ENVIRONMENT DESIGN GUIDE

PLANNING AND DESIGN FOR BUSHFIRE PROTECTION

Nigel Bell

SUMMARY OF

ACTIONS TOWARDS SUSTAINABLE OUTCOMES

Environmental Issues/Principal Impacts

- As bushfires penetrate closer to urban areas (and we build into bushland), we need to be more proactive in planning design and construction for bushfire safety.
- Buildings are attacked by burning debris or embers some time and distance from the main fire front, and this is the main source of building ignition.
- Radiant heat from an intense bushfire is significant in pre-heating buildings prior to their ignition from other causes such as debris or embers. The building should be a point of refuge from radiant heat and flames.
- Direct flame contact occurs if close bushland, garden or even dry garden mulch carries flame to the building.
- Extreme wind effects associated with major bushfires can lift roofs, suck out windows or otherwise damage buildings in ways that then opens them up to destruction by fire.
- Most buildings destroyed by bushfire have burnt from the inside out, without fire-fighting protection.

Basic Strategies

In many design situations, boundaries and constraints limit the application of cutting EDGe actions. In these circumstances, designers should at least consider the following:

- Built-in (passive) bushfire-resistant design is increasingly required within bushfire-prone areas in planning, design and construction. These are becoming regulated.
- Active systems (e.g. external sprinkler systems) are seen as a useful additional protection, not an alternative.
- Planning for bushfire protection needs to commence with a bushfire hazard assessment report that considers all the required factors to derive an acceptable package of control measures.
- Design within bushfire-prone areas must address mandated planning and construction requirements, whilst trying to create/maintain design quality.
- Construction requirements are largely determined by the mandated reference to *AS 3959 Construction of buildings in bushfire-prone areas*.

Cutting EDGe Strategies

- In many cases a good 'fire expert report' may be money well spent in negotiating with regulators an acceptable package of responses when standard bushfire controls are too limiting upon design response.
- Consider the bushfire issues from project inception, through planning, design and documentation with as much certainty as possible, through gaining early agreement on the required 'level' of building construction to *AS 3959*.
- Get good advice on nearby vegetation and proposed landscaping to ensure appropriate species and treatment.
- Consider building into the land, rather than high and exposed, to allow a bushfire to sweep past without igniting. Keep the building form simple so as not to collect burning debris and embers.
- Eliminate elevated and combustible decks, balconies or verandas.
- Seal all gaps and cracks where burning debris and embers could collect around the building, penetrate into sub-floor, walls or roofs and then ignite the building.
- Protect all glazing facing the fire-front either by metal gauze screens (low risk), toughened/laminated glass (medium risk) and/or metal shutters (high or extreme risk).
- Consider flammability and burn characteristics of all materials, products and components.

Synergies and References

There is no one text or reference available that comprehensively covers all requirements. Nevertheless, practitioners within bushfire-prone areas (or their advisors) must address the planning, design and construction criteria relevant to their project and jurisdiction through a bushfire hazard assessment report. The following two documents are thus essential:

- Australian Standard *AS 3959 – 1999* (plus amendments) *Construction of buildings in bushfire-prone areas*.
- Applicable State or Territory planning and construction regulations and controls (state, regional and local).
- *BDP Environment Design Guide:* GEN 53, DES 8, DES 9, DES 18.

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Bushfires are a natural part of Australian landscape ecology. However increasing pressure is being placed on building design professionals to be proactive in planning, design and construction management in bushfire prone areas – including major parts of urban areas. Just as firefighting techniques are developing, so are the requirements for passive and active methods of protection of both life and property.

This Note outlines the practical considerations and necessary methodology in planning and design for bushfire protection, which in some jurisdictions, has been elevated to a primacy never seen before. Irrespective, ignoring proactive bushfire management strategies is no longer an option. Denial of our role in proactive design solutions is equally naive. The question remains as to whether bushfire management will dominate design and construction in bushfire-prone areas, or whether it will be balanced with other ESD considerations.

