kW/m <sup>2</sup>	Hazardous conditions. Firefighters expected to operate for a short period (10 minutes)	100 metres
4.7 kW/m <sup>2</sup>	Extreme conditions. Firefighter in protective clothing will feel pain. (60 seconds exposure)	70 metres
7 kW/m <sup>2</sup>	Likely fatal to unprotected person after exposure for several minutes	55 metres
10 kW/m <sup>2</sup>	Critical conditions. Firefighters not expected to operate in these conditions although they may be encountered. Considered to be life threatening < 1 minute in protective equipment. Fabrics inside a building could ignite spontaneously with long exposures.	45 metres
12.5 kW/m <sup>2</sup>	Standard float glass could fail (BAL-12.5 construction) during the passage of a bush fire. Some timbers can ignite with prolonged exposure and with piloted ignition source (e.g. embers).	40 metres
19 kW/m <sup>2</sup>	Screened float glass could fail (BAL-19 construction) during the passage of a bush fire.	27 metres
29 kW/m <sup>2</sup>	Ignition of most timbers without piloted ignition (3 minutes exposure) (BAL-29 construction) during the passage of a bush fire. Toughened glass could fail.	20 metres
>29 – 40 kW/m <sup>2</sup>	<i>Potential flame contact and increased radiant heat and ember attack.</i>	15 - 20 metres
>40 – 110 kW/m <sup>2</sup>	<i>Significant higher likelihood of flame contact. Coupled with the radiant heat and increased ember attack is a significant risk to most structures and building materials.</i>	0 - 15 metres

**Note:** Assumes flame temperature of 1090K for all scenarios.

In general, a deemed-to-satisfy outcome can be achieved where the building is exposed to a radiant heat flux of less than or equal to 40 kW/m<sup>2</sup> (BAL-40). There is no deemed-to-satisfy for construction in the **Flame Zone**. Applicants need to consider the Performance Requirements of the BCA and the Specific Objectives of PBP for the type of building constructed.

The level of construction cannot fall to less than BAL-12.5 construction where any part of the building is closer than 100 metres to the source of bush fire attack (unless otherwise provided for).

An elevation is exposed if there is a direct line of sight from any part of that elevation to the source of the bush fire attack (excluding fencing and other minor obstructions).

*Construction should not proceed where the proposed building has been identified as being at unacceptable risk because of any of the following:*

- *It is located within the BAL-FZ and sufficient defensible space is not provided to protect the structure;*
- *there is no safe escape route for the building occupants and firefighters likely to be involved in protecting the building and its occupants during a bush fire.*

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The following table shows the bush fire attack levels under AS3959-2009.

Table A3.4.2 Radiant heat flux exposure and appropriate Bush Fire Attack Levels (BALs)

Heat Flux Exposure	Description	AS3959-2009 Construction Level
N/A	Minimal attack from radiant heat and flame due to the distance of the site from the vegetation, although some attack by burning debris is possible. There is insufficient threat to warrant specific construction requirements.	Bush Fire Attack Level – Low (BAL-LOW)
≤12.5	Attack by burning debris is significant with radiant heat (not greater than 12.5 kW/m <sup>2</sup> ). Radiant heat is unlikely to threaten building elements (eg unscreened glass). Specific construction requirements for ember protection and accumulation of debris are warranted.	Bush Fire Attack Level – 12.5 (BAL-12.5)
>12.5 ≤19	Attack by burning debris is significant with radiant heat flux (not greater than 19 kW/m <sup>2</sup> ) threatening some building elements (screened glass). Specific construction requirements for embers and radiant heat are warranted.	Bush Fire Attack Level – 19 (BAL-19)
>19 ≤29	Attack by burning debris is significant and radiant heat flux (not greater than 29 kW/m <sup>2</sup> ) threaten building integrity. Specific construction requirements for ember and higher radiant heat are warranted. Some flame contact is possible.	Bush Fire Attack Level – 29 (BAL-29)
>29 ≤40	Radiant heat flux and potential flame contact could threaten building integrity.	Bush Fire Attack Level – 40 (BAL-40)
>40	Significant radiant heat and significant higher likelihood of flame contact from the fire front will threaten building integrity and result in significant risk to residents.	Bush Fire Attack Level – Flame Zone (BAL-FZ)

*Note: Attack from burning debris increases with the bush fire attack level.*

*An Alternative Solution will be required if the building exceeds the specification of BAL-40 of AS 3959 (ie >40 kW/m<sup>2</sup>) in which case it is considered to be within the 'Flame Zone'. NSW has made a State based variation to the BCA. This variation excludes BAL-FZ as a deemed-to-satisfy solution.*

The following subsection describes how to determine the appropriate bush fire attack level.

