BUSHFIRE CONSTRUCTION

AUSTRALIA
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DESIGN MANUAL






James Hardie®

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1 INTRODUCTION

1.1 GENERAL

This manual is intended to be used as a guide in the design and construction of buildings in bushfire-prone areas. It promotes the successful use of non-combustible fibre cement materials in such buildings. This document contains extensive information provided by CSIRO, the nation's leading authority on bushfire research.

In Australia, bushfires are part of the nation's fabric, however unfortunate or tragic the results may be. These fires are a natural hazard that occur from time to time – particularly in the heat of summer – and can occur anywhere that there is sufficient vegetation to provide fuel. In fact, our vegetation has evolved to rely on bushfire for its very survival. Bushfires, however, can enter suburban areas and cause devastation to life and housing. The design and siting of buildings is therefore of paramount importance, in order to reduce the risk of property damage and loss associated with bushfires.

Forest fuels in Australia are extremely abundant and the heat yield generated by eucalypt forest and scrub fires is significant. Most states in Australia now have some form of planning provisions relating to bushfire-prone areas. Guidelines have been prepared that aid local governments to establish fire hazard ratings for particular local areas.

If you are concerned that you may live in an area prone to bushfire, your local fire brigade is an excellent organisation to contact to gain an understanding of the specific risks.

1.2 BUSHFIRE FIGHTING IN AUSTRALIA

An appreciation of the effort required to fight bushfires in Australia, is gained from the 2002/03 Annual Report of the NSW Rural Fire Service (RFS). It states that there were continuous Section 44 emergencies in NSW for 151 days from 27 September 2002 until 24 February 2003. During that period there were 459 fires with a total perimeter of 10,340 kilometres, resulting in approximately 1.465 million hectares of land being burnt. The fires were fought by RFS personnel assisted by colleagues from Victoria, Tasmania, Queensland, South Australia and Western Australia.

On 18 January 2003, the ACT had its date with bushfire destiny when the city of Canberra and its surroundings were devastated. Apart from the loss of the Mount Stromlo Observatory, the razing of most of the Namadgi National Park and the Tidbinbilla Nature Reserve, more than 30 farms were destroyed. Some 300 cars and 530 houses were lost, with another 800 homes seriously damaged. Losses were estimated at $250 million, a fire bill surpassed only by the 1983 Ash Wednesday fires.

During the disastrous Ash Wednesday fires in South Australia and Victoria in 1983, the Victorian fires alone burnt an area twice the size of metropolitan Melbourne, around 200,000 hectares. The South Australian toll was some 159,000 hectares. In the extremely hot and dry weather conditions, around 180 bushfires broke out on that one day, 16 February 1983, resulting in 75 deaths and destroying about 1,600 homes.

Victorian Department of Sustainability and Environment (DSE) literature states that more than 16,000 firefighters attended the Ash Wednesday fires, including park and forest firefighters and Country Fire Authority volunteers. They were assisted by 1,000 police, 500 defence force personnel and many local residents. Some 400 vehicles (fire-trucks, water tankers and bulldozers), 11 helicopters and 14 fixed wing aircraft were included in the variety of equipment used to fight the fires.

Bushfires are a reality of life on this expansive and dry continent. Being able to live in or near the bush, many Australian residents enjoy a privileged quality of life. And with that, people must grow to accept the associated risks. However, the challenge to the building industry and code writers is to attempt to reduce the risk of ignition during fires, at the same time as not causing undue restriction in the lives of our citizens.

1.3 BUSHFIRE RESEARCH

After every major bushfire since Ash Wednesday in 1983, CSIRO scientists have been sifting through the ashes in search of more clues on what makes a house prone to fire and how such losses might be avoided in the future. The information gathered on topics such as the design and materials of houses and other factors has been progressively incorporated into national standards for buildings in bushfire-prone areas.

The ABC News in Science program on 18 January 2002 quoted the survey coordinator of CSIRO Fire Science & Technology as saying that the research was indicating that the majority of houses destroyed in bushfires actually survive the few minutes of the fire front, only to burn down later due to fire spreading from ignitions caused by wind-borne burning debris. And even then the houses usually burn from the inside out. It is quite obvious that a key challenge is to keep burning embers out.

This finding dispels the widespread community belief, reinforced by the news media, that bushfires move at the speed of express trains, that houses explode into flames and burn down in minutes, and that there is not much that can be done to prevent it. Burning debris can also reach the house some time before the fire front arrives and for many hours after the fire front has passed. People who are therefore able to extinguish these small ignitions can often save their whole house from burning down. According to the CSIRO, however, a few changes to their homes may reduce the chance of ignition in the first place.

Protecting windows, for example, was important since glass often cracked and fell away due to the radiant heat of the fire. While high-tech solutions such as specially treated glass are still being researched, other low-tech options are available such as toughened glass and/or the addition of metal fly screens, which, apart from keeping insects out, could prevent embers from entering the house even if the windows did shatter or were left slightly open.