1.0 INTRODUCTION

Over the last 50 years the urban/bushland interface has become blurred. Development has spread out along bushland ridges, native gardens have been encouraged and eucalypts retained/replanted right up to buildings. In expensive areas, many houses are elevated over views and ridges, exposing their under-side to wind and fire. Others feature extensive timber cantilevered decks with trees growing through them and operable glass walls opening to the sun. This may be lovely architecture – but it is also bushfire-lethal. If the 'Sydney School' of architecture started this trend in the 1960's, recent planning practice that spreads houses ever further out into bushland, exacerbates the problem. There are now more houses (and other buildings), spread over more terrain, with an increasing bushfire frequency and severity.

Bushfires destroy and damage thousands of buildings every year in Australia, costing an average of $77 million, with individual events such as Ash Wednesday costing vastly more ($761 million cited by CSIRO, 2003).

The balance between bushfire prevention and suppression is changing. Some groups lobby for controlled burns or selective fuel reduction, others for letting fires progress naturally (as long as it's not near them). Some see responsibility as lying with planning failures, whilst others point to design and construction. With every new fire emergency, public fear and political populism drive the calls for more control. Occasionally this is with measured response (e.g. the new Co-operative Research Centre for Bushfire Research) but more commonly, by restrictive regulation. Led by NSW, followed by the ACT and now nationally, a government inquiry has been followed by calls for stricter planning controls (House of Representatives Select Committee 2003). This has translated into design and construction controls through the Building Code of Australia and Australian Standard *AS 3959* - 1999 (plus amendments, in 2003). The wider ESD consequences of this reactive approach are only starting to be appreciated.

Nevertheless, planning, design and construction in bushfire-prone areas (including urban areas) is changing forever what, where and how we can build.

2.0 HOW BUSHFIRES ATTACK BUILDINGS

Buildings can be exposed to bushfire through four modes (SAA, 1993):

- burning debris or embers;
- radiant heat emitted from a nearby fire;
- direct flame contact;
- wind effects accompanying bushfire.

2.1 Burning debris or embers

Burning debris or embers fall or are blown onto or into combustible parts of a building. The amount of debris increases as the intensity of a fire increases, often carrying burning embers kilometres ahead of the main fire front (CSIRO, 2000/28). The burning debris may ignite buildings in a number of ways:

- It may collect with other wind-borne combustibles against stumps, posts, sub-floor enclosures, steps, doors and windows;
- It can accumulate on timber or other combustible materials for decks, verandahs, pergolas and the like;
- It can lodge in gaps in combustible materials used for cladding, window or door frames;
- It can gain entry inside through broken windows (typically caused by radiant heat and/or wind) or gaps to the cladding or roofing, thereby igniting the building from the inside.

Small ignition points gradually fester and grow (if there's no fire-fighting intervention), igniting more and more of the building until the whole structure is consumed. There is a strong correlation between houses being saved by firefighters and well-prepared householders extinguishing the ignition points. Research has shown ember attack as the primary cause of house loss, sometimes kilometres away from the main fire front and hours later (Leonard & McArthur, 1999; Ramsay, 1993).

The BDP Environment Design Guide is published by The Royal Australian Institute of Architects

2.2 Radiant heat

Radiant heat emitted from a nearby fire largely depends upon the fire intensity (fuel, slope, wind, aspect) and proximity. The amount of heat radiation is very dependent upon the distance of building from the heat source - with the doubling of distance the heat is reduced by a factor of four. The duration of the radiant heat can also be important, with many standard building materials withstanding brief high exposures (more than considered in regulations). Preliminary findings from the Canberra 2003 fires indicated that fire spread from house to house, well after the bushfire had ignited the first and moved on (SMH, Macey 2003).

Radiant heat assists ignition from burning debris by pre-heating materials and breaking window glass, thereby allowing ignition inside of curtains or furnishings. If the heat flux is sufficient from an intense fire very close, the radiant heat may be sufficient to ignite combustible materials inside or outside the house.