## A3.5 Site assessment methodology for determining level of bush fire attack

*This general method has been used to determine the bush fire attack level using NSW data. This provides a more refined bush fire attack site assessment.*

*The methodology was developed (see Douglas and Tan, 2005) from the following inputs:*

- *the relevant weather scenario for the fire weather district in NSW (see inside rear cover and Table A2.3)*
- *vegetation types and the corresponding fuel types present were determined (see Table A2.1)*
- *the appropriate fuel loads for the fuel types were used for input into fire behaviour models*
- *the fire-line intensity (kW/m) for a range of slope and distance combinations was calculated*

- *the sustained flame length was calculated and a flame temperature of 1090K was applied*
- *distance classes for radiant heat flux for 12.5 kW/m<sup>2</sup>, 19 kW/m<sup>2</sup>, 29 kW/m<sup>2</sup> and 40kW/m<sup>2</sup> were determined using the View Factor model*
- *based on the calculated fire behaviour, the level of bush fire attack (BAL 12.5, 19, 29 and 40) corresponding to the relevant radiant heat flux on the proposed building was then determined.*

*This procedure is based upon the generic method described above and uses the weather scenario of an appropriate Forest Fire Danger Index (FFDI) (for forest fuels), wind speeds of 45kph and typical fuel loads for NSW vegetation experienced during a severe bush fire in NSW.*

*For the purposes of this Appendix, a flame temperature of 1090K has been adopted when calculating the level of bush fire attack to building elements. 1090K reflects the standard used for flame temperature for determining requirements for buildings other than for Special Fire Protection Purpose Developments.*

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*When calculating APZ distances for Special Fire Protection Purpose Developments (Table A2.6) a 1200K flame temperature was adopted. This higher flame temperature is used for developments where occupants are considered more vulnerable to reflect a higher degree of conservatism, the key design consideration for SFPP developments.*

To determine the required level of construction for a building the following steps must be followed:

**Step 1: Determine vegetation** formation types and sub-formations around the building (see Appendix 2), as follows:

- (i) Identify all the vegetation types within 140 metres of the site using Keith (2004);
- (ii) Classify the vegetation formations as set out in Table A2.1 in Appendix 2; and
- (iii) Convert Keith to Specht classifications using Table A3.5.1 below.

*AS3959-2009 as referenced in the BCA-2010 uses AUSLIG (1990) vegetation classifications while PBP uses Keith.*

**Step 2: Determine the distance** between each vegetation formation identified (from the edge of the foliage cover) and the building.

**Step 3: Determine the effective slope** of the ground for each vegetation group (see Appendix 2) using the classes provided below.

Slopes are classified as follows:

- (i) Upslopes are considered to be 0°.
- (ii) Greater than 0° but not greater than 5° downslope.
- (iii) Greater than 5° but not greater than 10° downslope.
- (iv) Greater than 10° but not greater than 15° downslope.
- (v) Greater than 15° but not greater than 20° downslope.

**Step 4: Determine the relevant FDI** for the council **area** in which the development is to take place from Table A2.3 in Appendix 2. For Alpine Resorts see Step 5 below.

**Step 5: Match the relevant FDI, appropriate vegetation, distance and effective slope classes** to determine the bush fire attack levels using the relevant tables of AS3959-2009 as indicated below:

- FDI 100 -Table 2.4.2
- FDI 80 - Table 2.4.3
- FDI 50 - Table 2.4.4

Note: A building with any facade identified as requiring a construction level must build all facades to at least BAL-12.5. Where more than one facade is exposed to a hazard, then the facade with the highest construction requirement is used to determine the appropriate level of construction. All other facades may be reduced by one level of construction unless that facade is also subject to the same bush fire attack level.

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Table A3.5.1 – Conversion of vegetation classification from David Keith's *Ocean Shores to Desert Dunes* (used in PBP) to the AUSLIG Pictorial Analysis in AS3959-2009. This conversion is based on what is considered the best representation of similar bush fire behavior potential.

