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AUSTRALIA

November 2004

*Construction in
Bushfire prone areas*

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OFFICIAL JOURNAL OF FIRE PROTECTION
ASSOCIATION AUSTRALIA AND THE
INSTITUTION OF FIRE ENGINEERS AUSTRALIA,
INCORPORATED ISSN 1032-6529
PRINT POST PUBLICATION NO. PP328567/00071





Construction in bushfire prone areas: Manufacturers and supplier of materials respond to the challenge

By John Rakic – Executive Director of the Alliance for Fire & Smoke Containment and Principal of J-RAK Consulting

Introduction —

The recent Canberra bushfires again reminded us in no uncertain terms of the devastating effects that bushfires have on the Australian community at large. We as a nation will continue to build on the urban interface, and please be honest, probably next to ocean views, a bush setting adjacent to your home should be rather appealing to us all.

Unfortunately, one thing we have to accept is that bushfires are inevitable and with buildings adjacent to or in close vicinity to the bush, we have to try and combat the effects the fires may have on this building stock.

Protection of our buildings in bushfire prone areas requires an all encompassing approach including but not limited to issues with planning and zoning, forest (bush land) management, housekeeping, fire fighting and of course construction methods and materials. This article deals with the latter; it provides an overview of the current technical requirements for construction in bushfire prone areas along with a snap shot of some advances made by manufacturers of building products for use in these areas.

Acts & Regulations —

It would be remiss of me not to touch briefly on the Regulatory framework here in Australia that to a large degree sets the foundations for building control generally. Like many areas, but perhaps even more so, the Building Acts & Regulations for bushfires are far from uniform nationally. Each State and Territory has its own Acts and Regulations dealing with bushfires and to make matters a little more complicated in some cases there is more than one set of Legislation you need to refer to understand the overall controls relating to construction in bushfire prone areas. *This Legislation provides the Administrative framework by which the authorities given jurisdiction in this documentation administer the relevant building control initiatives.*

As an example only, in NSW we see the use of the Environmental, Planning and Assessment Act and associated Regulations and the Rural Fire Services Act and associated Regulations, both having some jurisdiction over bushfire related issues. There is also the Planning for Bushfire Protection document to make matters even more confusing to those who do not know all the "ins and outs". The

overall result of all this is, is that in NSW, unlike most other states, the NSW RFS have a say in the development approval process, which would otherwise vest with a Municipal or Private Building Surveyor.

Building Code of Australia —

Comparing and contrasting with Administrative Provision for building control contained within the various Acts & Regulation discussed above, the Technical Provisions have, relatively speaking, a degree of uniformity by way of National adoption of the Building Code of Australia, (BCA). Since 1990 or thereabouts, all States and Territories have adopted the BCA as their Technical Handbook if you like for design of buildings.

The first edition of the BCA was published in 1990 and was totally prescriptive in nature. Compliance with the BCA was by way of meeting the specific requirements of each and every individual technical clause of the Building Code.

Today however, we operate with a so-called Performance based Building Code of Australia, (PBCA). This Code provides

for a performance-based hierarchy allowing for different means of showing compliance. Each section of PBCA contains Objectives, Functional Statements, and Performance Requirements. A Building Solution only to comply with the Performance Requirements as the Objectives and Functional Statements are non-mandatory provisions.

Building Solutions can either meet the Performance Requirements by way of compliance with the pre-existing prescriptive clauses, now referred to as the deemed-to-satisfy provisions, or by way of an Alternative Solutions. *Alternative Solutions are often referred to as "Fire Safety Engineered Designs", as they are normally prepared on a job specific basis by Fire Safety Engineering organisations.*

Bushfire requirements and the BCA

The relevant Performance Requirements from the Building Code of Australia for residential homes and relating specifically to construction in bushfire prone areas are contained in Part 2.3 of Volume Two,

whilst the Prescriptive, deemed-to-satisfy (acceptable construction) requirements are contained in Part 3.7.4.

PART 2.3 – FIRE SAFETY

GENERAL (& PERFORMANCE) PROVISIONS

OBJECTIVE

O2.3 - The Objective relating to bushfires is to:

(c) *protect a building from the effects of a bushfire.*

FUNCTIONAL STATEMENT

F2.3.4 - Bushfire areas

A Class 1 building constructed in a designated bushfire prone area is to provide resistance to bushfires in order to reduce the danger to life and reduce the risk of the loss of the building.

PERFORMANCE REQUIREMENT

P2.3.4 - Bushfire areas

A Class 1 building that is constructed in a designated bushfire prone area must be

designed and constructed to reduce the risk of ignition from a bushfire while the fire front passes.

PART 3.7.4 - BUSHFIRE AREAS

DEEMED TO SATISFY PROVISIONS

(Acceptable Construction Practices)

Appropriate Performance Requirements

Where an alternative bushfire protection design is proposed to that described in Part 3.7.4, that proposal must comply with Performance Requirement P2.3.4 in Section 2.

Acceptable construction manuals

3.7.4.0

Performance Requirement P2.3.4 is satisfied for a Class 1 building located in a designated bushfire prone area if it is constructed in accordance with AS 3959 - Construction of buildings in bushfire prone areas.

Note – There are some individual State & Territory Variations to these collective BCA Clauses

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Australian Standards and bushfires

The Building Code of Australia adopts documents by way of a primary reference. These documents are typically Australian Standards and by way of this primary reference, they form an integral part of the technical provisions and requirements of the BCA.

For construction in bushfire prone areas, the BCA and its so called deemed-to-satisfy provisions, have adopted Australian Standard AS3959 as the acceptable and default construction methods for buildings in designated bushfire prone areas. Refer to Part 3.7.4 of BCA Volume 2 as shown above.