2.3 Direct flame contact

Direct flame contact can ignite a range of buildings and materials. This also depends upon the nearby fuel load and fire intensity, as above. Generally, the closer the vegetation or combustible fire-source, the greater the bushfire hazard. Similarly, the stronger the winds and/or slope, the greater the likelihood of flame contact. A new concern arising from the Canberra 2003 fires is the house ignitions that occurred from burning gas lines, plus house-to-house spread. In these instances, the conflagration in houses ignited the adjacent, due to intense flame contact and lack of suppression activity.

2.4 Wind effects accompanying bushfire

Wind effects accompanying bushfires are responsible for ignition and destruction of many buildings. Wind intensifies a bushfire, which then creates its own eddies that in some instances can become a cyclonic windstorm (see GEN 53; SMH, Jan 25-26, 2003). Thus wind can have the following effects:

- The force of the wind can create suction effects that can break glass, remove portions of walls or even whole roofs – thereby opening up the building to fire.
- The force of the wind can carry (and hold) burning debris against the building, with larger items (branches, building materials from nearby) smashing windows or roof tiles.

Whilst buildings may be exposed to all four types of bushfire attack, burning debris and embers tend to be the main source of ignition, often some distance and time away from the main fire front. Undetected debris or embers may too easily cause ignition in the roof, under the floor or even at the door mat. Wood-chip or mulch adjacent to structures can also cause later ignitions. Hence the fundamental point is that unattended buildings burn down more readily than those where people (and water) are available before, during and after the fire-front moving through.

Buildings should protect occupants from the radiant heat of a fire, who in turn are able to protect the building from ignition. Fire authorities have moved from encouraging residents to evacuate towards encouraging owners to prepare to fight it from 'defendable' space (AFAC, 2001). In many cases this is a practical reality as there cannot be sufficient firefighting assistance when resources are devoted to containment of the fire. There has also been an unfortunate history of fatalities as people flee at the last minute, being trapped by flames, electrocuted by fallen power lines or killed in road accidents in the confusion of smoke and fire. As Neville McArthur has said (cited in Baker, 2002) 'though staying in a house is usually preferable, orderly evacuation has saved many lives. Equally it has resulted in the loss of many buildings.'

2.5 Categories of bushfire attack

Assessment of bushfire hazard is required for all site assessments prior to submission for authority approval (see GEN 53). Whilst fire danger indices have been developed, *AS 3959* and other sources use simplified categories.

Category	Description
Low	Insignificant attack from burning debris (embers), radiant heat and flame due to the distance of the building from the vegetation. There is insufficient threat to warrant specific construction requirements.
Medium	Attack from burning debris is significant therefore protection from embers is required. Minimal attack from radiant heat and flame due to the distance of the site from the vegetation. Heat radiating onto a building is predicted to be less than 12.5 kW/m². There is sufficient threat to warrant specific construction requirements.
High	Attack from burning debris is significant and radiant heat and flame attack are sufficient to threaten some building elements (such as standard windows). Heat radiating onto a building is predicted to be 29 kW/m² or more. There is sufficient threat to warrant specific construction requirements.
Extreme	Attack from burning debris is significant and radiant heat levels and flame is sufficient to threaten some building elements (such as timber walls). Heat radiating onto a building is predicted to be 29 kW/m² or more. There is sufficient threat to warrant specific construction requirements.
Flame zone	Attack by burning debris is significant and radiant heat levels and flame is sufficient to threaten building integrity. Specific construction requirements are warranted, but such requirements are beyond the scope of this Standard.

Source: Table 2.1, *AS 3959* (draft amendment 2003)

Hence *AS 3959* addresses the central three categories of bushfire attack only. Yet much existing development is closely adjacent to bushland, being within the category of 'flame zone'. In the absence of any guidelines from the Standard, some jurisdictions have developed their own (Blue Mountains City Council, 2002). The central development issue of how regulators should treat existing developments for bushfire protection (e.g. alterations, additions) and/or compromises for reasons of heritage, amenity, protection of biodiversity, water quality – ESD type issues – typically remains unresolved.