David Keith's <i>Ocean Shores to Desert Dunes</i>	AUSLIG (1990) Pictorial Analysis (AS3959-2009)
Forests (Wet & Dry Sclerophyll)	Forest
Pine Plantations	
Forested Wetlands	
Woodlands (Grassy, Semi-Arid)	Woodland
Tall Heath (Scrub)	Scrub
Freshwater Wetlands	
Short Heath (Open Scrub)	Shrubland
Arid Shrubland	Mallee/Mulga
Alpine Complex (Sedgeland)	Tussock Moorland
Rainforest	Rainforest
Grassland	Grassland

For the purposes of Table A2.6 in Appendix 2, the requirements for Alpine Resorts should be developed using Table 2.4.4 of AS3959-2009. Generally, most development applications within the Alpine Resorts consist of alterations and additions to existing buildings and therefore would be treated as infill development. Developments involving new leases or new alpine resorts must contact the RFS to determine the APZ requirements.

### A3.6 Construction Considerations within the Flame Zone

There is potential for flames to ignite the external facade of a building which can continue to burn after the passage of the fire front. Therefore some degree of conservatism in relation to the exposure period is appropriate.

In NSW there are no recognized deemed-to-satisfy arrangements for construction of buildings within the Flame Zone. Where sustained flame contact is likely, the radiant heat and convective heat exposures are considerable and overwhelms most materials.

While AS3959 can be used as a guide to improve building safety, this is subject to additional control measures not included in this document. The design and construction of a building is just one means of mitigating the bush fire risk and will normally require supplementation by a range of other mitigation measures to the satisfaction of the authority having jurisdiction. The extent of additional measures required will be dependent upon the bush fire hazard and its proximity to the buildings. In addition to the construction requirement of AS3959, applicants should also address the Performance Requirements of the BCA and consider the siting and the design principles in Section 4.3.5 of PBP.

Where new testing regimes are developed and deemed appropriate by the NSW Rural Fire Service, these may be incorporated as part of

the process of developing alternative solutions. Alternative solutions will be considered on their merits.

### A3.7 Additional Construction Requirements

Planning for Bush Fire Protection is designed to provide for improved bush fire protection outcomes through the planning system, whereas the construction requirements are established through the operation of the BCA. However, based on a review of AS3959-2009 and recent developments through the interim findings from the Victorian Royal Commission, the RFS has concerns over the levels of safety for ember protection at lower BAL levels (BALs 12.5 and 19) provided by AS3959-2009. The RFS is concerned that by adopting the new Standard there would be a reduction in safety created from that afforded by the previous NSW application of AS3959-1999 in relation to ember protection. In this regard, the RFS will aim to maintain the safety levels previously provided by AS3959-1999. In particular, the areas of concern arise from requirements for:

- Sarking
- Sub floor screening
- Floors
- Verandas, Decks, Steps, Ramps And Landings

In addition, in order to provide a suitable combination of bush fire protection measures the NSW Rural Fire Service will, as part of the planning assessment process, recommend / require additional construction requirements beyond those prescribed in AS3959-2009 as deemed appropriate.

Planning requirements for grasslands are contained within the main body of PBP.

As part of the planning requirements, the following will create part of the suite of protection

measures required to form compliance with *Planning for Bush Fire Protection*.

## SARKING

Any sarking used for BAL-12.5, BAL-19, BAL-29 or BAL-40 shall be:

- a. Non-combustible; or
- b. Breather-type sarking complying with AS/NZS 4200.1 and with a flammability index of not more than 5 (see AS1530.2) and sarked on the outside of the frame; or
- c. An insulation material conforming to the appropriate Australian Standard for that material.

## SUBFLOOR SUPPORTS

For BAL-12.5 and BAL-19, Clause 5.2 and 6.2 shall be replaced by the provisions of Clause 7.2. In this regard, Clause 7.2 states:

### “7.2 SUBFLOOR SUPPORTS

*This Standard does not provide construction requirements for subfloor supports where the subfloor space is enclosed with—*

- a. *a wall that complies with ..... (Clause 5.4 or 6.4 as appropriate); or*
- b. *a mesh or perforated sheet with a maximum aperture of 2 mm, made of corrosion resistant steel, bronze or aluminium; or*
- c. *a combination of Items (a) and (b) above.*

*Where the subfloor space is unenclosed, the support posts, columns, stumps, piers and poles shall be—*

- (i) *of non-combustible material; or*
- (ii) *of bushfire-resisting timber (see Appendix F); or*
- (iii) *a combination of Items (i) and (ii) above.*

*NOTE: This requirement applies to the principal building only and not to verandas, decks, steps, ramps and landings (see Clause 7.7).”*

## ELEVATED FLOORS

For BAL-12.5 and BAL-19, Clause 5.3 and 6.3 shall be replaced by the provisions of clause 7.3. In this regard, clause 7.3.2 states:

### “7.3.2 Elevated floors

#### 7.3.2.1 Enclosed subfloor space

*This Standard does not provide construction requirements for elevated floors, including bearers, joists and flooring, where the subfloor space is enclosed with—*

- a. *a wall that complies with ..... (Clause 5.4 or 6.4 as appropriate); or*
- b. *a mesh or perforated sheet with a maximum aperture of 2 mm, made of corrosion resistant steel, bronze or aluminium; or*
- c. *a combination of Items (a) and (b) above.*

#### 7.3.2.2 Unenclosed subfloor space

*Where the subfloor space is unenclosed, the bearers, joists and flooring, less than 400 mm above finished ground level, shall be one of the following:*

- a. *Materials that comply with the following:*
  - (i) *Bearers and joists shall be—*
    - A. *non-combustible; or*
    - B. *bushfire-resisting timber (see Appendix F); or*
    - C. *a combination of Items (A) and (B) above.*
  - (ii) *Flooring shall be—*
    - A. *non-combustible; or*
    - B. *bushfire-resisting timber (see Appendix F); or*
    - C. *timber (other than bushfire-resisting timber), particleboard or plywood flooring where the underside is lined with sarking-type material or mineral wool insulation; or*
    - D. *a combination of any of Items (A), (B) or (C) above. or*
- b. *A system complying with AS 1530.8.1*

*This Standard does not provide construction requirements for elements of elevated floors, including bearers, joists and flooring, if the underside of the element is 400 mm or more above finished ground level.”*

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## VERANDAS, DECKS, STEPS, RAMPS AND LANDINGS

For BAL-12.5 and BAL-19, Clause 5.7 and 6.7 shall be replaced by the provisions of clause 7.7. In this regard, clause 7.7 states:

### "7.7 VERANDAS, DECKS, STEPS, RAMPS AND LANDINGS

#### 7.7.1 General

*Decking may be spaced.*

*There is no requirement to enclose the subfloor spaces of verandas, decks, steps, ramps or landings.*

#### 7.7.2 Enclosed subfloor spaces of verandas, decks, steps, ramps and landings

##### 7.7.2.1 Materials to enclose a subfloor space

*The subfloor spaces of verandas, decks, steps, ramps and landings are considered to be 'enclosed' when —*

- a. *the material used to enclose the subfloor space complies with .... **(Clause 5.4 or 6.4 as appropriate)**; and*
- b. *all openings greater than 3 mm are screened with a mesh or perforated sheet with a maximum aperture of 2 mm, made of corrosion-resistant steel, bronze or aluminium.*

##### 7.7.2.2 Supports

*This Standard does not provide construction requirements for support posts, columns, stumps, stringers, piers and poles.*

##### 7.7.2.3 Framing

*This Standard does not provide construction requirements for the framing of verandas, decks, ramps or landings (i.e., bearers and joists).*

#### 7.7.2.4 Decking, stair treads and the trafficable surfaces of ramps and landings

*Decking, stair treads and the trafficable surfaces of ramps and landings shall be—*

- a. *of non-combustible material; or*
- b. *of bushfire-resisting timber (see Appendix F); or*
- c. *a combination of Items (a) and (b) above.*

#### 7.7.3 Unenclosed subfloor spaces of verandas, decks, steps, ramps and landings

##### 7.7.3.1 Supports

*Support posts, columns, stumps, stringers, piers and poles shall be—*

- a. *of non-combustible material; or*
- b. *of bushfire-resisting timber (see Appendix F); or*
- c. *a combination of Items (a) and (b) above.*

##### 7.7.3.2 Framing

*Framing of verandas, decks, ramps or landings (i.e., bearers and joists) shall be—*

- a. *of non-combustible material; or*
- b. *of bushfire-resisting timber (see Appendix F); or*
- c. *a combination of Items (a) and (b) above.*

#### 7.7.3.3 Decking, stair treads and the trafficable surfaces of ramps and landings

*Decking, stair treads and the trafficable surfaces of ramps and landings shall be—*

- a. *of non-combustible material; or*
- b. *of bushfire-resisting timber (see Appendix F); or*
- c. *a combination of Items (a) and (b) above.*

#### 7.7.4 Balustrades, handrails or other barriers

*Those parts of the handrails and balustrades less than 125 mm from any glazing or any combustible wall shall be—*

- a. *of non-combustible material; or*
- b. *bushfire-resisting timber (see Appendix F); or*
- c. *a combination of Items (i) and (ii) above.*

*Those parts of the handrails and balustrades that are 125 mm or more from the building have no requirements."*