Horizontal surfaces such as large timber decks are singled out as being particularly vulnerable, with leaves accumulating on bearers beneath the timber slats adding to the risk. Whilst it is acknowledged that replacing a nice timber deck with a suspended concrete slab would not be to everyone's liking, other options include decks without gaps, metal capping on bearers, and decks made of fire-resistant timber.

Survey coordinator, Justin Leonard, told ABC News that the CSIRO is neither saying that a house in bushfire-prone areas should be a concrete bunker, nor that people should forget about living in the bush. The revised Bushfire Standard does not require the house to be significantly different, he believed. "And if having trees close to your house is important to your lifestyle, then you must focus more on the design details of the house," he said, adding that this trade-off was incorporated into national standards.

The National Timber Development Program (NTDP) Technical Report Issue 4 of December 2003 made the following statements about bushfire entry points to buildings:

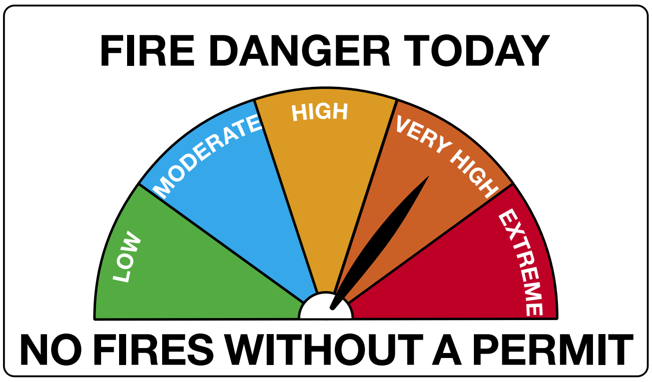
'The heat and wind from the passage of the fire front, and/or fast moving embers, can often cause windows to shatter. Burning embers can then enter the house, and curtains near the windows are an obvious ignition point. Embers may also land in gutters, igniting accumulated dry debris such as dead leaves, or on any part of the building where the design allows accumulation of wind-borne material. This can be roof gulleys, open eaves, or on the ground in narrow corners.

'The wind and the fall of hot debris may crack or remove roof tiles, opening another entry point into an area that is dry and that may contain readily combustible material (insulation). Even ventilation holes and weep holes can be entry points for embers. Wherever possible, they should be covered by fine metal mesh. Vegetation close to or overhanging a house may also trap embers and ignite, making eventual entry of the fire into the house more likely.'

In response to the above, Justin Leonard of the CSIRO has commented that heat, and specifically radiant heat, is the only fire attack mechanism that consistently causes window breakage. He added that no evidence has been found of hot material cracking roof tiles. High winds can lift tiles, however, winds of this intensity are rarely coincident with bushfires. Ash Wednesday was one of the few times that it did occur.

1.4 FIRE DANGER

During the fire season the Bureau of Meteorology each day calculates the maximum fire danger for the day. These fire danger warnings are repeated in the media and shown on fire danger signs along the roadside. The forecasts of fire danger are used by fire authorities across the country to warn the public of bad fire weather. They also use it to determine the level of suppression preparedness needed – that is, the amount of manpower and equipment needed to suppress fires under the prevailing weather conditions.



The CSIRO's Fire Fact of the Month for November 2002 provides the following information on how the fire danger is assessed:

'There are two fire danger rating systems in Australia – one for forest country and one for grassland and pastoral areas. The fire danger classes of **Low, Moderate, High, Very High** and **Extreme** are a rating of the difficulty of suppression of a well-developed fire in each fuel type. At a fire danger of Low, fires either will not burn or spread so slowly that they are very easy to extinguish.'

'At a fire danger of Extreme fires start very easily from sources which, under milder conditions, normally do not start fires, (e.g. from the hot molten metal produced when power lines clash together or from the incandescent carbon particles produced by faulty engine exhausts) and spread so rapidly and fiercely that they are impossible to extinguish unless they are attacked within a few minutes of starting.

Under these conditions, a large number of firefighters are placed on standby ready to be dispatched immediately a fire breaks out so they have a chance of suppressing it before it has developed to its full potential.'

'The fire danger rating systems provide a measure of suppression difficulty based on the prevailing weather and the seasonal conditions of the fuel. The following factors are combined to produce a numerical index:

- The seasonal dryness – this is indicated by a drought index or a soil dryness index for forests or by the degree of curing in grasslands.
- The amount and duration of rainfall.
- The temperature and relative humidity of the air.
- The wind speed.

'Rainfall is not used in calculating grassland fire danger index because the effect of recent rain in open grasslands may evaporate in two or three hours.

'In regions where there are tracts of both forest and grassland, fire authorities calculate both the forest and grassland fire danger and set their fire danger signs according to the system that calculates the highest index. At times, particularly early in the season, these signs may indicate a High fire danger when the surrounding grasslands are still green and obviously will not burn. This is because the forest fuels have already dried out and are quite flammable.