3.0 BUSHFIRE PLANNING PRINCIPLES

Proactive bushfire planning is essential, whatever the scale and nature of the development. For maximum effectiveness, consistency in approach from regional or area planning down to the individual lot and building is required. This primarily involves siting, landscaping and maintenance (SAA, 1993).

3.1 Siting

The siting of a building can have a major effect upon its performance during a bushfire attack. The three main considerations are:

- The location of the subdivision of lot in relationship to what surrounds it.
- The location of the building lot within the subdivision.
- The position of the building within the lot.

Site selection in a bushfire prone area must consider each of the following elements.

Vegetation (fuel) is a key necessity for bushfire growth and development and is a determinant of fire intensity. For example, whilst closed heath land or open shrubs may burn with intensity of 11 to 14 kW/m^2, woodland might be 18 to 30 kW/m^2 and a well-developed forest fire from 48 to 77 kW/m^2. Choosing site location where the vegetation hazard is minimised is desirable, for example where:

- The vegetation density is low or not continuous;
- The vegetation species/type does not readily burn;
- There is distance between the vegetation and building.

Where buildings are located near fire-prone vegetation, then more attention to landscaping and building matters will be required. The developing knowledge on vegetation characteristics and bushfires will be the subject of future exploration.

The potential for fuel reduction as a key part of bushfire management depends upon:

- The size of the subdivision and/or lot;
- Ownership and/or management of adjacent lots and countryside;
- The location of the site within the subdivision – on the exposed fire edge or more sheltered;
- Required building setbacks that enable fuel management /reduction on the site.

There are numerous guides for subdivision layout that incorporate access roadways, paths and fire-trails to act as a fire break and assist with fuel management (e.g. Rural Fire Service, 2001; Country Fire Authority, nd). Attention also needs to be given to future development of potential and possible changes in fuel loadings. There are also strong legislative requirements in most jurisdictions limiting removal of trees and vegetation, which might be at complete variance with bushfire hazard management. Hence the research and debates regarding the efficacy, scale, frequency and consequences of hazard reduction through fuel reduction – usually by prescribed burning prior to the fire season (McCormick, 2003).

Landscape features that may increase or reduce the fuel load must be taken into account. Keeping a fuel-reduced area between bushland and buildings should be the aim. Useful measures from a fire perspective include lakes, dams, swimming pools, lawns, lush gardens and sporting facilities (e.g. ovals, tennis courts). Strategic planting of appropriate plant species can minimise embers, radiant heat and mitigate wind effects. Doubtless there will be further research on the bushfire resistance of endemic plant species.

Ignition sources that are downwind and/or downslope must be considered, be they recreational or industrial areas – in fact anywhere where careless practices could occur (e.g. barbeques, cigarettes).

Slope considerations are crucial as the rate of spread of a bushfire can double on upslopes of 10° and double again at 20°. Hence location of buildings on level or gentle slopes is preferable than steeper slopes or the tops of ridges – no matter what the view! Bushfire history shows the extraordinary destruction of houses near ridge tops. Yet burning embers can spread fire down slope over considerable distances.

Aspect is another key factor, as prevailing winds, sun radiation and topography all can intensify bushfires. In many temperate regions of Australia, the tops of northern and/or western ridges tend to be the most fire-prone.

Access and egress for owners and firefighters is vital for people protection. Hence in planning terms:

- Keep 'cul-de-sacs' short as there's only one way out;
- Provide access roads wide enough for emergency vehicles to pass any parked cars;
- Provide access in two directions away from the hazard;
- Use access as part of fuel reduction measures.

3.2 Landscaping

Landscaping associated with construction in bushfire prone areas requires consideration at the scale of the region, subdivision and the individual lot.

Vegetation management involves existing vegetation as well as new. For existing vegetation with appropriate authority approval only, the following measures may be considered:

- Reduction of fine fuels by mechanical means or controlled burning;

- Thinning of trees to avoid continuous tree canopies (selecting trees of high flammability and/or loose bark for removal);
- Removal of lower limbs from trees to better separate ground fuel from the canopy;
- Removal of tree limbs that overhang buildings;
- Removal of trees and vegetation adjacent to buildings; and
- Removal of dead trees and vegetation.

Management of new vegetation includes appropriate selection and placement of species that may reduce the effects of any bushfire. Landscape planning should consider:

- Deciduous trees;
- Densely foliated evergreen trees of low ignitability, planted in discrete clumps;
- Smooth-barked trees rather than rough or ribbon-barked trees;
- Areas of lawn or native grasses;
- The effects of garden pine-bark or mulch in carrying a fire to the building.

Windbreaks can protect buildings from bushfires when well-designed and maintained. Typically, buildings need to be located four to six times the full-grown height of the trees, to the leeward side. Windbreaks can protect buildings through:

- Reducing wind speed and providing a protected area on the leeward side;
- Filtering out flying sparks and debris if there is good leaf moisture content;
- Slowing the spread of fire by slowing the wind speed.

Shielding from radiant heat needs to occur close to a building to be effective. It can be of any non-combustible material – earth, masonry, steel fencing – or even windbreak vegetation in some instances (as long as it doesn't ignite).

Water supplies are essential for three main protective purposes:

- Connection to hand-held hoses to wet down combustible materials and extinguish any spot fires;
- Connection to bushfire sprinkler systems;
- As water for fire-fighting appliances.

In planning water requirements for fire-fighting purposes there are a series of important considerations:

- A water supply independent from the mains (which can lose pressure or be non-existent during fire emergency);
- The water supply should last a minimum of two hours at full operation (10,000 litres fills three water tankers, 22,000 litres will service an average sprinkler service for 2 – 3 hours);
- The water supply needs enough water pressure ('head'), or a pump will be required;
- Diesel pumps are preferable as electricity often fails and petrol may vaporise in the line;
- All water supply components need to be protected from radiant heat, so metal pipework should be used above ground;
- A suitable connection valve compatible with the local fire authority should be installed;
- Hose points need to be located so all points of the building can be reached.

External water spray systems are considered a useful further protection in many jurisdictions – but are not a complete fail-safe alternative. They need appropriate hydraulic design, ground and/or roof installation with appropriate nozzles, and manual activation. A research review of existing practices is now available (FPAA, July 2000).

3.3 Maintenance

Care is required to ensure that measures established in the initial hazard assessment continue to be appropriate and maintained. Emphasis is now placed by fire authorities on 'property fire management plans' for individual properties, with on-going community education and involvement aimed to avoid public complacency between bushfire emergencies. The need for indelible household instructions (e.g. along with pest treatment and smoke detector maintenance) has been suggested (Crane, pers com). Typically, essential maintenance will include:

- Removal of dead trees and vegetation;
- Pruning of vegetation that overhangs buildings and to maintain a 'broken canopy';
- The path of fire from ground to tree canopy needs to be maintained to provide a vertical firebreak;
- Vegetation adjacent to buildings removed and leaves removed from gutters;
- Accumulated fine fuel (leaf litter and twigs) should be reduced or removed;
- Grass needs to be mown, grazed and preferably kept green;
- In summer the moisture content needs to be maintained through watering.

3.4 The bushfire planning package

The relationship between the planned siting, landscape and maintenance measures need to be considered as parts of a 'package' that involves consideration of the fire hazard. For example, if there is concern about radiant heat, then separation of fire source from the building is paramount. If concern were about flame contact, then in addition you'd reconsider the cladding and roofing materials and protect all openings. Wind loadings at time of bushfire emergency may suggest the need for a higher standard of bracing and tie-downs, and possibly protection for window glass. Ember attack requires the most comprehensive response to the above, including all the elements within the package. There is an increasing number of specialist consultancy firms available to assist with these matters.