'When the fire danger rating reaches Extreme the fire authorities declare a day of total fire ban when lighting of any fire in the open is prohibited by law. A day of total fire ban normally stays in place for 24 hours but it may be extended for longer periods if fire-fighters are already tied up fighting large fires in the region. In some States, declaration of the total fire ban also prohibits other activities that may start fires such as harvesting operations, welding in the open, operation of chainsaws, etc.'

NOTE: The full document is accessible via the CSIRO Forestry and Forest products website www.ffp.csiro.au/nfm/fbm

1.5 FIRE AND THE LANDSCAPE

The CSIRO's Fire Fact of the Month for January 2003 entitled *'Bushfire in Australia'* provides an interesting insight into the phenomenon, albeit from a more alternative perspective:

'Bushfire has been part of the Australian landscape for millions of years so why can't we learn to live with it? Much of our vegetation has evolved with fire and curiously, like the vegetation in other harsh dry environments, it has developed characteristics that promote the spread of fire. The litter of the eucalypt is coarse and decays slowly ensuring that after several years there will be an abundant build up to carry the next fire. The bark of many species is flammable and loosely attached to the trees making ideal firebrands to carry fire across natural barriers. The green leaves contain highly flammable oils and resins that act as a catalyst to promote combustion before the leaves are fully dry. All the potentials are there and sooner or later, in some part of Australia, weather patterns will occur so that strong hot dry winds will blow from the centre of the continent after the fuel has been preconditioned by drought. All that is needed is a spark to produce a conflagration that simply cannot be stopped until the weather moderates.

'We need to accept fire for what it is – an ecological process that determines the composition of our flora and fauna. Fire is as natural as the sun and the rain. Nothing else can replace it completely. Nothing else produces the chemicals in the ash to stimulate new growth – or in the smoke to stimulate the flowering and regeneration of particular species. Nothing else produces the heat pulse that removes growth-inhibiting toxins in the litter; or opens tightly closed fruits release new seed; or penetrates deep into the soil to stimulate the germination of long-buried seed. Nothing else produces the succession of plant development to which our native fauna have adapted to meet their requirements for food, shelter and reproduction. Fire is not the foreigner in this country – we are.

'The first inhabitants of this country learnt that they had to break up the fuel to survive. They burnt extensively and often. They learnt the responses of the plants and animals to burning and took advantage of these responses to coexist. Since European settlement the total amount of fire in the landscape has declined. The bushland areas and particularly those around Sydney have thickened and accumulated more fuel. As a result, the infrequent fires that now occur under extreme weather burn much more intensely and have a significant impact on the built environment.

'Fragmentation of the bush by different land use practices, e.g. urbanisation and agriculture, means that the aboriginal fire regime is now no longer possible or desirable. However, our flora and fauna came from this regime and if we want to maintain the biodiversity in our native areas we have to accept that fire is a process that must be used to manage our native bushland. If we want to reduce fire intensity and make fire suppression safer and easier we need to accept that it is the dry undergrowth and dead leaf, bark and twig litter that provides the fuel for bushfire and use prescribed fire to reduce fuel loads. If we want to secure our homes and property we need to zone our bushland areas so ecotypes that require frequent fire regimes are adjacent to assets of high value and thereby reduce the impact of wildfires and promote biodiversity.

'We need to support the fire service and the land management agencies when there is no emergency and accept the minor inconvenience of smoke in the air when fire is prescribed for hazard reduction, forest regeneration or biodiversity management. Finally we need to individually take responsibility for managing the fuels we own and maintain our property and garden so that they do not burn in summer.'

NOTE: The document is accessible via the CSIRO Forestry and Forest products website www.ffp.csiro.au/nfm/fbm

In closing, it is indisputable that bushfire is a major concern to house owners in many parts of Australia. However, we are fortunate to have great expertise in the field of building in bushfire-prone areas, and by now there is much information and guidance available to facilitate the protection of our homes. By the time you have browsed through this manual, it is hoped that you will have gained knowledge as to what kinds of measures are required or at least where to find additional information.

2 DESIGN INFORMATION

2.1 GENERAL

In this manual we aim to provide useful information beyond what is found in the building codes. This will build a better understanding of how the design configuration of, and materials selection for, a building can improve its chances of survival in the event of a bushfire.

NOTE: Designers must determine the minimum bushfire construction requirements of the state and local planning provisions, as well as the Building Code of Australia (BCA) and AS 3959 *'Construction of buildings in bushfire prone areas'* and then ensure that the as-built structures satisfy those requirements. Ensure that you have the latest amendments of the relevant regulatory documents.

2.2 PLANNING PROVISIONS

Various planning provisions have been put in place by state governments and local councils in bushfire-prone areas. These provisions provide specific legislation on development and building in such areas and are the principal requirements that any designer would need to satisfy. The first step in any development, therefore, is to contact the local council for its specific planning provisions.

In NSW, for example, local councils are required to prepare Bushfire Prone Land Maps to use for planning and development control. The maps are based on the Bushfire Hazard Maps that councils are required to prepare under the Rural Fires Act as part of the council's Bushfire Risk Management Plan.

2.3 BUILDING CODE OF AUSTRALIA

The BCA is the national regulatory instrument for building construction and it includes provisions for bushfire risk. It requires Class 2 and Class 3 buildings constructed in a designated bushfire-prone area to be designed and built to reduce the risk of ignition from a bushfire while the fire front passes (refer to BCA Part G5, Clause GP5.1).

The BCA also states that a building complies with this requirement if it is provided with protection in accordance with AS 3959.

2.4 AUSTRALIAN STANDARD AS 3959

AS 3959 *'Construction of buildings in bushfire prone areas'* is the standard intended to provide design and construction rules to produce buildings to better withstand burning debris, radiant heat or flame contact from a bushfire.

NOTE: Even though this manual contains extracts from the standard it must not be used as a substitute for the standard.

The standard involves the assessment of bushfire attack risk for sites deemed to be situated within a bushfire-prone area. It has resulted from data obtained from bushfire studies and fire modelling. This has led to steps covering fire weather, vegetation types, forward rate of fire spread, fire line intensity, flame length and radiation load.

These considerations lead to the selection of a category of bushfire attack in Table 2.1 of the standard, reproduced here as Table 1. On the basis of predominant vegetation class and type, distance to the vegetation and the slope of the land, there are four categories, namely **Extreme, High, Medium and Low**. The Low degree of bushfire attack is insufficient to warrant specific construction requirements.

In Section 3 of the standard, three categories of concern (Extreme, High and Medium) are equated to three levels of construction requirements as follows:

- Level 1 construction for medium attack
- Level 2 construction for high attack
- Level 3 construction for extreme attack

The standard specifies the various construction requirements in terms of building elements for these various levels.

The factors responsible for the ignition of buildings during bushfires are burning debris, radiant heat, flame contact and wind. Of these, windblown burning debris is regarded as the most frequent cause of building ignition, and there are a number of construction practices that can be used to minimise this risk.

Fibre cement building products are ideal for use in bushfire-prone areas due to their fire resistant properties. This is evident from the BCA deeming fibre cement as non-combustible.

The requirements of AS 3959 for these three levels of construction have been tabulated in Table 2, relating generally only to elements where a fibre cement product is available for use. Section 2.5 presents some discussion on these elements.

TABLE 1

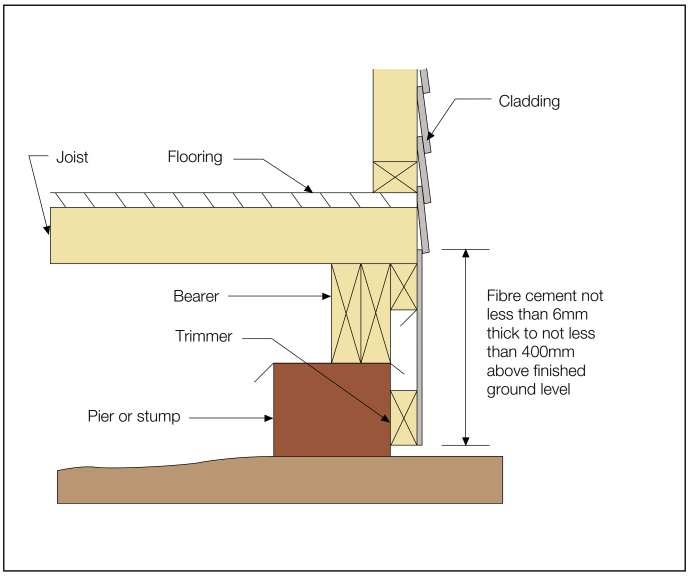
DETERMINATION OF CATEGORY OF BUSHFIRE ATTACK FOR A SITE IN ACCORDANCE WITH AS 3959: 1999

	Distance of the site from Predominant Vegetation Class							
Predominant Vegetation Class and Type (refer to Figure 2.1 of AS 3959)	< 15 m		15 – 40 m		> 40 – 100 m		> 100 m	
	Slope of site		Slope of site		Slope of site		Slope of site	
	> 10°	10° or less	> 10°	10° or less	> 10°	10° or less	> 10°	10° or less
A Forest (1) (2) (4) (5) (8) (9)	Extreme	Extreme	High	High	Med	Med	Low	Low
B Woodland (3) (6) (10)	Extreme	Extreme	High	High	Med	Low	Low	Low
C Tall shrubs (12) (13) (14)	Extreme	Extreme	High	High	Med	Low	Low	Low
D Low shrubs (16) (17) (18) (19)	High	Med	Med	Low	Low	Low	Low	Low
E Open Woodland (7) (17) and Open Shrubland (15)	Med	Med	Low	Low	Low	Low	Low	Low
F Grassland (20) to (28)	Med	Low	Low	Low	Low	Low	Low	Low

2.5 TYPICAL APPLICATIONS

2.5.1 Floors

There are requirements in certain cases where the sub-floor space must be fully enclosed with non-combustible material (for which fibre cement is suitable). There are also cases where the floor must be sheeted underneath with a fire-retardant-treated (FRT) timber or a non-combustible material (for which fibre cement is suitable). In both cases the minimum required thickness of the fibre cement is 6mm.