3.5 Asset protection zones

New emphasis (in NSW especially) has been placed on the requirements for planning of the Asset Protection Zone (APZ) (NSW RFS, 2001). The planning intention is to require a fuel-reduced buffer between the 'asset' (building) and the bushfire hazard, all within the site boundaries. An 'inner' and 'outer' protection zone is defined.

The primary interest of the APZ is to reduce the bushfire hazard by fuel reduction and separation – and mandate it as part of development consent. Steep land (e.g. >18° or 33%) makes all development difficult and some preferred land management practices impossible. Furthermore, on steeper land the canopy fuels are more readily available for fire. Hence NSW fire authorities are requiring that the development be located on land not steeper than 18° unless justified by a fire expert report. Consequently, in jurisdictions like NSW, steep land on or near a site may now preclude development (NSW RFS, 2001) if:

- The development cannot have required setbacks; or
- The development is likely to facilitate the spread of bushfire to neighbouring developments; or
- The development is likely to be difficult to evacuate; or
- The development is likely to create control difficulties during a bushfire; or
- The development is of a type that should not be permitted; or
- There are alternative acceptable sites for the same development.

The full impact of such restrictive planning based on bushfire hazard concerns is yet to be tested. Not only is the creation of fuel-reduced Asset Protection Zones within the site boundaries frequently not possible, it has been suggested as being overly simplistic and/or unnecessary when one considers the history of building ignitions. With ignitions predominantly occurring from burning debris (some distance from the fire front) and few ignitions from radiant heat or flame, mandated clearances are not a complete or satisfactory answer. Recent fire research (Warrington, 2002b) has suggested that even nine metres can have adequate beneficial impact, yet in NSW the Rural Fire Service's *Planning for Bushfire Protection* mandates minimum APZ's of 20 metres for grassland and rainforest, 35 to 60 metres for 'Woodland' and 40 to 70 metres for 'Forest' (NSW RFS, 2001, Table A2.2) all within the site.

To date, there has been political denial that these measures will 'sterilise' land for development, thereby avoiding a consequential debate about monetary compensation. This position cannot be maintained. Land-owners and managers will be forced to reconsider their desires and rights versus bushfire planning, probably through litigation. The irony of the same politicians promising those who have lost their homes to bushfires the right to immediately rebuild with like development will not be lost on the courts.

4.0 BUILDING DESIGN AND CONSTRUCTION ISSUES

The principles of resisting the four modes of bushfire attack (burning debris, radiant heat, flame contact and winds) are fairly simple, but hard to implement, and harder again to guarantee building survival when so many other factors come into play. Nevertheless, there are some imperatives for building design in bushfire prone areas (SAA, 1993).

4.1 Design requirements

Building shape influences the accumulation of burning debris, the exposure to radiant heat and wind attack on roofs especially. Generally, it is suggested that house plans be kept simple with minimal re-entrant corners or deep porches that may catch and accumulate burning debris. Similarly, if there are garages or out-buildings they need to be separated (e.g. 3 metres plus) to avoid wind-eddy effects.

Simple elevations are also suggested, without changes of roof pitch at verandahs, garages and carports. Roofs are best kept without projections such as dormer windows, gables, hips and valleys. Projections such as chimneys, roof lights and the like should be minimised.

Floors and underfloor, especially when elevated, can be subject to bushfire attack. This can be from the materials themselves (typically timber) or materials stored underfloor. That is why *AS 3959* has adopted for regulatory purposes an underfloor space height of 600mm as the point below which it should be enclosed with non-combustible material. Above 600mm they figure there is sufficient vision and access to deal with any spot fire. Irrespective, adequate under-floor ventilation is required to avoid rotting of the floor timbers, with air vents (if used) screened to prevent ember access.