2.5.2 External Walls

In accordance with AS 3959, most traditionally used wall lining materials are acceptable in bushfire-prone areas. However, thermoplastic materials should not be used because they sag and melt when exposed to severe radiated heat.

AS 3959 requires that the portion of the cladding near the ground must be treated with fire retardant material or covered or replaced with a non-combustible cladding to a minimum height of 400mm above ground level (refer to Section 3.4.2 of the standard).

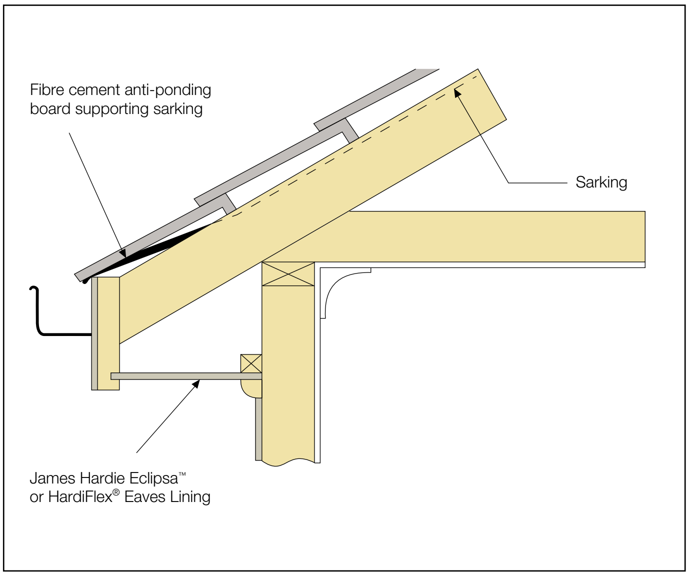
In high-risk and extreme bushfire zones timber external cladding must be of a FRT nature.

2.5.3 Eaves and Fascias

The roof/wall junction must be sealed by either the use of fascia or eaves linings or by sealing between the rafters at the line of the wall.

All other types of roofing must be constructed to ensure that burning embers do not penetrate into the roof space.

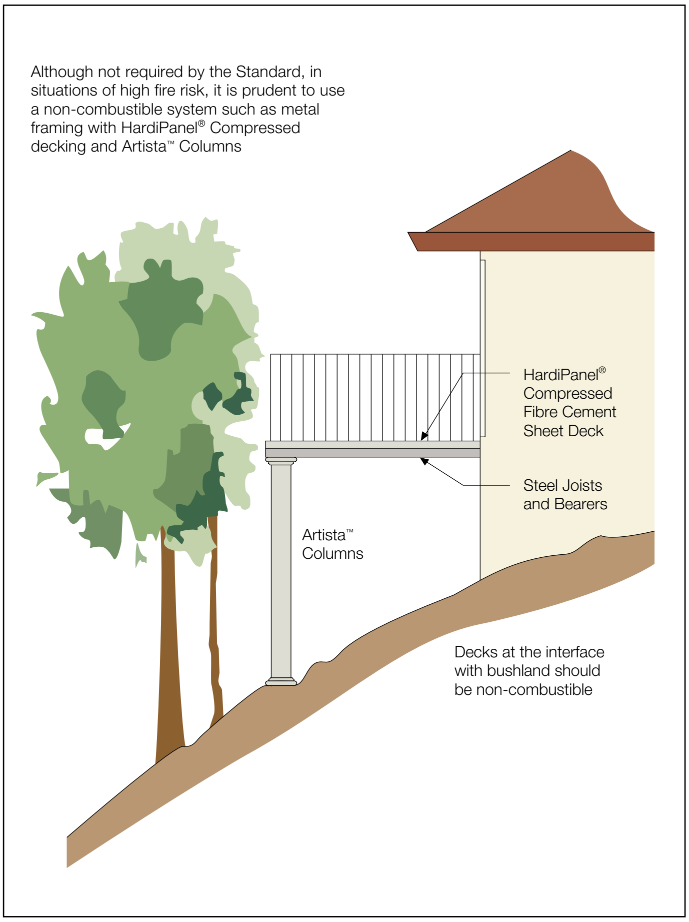
Eaves and fascias must be of non-combustible material or FRT timber.



2.5.4 Verandahs and Decks

For medium category of bushfire attack, two options are available for decking that has solid sheeting. The first option is to have all framing members at least 400mm above the ground. The second option is to enclose the perimeter of the deck in the same way as other sub-floor spaces.

Decking with gaps must have a gap that is a minimum of 5mm. Enclosure of a deck with gaps is not permitted because access beneath the deck must be available to extinguish any embers that may fall through the deck surface.



In high and extreme bushfire zones, the floor surface of the verandah or deck must consist of non-combustible material or FRT timber. A non-combustible system such as metal framing with compressed fibre cement decking would meet the criteria.

2.6 BUILDING MATERIALS

2.6.1 Fibre Cement

James Hardie fibre cement products are deemed non-combustible and non-flammable, and are thus ideal for use in fire-resistant construction. AS 3959, however, does exclude the use of fibre cement in certain applications in High and Extreme Bushfire Attack categories.

For further information on James Hardie Building Products visit **www.jameshardie.com.au** or **Ask James Hardie™** on **13 11 03**.

2.6.2 Timber

Timber may be used in most categories of bushfire attack, except that if the floor is not enclosed, or in the extreme bushfire attack category, it must be sheeted underneath with non-flammable material or FRT timber. The same requirement applies if the floor is closer than 600mm to the ground and is not enclosed.

FRT timber is at present not commercially available in Australia, but certain species of timber are naturally resistant to fire and meet the required performance levels without being treated. These are generally high-density timbers that include the following species:

- Blackbutt
- Spotted Gum
- Turpentine
- Red Ironbark
- Red River Gum
- Silver Top Ash
- Merbau (an imported rainforest timber)

NOTE: To meet the requirements of AS 3959, the timber must have a minimum thickness of 18mm.

TABLE 2

BUILDING IN BUSHFIRE-PRONE AREAS IN ACCORDANCE WITH AS 3959: 1999 – ITEMS RELATED TO FIBRE CEMENT ONLY

Building Element	**Level 1 Construction** (Medium Bushfire Attack)	**Level 2 Construction** (High Bushfire Attack)	**Level 3 Construction** (Extreme Bushfire Attack)
1. Flooring systems	**AS 3959: 1999, Clause 3.3.1** One or a combination of the following: (a) Concrete slab-on-ground. (b) Suspended floor (concrete or framed floor with all points greater than 600mm above FGL) supported by posts, columns, stumps, piers, poles or walls. (c) Suspended timber floor framed with timber or metal where the underside of any one bearer at any point is not greater than 600mm above the FGL, which has: (i) the subfloor space unenclosed and any timber flooring, bearers and joists of FRT timber, or (ii) the subfloor space fully enclosed, either by a wall that complies with this table, or by the use of non-combustible sheet material which extends for at least 400mm above FGL. Where non-combustible fibre cement sheet is used to enclose the subfloor space, the material must have a minimum thickness of 6mm and all joints must be covered and sealed. The sheet must meet the bottom of the cladding material to ensure that are no gaps on the exterior face of the building.	**AS 3959: 1999, Clause 3.3.2** As for Level 1 Construction.	**AS 3959: 1999, Clause 3.3.3** As for Level 2 Construction except that in the case of a framed floor, where any bearer or joist is greater than 600mm above FGL and the floor is not enclosed as described in Cl 3.3.1(c)(ii), the bearer, joists and flooring shall be of FRT timber or sheeted underneath with non-combustible material.
2. External walls	**AS 3959: 1999, Clause 3.5.1** (a) One or a combination of the following: (i) A wall having an external leaf of masonry, concrete, pise, rammed earth or stabilised earth. (ii) A framed wall that incorporates either (A) breather-type sarking complying with AS/NZS 4200.1 and with a flammability index of not more than 5, installed immediately behind the external cladding, or (B) an insulation material conforming to the appropriate AS for that material. (iii) A wall of timber logs that have butting faces of adjacent logs, gauge-planed, and the space between the logs sealed in a manner that prevents the entry of burning debris and which allows for building movement. (b) Where the external leaf or cladding is of a combustible sheet material and is less than 400mm above FGL, the cladding shall be protected for not less than 400mm above the adjacent FGL: (i) by covering it with a suitable non-combustible material, or FRT timber suitably sealed to the existing cladding so as to prevent the entry of burning debris; (ii) by substituting with a suitable non-combustible sheet material such as fibre cement, or FRT timber, or (iii) where the external cladding is timber, by using FRT timber.	**AS 3959: 1999, Clause 3.5.2** As for Level 1 except that PVC cladding is not permitted and all external timber wall cladding shall be of FRT timber.	**AS 3959: 1999, Clause 3.5.3** As for Level 2 Construction.