Concrete slab-on-ground (or elevated – but dependent upon supports) obviously presents less of a fire risk.

Generally the floor system will not be affected by radiant heat or flame contact from a bushfire. However if stored materials below catch alight, secondary ignition could occur presenting an intense fire to the underside of the floor. Hence designers should consider lining the underside with non-combustible lining.

Supporting posts or columns connect the building, verandah, balcony, deck or carport to the ground. It's essential to prevent them igniting and spreading the fire into the building, which could then collapse. Depending upon the heat intensity, combustible materials (timber) may ignite and steel deform (from adjacent combustibles, not the bushfire). Hence additional fire protection may be required, or non-combustible materials like brick or concrete used. Vegetation and mulching should not be planted around combustible posts.

External walls need to prevent the passage of burning debris inside, not be ignited or distort through heat or flame, nor allow wind-borne objects to fracture the cladding and allow burning debris to enter. Non-combustible materials like masonry, concrete or earth wall construction will obviously resist fire. Framed and clad walls with steel or aluminium sheeting won't burn but may distort and/or transmit the heat inside, causing ignition elsewhere – but are permitted in all categories! Fibre-cement sheeting needs to be thicker and preferably autoclaved (e.g. 7.5mm plus), with smooth jointing system. Timber cladding is more vulnerable if it is rough-sawn or has crevices where burning embers can collect. The fire characteristics of most timbers are well established (NTDC, 2000; Dunn, 2002) with newer research investigating species that meet the definitions within *AS 3959* (Warrington, 2001).

Whatever material is selected for the level of fire hazard that exists, the integrity of the wall system as a barrier to burning debris, heat and flame contact must be maintained. *AS 3959* is very particular in what materials are acceptable.

Windows and doors can be highly vulnerable to bushfire attack. PVC frames are regarded as unsuitable in all bushfire zones. Aluminium or metal frames are accepted although there are concerns about distortion and subsequent loss of glass and easy ignition. Timber frames must now conform to the definition of Fire-Retardant Treated Timber specified in *AS 3959* – 1999, incorporating Amendments 1 and 2. This is problematic in that currently there are no such timbers (retardant treatment is non-durable) and the 'untreated' species are in short supply and/or rainforest imported species. There is on-going research into this matter (see Warrington, 2001).

Flush panel external doors will generally provide adequate protection when fitted with weather strips and draft excluders to prevent ember entry. In many cases, a self-closing metal mesh screen door is required for protection when solid doors are open. There is a new concern with ember attack occurring around garage doors (draft amendments *AS 3959*).

Glazing needs to be toughened or laminated to resist cracking better than ordinary annealed glass. Smooth panel-clad timber shutters can assist radiant heat protection, but only if tightly fitting. Non-combustible (metal) shutters – either roll-down or pivoted – are better again as long as they have no exposed plastic components. Metal-mesh screens (not fibreglass flyscreens) reduce radiant heat and can prevent burning embers entering. Metal-mesh screening of *all* glazing (not just the opening sashes) is required at most levels of construction by *AS 3959*.

Roofs, roof lights and penetrations need to be designed so that areas that could collect burning debris are eliminated. This includes under-eaves, ridges and gables. Timber shingles and shakes, plywood/bituminous felt, thermoplastics and fibreglass that could melt or burn are all quite unsuitable. Depending upon the degree of protection required:

- ***Tiles*** require greater tie-downs than has been the norm in fire-prone area, due to the wind effects. The whole roof needs to be sarked and all gaps sealed.
- ***Sheeted roofs*** are generally suitable as long as ridge-caps and eaves are sealed – although ventilation is still necessary. No gaps should remain and exposed rafters at eaves could be vulnerable. Sarking may be required.
- ***Roof lights and penetrations*** of thermoplastics are generally not suitable unless they have a non-combustible shaft below with non-combustible diffuser. There is concern about what this may do to aspects of solar design and the use of roof windows.