TABLE 2 CONTINUED

BUILDING IN BUSHFIRE-PRONE AREAS IN ACCORDANCE WITH AS 3959: 1999 – ITEMS RELATED TO FIBRE CEMENT ONLY			
Building Element	**Level 1 Construction** (Medium Bushfire Attack)	**Level 2 Construction** (High Bushfire Attack)	**Level 3 Construction** (Extreme Bushfire Attack)
3. Vents and Weepholes	**AS 3959: 1999, Clause 3.8.1** Must be protected with spark guards made from corrosion-resistant steel, bronze or aluminium mesh with maximum aperture size 1.8mm.	**AS 3959: 1999, Clause 3.8.2** As for Level 1, except that aluminium must not be used.	**AS 3959: 1999, Clause 3.8.3** As for Level 2 construction.
4. Eaves	**AS 3959: 1999, Clause 3.10.1** Must be enclosed and the fascia or the gaps between the rafters must be sealed.	**AS 3959: 1999, Clause 3.10.2** As for Level 1 except that all timber eaves lining and jointing strips must be of FRT timber.	**AS 3959: 1999, Clause 3.10.3** As for Level 2 except that no aluminium is to be used.
5. Fascias	**AS 3959: 1999, Clause 3.11.1** No specific requirements.	**AS 3959: 1999, Clause 3.11.2** All materials must be either non-combustible or of FRT timber.	**AS 3959: 1999, Clause 3.11.3** As for Level 2 except that no fibre cement or aluminium sheet to be used.
6. Verandahs and Decks	**AS 3959: 1999, Clause 3.13.1** Comply with one or a combination of the following: (a) Slab: A reinforced concrete suspended slab floor, supported by posts or columns complying with Cl 3.4 or walls complying with Cl 3.5 or a slab-on-the-ground floor complying with Cl 3.3. (b) Sheeted or T&G solid flooring: Comply with flooring requirements of Cl 3.3. Where the clearance between the FGL and the underside of the floor is not greater than 400mm above FGL, all joints in the flooring must be covered (above the floor level) or must be sealed. (c) Spaced decking: (i) Decking timbers must be fixed with a clearance of not less than 5mm between adjacent timbers. (ii) The external perimeter beneath the decking must not be enclosed, nor must access to the space beneath the decking be impeded. (iii) Any supports must be treated as set out in Cl 3.4. (iv) Decking timbers must not be allowed to connect with the remainder of the building unless measures are used to prevent the spread of fire into the building.	**AS 3959: 1999, Clause 3.13.2** As for Level 1 except that if spaced decking is used, FRT timber must be used.	**AS 3959: 1999, Clause 3.13.3** As for Level 2 except that all materials shall be non-combustible, or where timber is used, it must be FRT timber (including any balustrades).

NOTE: Specific requirements are applicable for penetrations passing through a separating wall – refer to the BCA for details.

2.7 RAIA RECOMMENDATIONS

Through its subsidiary, Archicentre Limited, the Royal Australian Institute of Architects (RAIA) published a Bushfire Design Guide in September 2003. As a starting point in the design of a house in a bushfire-prone area, it stresses the following:

Site Selection: The building should be sited to minimise the risk, and this may include ensuring that there is enough cleared land between the house and the bush, or avoiding steep hillsides where the intensity of the fire can double for each 10 degrees of slope.

Landscaping: There are a number of landscaping features able to slow the momentum of a bushfire, for example bodies of flowing or stationary water (eg a swimming pool), irrigated or green summer crops, orchards, gardens or tennis courts. Wind breaks and barriers may be created with certain tree species classified as bushfire-resistant.

Design Development: Good design attempts to protect the house and its inhabitants from the five major dangers in a bushfire, namely wind, ember attack, radiant heat, direct flame and smoke. This can be achieved by integrating principles such as simple rooflines, uncomplicated layouts, window protection, inbuilt water storage, fire-resistant materials (where necessary) and sprinkler systems.

The Archicentre Bushfire Design Guide then continues with essential construction requirements for external doors, roofing, eaves, fascias, verandahs and decks, and services pipes.

2.8 CSIRO RECOMMENDATIONS

The CSIRO in its Building Innovation & Construction Technology Bulletin No.11 *'Building in Bushfire Prone Areas'* of February 2000, in addition to the information given in Section 1.4, included further information useful to a designer.

Burning debris is a major cause of ignition of buildings during a bushfire mainly because it has a longer time to attack the building than the fire front. Showers of burning debris may attack a building for some time before the fire front arrives, during the passage of the fire front and for several hours after the fire front has passed. Burning debris may ignite buildings in a number of ways:

- With other wind-borne combustible debris, it can pile up against timber or other combustible materials used at or near ground level such as stumps, posts, sub-floor enclosures, steps, door frames and window frames.
- It can accumulate on timber or other combustible materials used for decks, verandahs and pergolas.
- It can lodge in gaps in and around timber or other combustible materials used for exterior wall cladding, and window and door frames.
- It can gain entry to the interior of the building through windows broken by radiant heat or flying debris. Once inside the building the burning debris may ignite furniture, fittings and other contents.

The CSIRO are finding that various approaches can play a part in mitigating bushfire attack on buildings, including:

- Modification, where possible, of the proximity to and type of vegetation around a building.
- Protection of windows.
- Modifying the design of the building to reduce its susceptibility to debris build-up.
- Selection of construction materials that will resist ignition from ember attack.