Verandahs and decks may be made from timber – but with the expectation that it be 'fire-retardant treated timber', usually with tall, galvanised metal shoes at the base (100mm). No timber should directly connect with the remainder of the building. Non-combustible materials such as steel or concrete will be more resistant to intense radiant heat.

Fire refuges within buildings have previously been recommended in rural areas, yet can readily be created in dwellings with some attention to detail. Such a room can give enhanced protection from smoke and heat for children or the lesser able till the fire front moves past. Typically a laundry with both internal and external door (draft and smoke sealed), water, non-combustible linings and ventilator sealed. This room can also be useful for storage of fire protection equipment, from buckets, cloths to hoses.

4.2 Commentary

Whilst planning and design requirements for bushfire-prone areas, varies across jurisdictions, *AS 3959* is now mandated through the BCA at time of building approval. Nevertheless, the applicability of both BCA bushfire clauses (O2.3, F2.3.4 and P2.3.4) and/or *AS 3959* depends upon the state or territory - with NSW preferring its *Planning for Bushfire Protection* which invokes higher protection/construction 'Level' standards as well as large 'asset protection zones'. This has prevented a consistent national regulatory approach (e.g. draft amendments *AS 3959*).

In many places development planning and design must now *start* with a competent bushfire hazard assessment. This has strong implications for planning processes and design freedom, with further conflicts with ESD imperatives such as maintaining bushland habitat, erosion controls, water quality, visual amenity as well as our cultural connection with the bush. Especially in NSW, these presently hold little sway as the Rural Fire Service has been empowered to determine bushfire requirements, with Councils effectively obliged to adopt their 'recommendations' due to litigation concerns. There are further significant ESD implications in the restrictions on acceptable materials – most notably the use of 'fire retardant treated timbers'.

4.3 'Fire retardant treated timbers'

There is *no* timber treatment that meets the requirements for 'fire retardant treated timbers' to *AS 3959*. Research (Warrington, 2002) has shown that a limited number of (untreated) species meet the requirements:

- Blackbutt
- Kwila (Merbau) – an imported rainforest species
- Red Iron Bark, River Red Gum
- Silver Top Ash
- Spotted Gum and Turpentine.

Most of these indigenous species are not readily available and/or suitable for common building applications, leading to pressure to use Kwila for doors, windows, decks, etc, in *all* bushfire prone areas – mandated from 'Medium' risk (Level 1 construction) upwards. This is not sustainable.

5.0 MANAGEMENT AND MAINTENANCE

Maintenance and ongoing management of bushfire provisions is essential throughout the life of the development. This is hard to regulate. Quite commonly there is a lack of training, tools, resources and community compliance. Hence the pressures for hazard reduction through fuel reduction on public lands. Enforced hazard reduction on private property remains contentious. Most jurisdictions have placed great emphasis on community education and voluntary compliance (Ahern & Chladil, 1999). There has been a general perception that fire authorities need more options for safe living in bushfire prone areas, backed by reliable scientific research.

6.0 CONCLUSIONS

In bushfire prone areas, design procedures must now *follow* detailed assessment of planning and construction requirements for bushfire protection. Planners, surveyors, engineers, architects and builders must *start* their work with bushfire assessment procedures in mind – no longer can it be a later consideration. The new bushfire planning and management regime (NSW, with other states to follow?) determines/precludes *what* may be built *where;* proximity of trees/vegetation; acceptable materials, roofs, windows/doors, etc; services requirements and the like.

In bushfire prone areas, approval decisions may be *led* by bushfire concerns (NSW) – even when opposing other legislated ESD concerns (e.g. threatened species) or eco-materials concerns (e.g. avoiding imported rainforest timbers). Where governments mandate bushfire requirements, major restrictions on siting, planning, design and materials will lead to difficulties with development through to major restrictions and/or sterilisation of land for development. Our professional, financial and cultural connections to land will be tested. The debate on appropriate planning, design, management and regulation within bushfire prone land is certain to continue.

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