The following text is taken directly from the CSIRO Building Innovation & Technology's February 2000 Bulletin No.11:

'Vegetation

It is desirable to have a fuel-reduced area around a building to reduce the level of hazard, in particular the risk of attack by flame contact and radiant heat. The practical extent of the fuel-reduced area depends on the type of vegetation, slope of the land and its aspect. Advice on the size of this area can be obtained from the appropriate authorities. In some cases it may include neighbouring lots or public land, necessitating approaches to owners for concerted action. The management of existing vegetation involves both selective fuel reduction (removal, thinning or pruning) and the retention of vegetation which may have beneficial effects by acting as windbreaks and radiant heat barriers.

'Building design

It is desirable that the shape of new buildings incorporates the minimum of re-entrant corners and changes in roof profile where burning debris may accumulate and ignite the building.

'Windows

Windows are the most vulnerable features of a house exposed to bushfire attack. AS 3959 specifies wire mesh on all opening windows including louvres. This reduces, to some extent, the levels of radiant heat impacting on the glazing and, if the glass cracks and falls away, it can help prevent wind-borne burning debris from entering the building. It is, however, less effective on the inside of hopper windows, it is difficult to fit on non-opening sashes, especially with aluminium windows, and it impairs the view from picture windows.

'Shutters can provide superior protection for windows, including protection from objects carried by the wind. Shutters, however, need to be closed to be effective. Optimum protection is provided by shutters (hinged or roll-down) that are made from materials that are not combustible, such as aluminium or steel. As well as protecting the glazing, shutters usually cover and protect window sills. This is of considerable advantage in the case of timber window sills, which, like all horizontal timber elements of a house, are vulnerable to ember ignition.

'Passive protection can be provided by glazing options such as wired, laminated or toughened glass. Wired glass is generally confined to bathrooms, laundries and the like, on aesthetic grounds. Laminated glass resists radiation cracking better than ordinary glass but its performance under high heat loads is variable across the product range. Laboratory experience from other projects, however, suggests that toughened glass withstands high levels of radiant heat very well.

'Conventional double-glazing, or the use of ordinary glass thicker than is required for a particular window size and wind zone, gives little improvement in window performance against intense radiant heat unless at least one of the glazing elements is toughened.

‘Decks

Research has found timber decks to be particularly vulnerable to multiple ignitions from burning wind-borne debris, due to the large areas of horizontal timber surface they present. These ignitions grow and join to attack windows and doorways opening on to the deck, taking the fire to the interior of the house. In the absence of successful fire-fighting intervention, this leads to total destruction of the house. Design alternatives such as suspended concrete decks or decks paved with highly compressed cellulose-cement sheet tend to be considerably more expensive and aesthetically less acceptable than timber decks. Further research is planned to investigate design alternatives to improve the performance of timber decks.

‘Other building elements

AS3959-1999 gives some basic guidelines for the protection of other building elements. In areas likely to be subject to attack by embers alone (without direct flame contact or significant heat radiation) the general rule is to protect combustible wall cladding, and post and poles for the first 300 mm above a horizontal surface where debris and embers can accumulate. Wall vents should be screened with metal mesh (bronze flywire is suitable) to prevent embers from entering underfloor areas.

‘External drencher systems

Although an external drencher system is a useful ‘optional extra’ for protecting buildings, it does not provide absolute protection, especially as it needs to be activated (normally manually) in case of a bushfire. Where such a system is considered, it is advisable that specialist assistance be obtained.

‘Evacuation

There is considerable debate within the emergency services about the relative merits of timely evacuation before a bushfire or staying with a house during a bushfire. Luke and McArthur, in their book, *‘Bushfires in Australia’*, expressed the problem succinctly saying: “Though staying in a house is usually preferable, orderly evacuation has saved many lives. Equally it has resulted in the loss of many houses.”’

NOTE: The full document is accessible via the CSIRO website www.cmit.csiro.au/innovation/2000-02/bushfire_prone.htm

2.9 MORE DESIGN INFORMATION

If you have any queries that have not been addressed in this manual, **Ask James Hardie**™ on **13 11 03** for further advice.

For further information on design for bushfire areas refer to the following publications:

- *‘Landscape and Building Design for Bushfire Areas’*, Caird Ramsay and Lisle Rudolph, CSIRO Publishing, 2003
- National Timber Development Program (NTDP) Technical Report Issue 4, 4 December 2003: *‘Building with timber in bushfire-prone areas’*

For further information on timber-framed construction refer to the following publications:

- AS1684 – Residential timber-framed construction
- AS1720 – Timber structures
- Multi Residential Timber Framed Construction (MRTFC) Manuals published by the Timber Development Council or, contact the National Timber Association in each state or territory

For further information on steel-framed construction refer to AS/NZS 4600 *‘Cold Formed Steel Structures’*, or contact Metal Building Systems or Rondo Building Services.

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