AS3959

AS3959, Construction of building in bush fire-prone areas, essentially consists of two complementary sections, namely Assessment and Construction.

The latest published edition is 1999, however it is expected that a new, revised and greatly improved version will be published in 2005.

Assessment of bushfire hazard

Assessment provides a methodology for determining the severity of bushfire attack. It is a function of many variables including the type of vegetation, the proximity of the building to the vegetation, the topography of the site and other relevant variables.

The experienced user can determine using this section of the Standard, the **Category of Bushfire Attack** that applies to the building in question.

The Category of Bushfire Attack determines the Level of Construction, or the severity of in built fire protection requirements for the building in question.

The Categories of Bushfire Attack and corresponding Levels of Construction are as follows:

Category of Bushfire Attack	Level of Construction
Low	Not applicable – no restriction on construction methods and materials used apply
Medium	Level 1
High	Level 2
Extreme	Level 3
Flame Zone	Outside the scope of the current version of the Standard

Construction Requirements

Once the Category of Bushfire has been determined and the corresponding Level of Construction is known, using the Assessment section above, the user can then refer to the appropriate prescriptive construction requirements. These provide the "dos and don'ts" for the different elements of constructions that are covered by the Standard.

The following construction elements are currently covered by the Standard which essentially cover the external envelope of the building and some penetrations:

- Flooring systems
- Supporting posts, columns, stumps, piers and poles
- External Walls
- Windows
- External Doors
- Vents and Weepholes
- Roofs
- Eaves
- Fascias
- Gutters and downpipes
- Verandas and Decks
- Service pipes (water & gas)

Origins of the acceptable building construction requirements

There is no documented scientific explanation or any associated fire testing research accompanying the acceptable construction requirements in the current 1999 version of AS3959. The construction requirements have been included based on observations from real bushfires and the relative performance of various construction types.

For example, fly wire mesh on windows have in some instances stopped flying embers from entering windows that have broken from the effects of radiant heat exposure from bushfire fronts and therefore there are some

recommendations for different configurations of screens for protection of windows for some Levels of Construction.

This approach was the best available at the time of development of previous versions of AS3959 and although it is easy to be critical from a scientific basis once more knowledge comes to hand, the Standards has served our Community well for over a decade or more now.

Performance fire testing of materials

BCA and Australian Standards

Unlike commercial buildings, where under the deemed to satisfy provisions, materials or construction elements which require a Fire Resistance Level (FRL) or fire rating are tested to a well documented and accepted Australian fire test methodology, AS1530/4, apart from so called Fire Retardant timber, there are no accepted Australian Standards detailing any fire test methodologies for materials or construction elements for Residential bushfire prone areas.

In many ways this is ironic as although we operate in a performance based environment, we have no accepted methods by which to prove the performance of materials and construction elements for use in construction in bushfire prone areas (again except for Fire Retardant timber).

This is not unrecognised by the Australian Building Code Board, who are responsible for the development and the publishing of the BCA, nor SAI Global who are responsible for development and the publishing our Australian Standards.

The problem is that we do not fully understand enough about bushfires and specifically the exposure mechanisms that a building will be subject to in a bushfire attack. However it should be noted that we are gaining more knowledge as more research initiatives are conducted in this very topical and important area of fire protection.

To understand the effects of bushfires on structures, one needs to consider multiple attack mechanisms when and their simultaneous effects on the building as a whole. These effects include but are not limited to the radiant heat exposure the bushfire (flame) front itself, its intensity and duration profile, the effect of any flames, and the effect of burning brands and wind borne embers.

It is therefore not as easy a task as you can see to develop the required fire test

method(s) and associated acceptance (pass / fail) criteria for the different construction elements for building in designated bushfire prone areas, and for the different categories of bushfire attack for that matter.

Research related initiatives & developments

There are various research related organisations here locally and of course overseas who are working on improving our understand of bushfires and there has been some progress, but like many other areas of research, some of us would like to see things move just that little bit quicker.

A couple of key examples are provided below but this list is by no means definitive.

CRC for bushfire

After those now infamous Canberra Bushfires, we have seen the creation of a Co-operative Research Centre for Bushfires. The Bushfire CRC states its objectives and aims as follows:

Our objectives can be summarised as providing research which manages bushfire risk to the community in an economically and ecologically sustainable way.

Aims of the Bushfire CRC:

To develop an internationally renowned centre of excellence to lead and coordinate bushfire research in Australia.

To provide a research framework that will improve the effectiveness of bushfire management agencies.

To increase the self-sufficiency of communities in managing the risks from bushfires.

To learn more about this organisation visit www.bushfirecrc.com

Warrington Fire Research Australia

Another organisation that has been active in bushfire related research and specifically in relation to performance of materials and also the development of fire test methodologies is Warrington Fire Research Australia, WFRA.

WFRA have developed and published some DRAFT fire testing methods which have been provided to SAI Global as a good starting point for what we hope will be the timely development and publishing of Australian Standards for fire testing of materials and construction elements for use in construction in bushfire prone areas.

To learn more about WFRA and to views

the DRAFT FSE025 series of test methods visit www.wfra.com.au.

AS3959 and Fire Retardant timber

Fire Retardant timber is specified for various Levels of Construction and specific construction elements when timber is used under the requirements of AS3959.

The current 1999 version of AS3959 defines Fire Retardant timber as:

Fire retardant: A substance or a treatment incorporated in or applied to a material, which suppresses or delays the combustion of that material under specified conditions.

Fire retardant timbers are those which have been treated (impregnated or painted/coated) and which meet the following requirements when fire tested against the cone calorimeter test methodology.

For the purpose of this standard, fire-retardant timber is timber that is specified when fire tested to AS/NZS 3837 (Cone Calorimeter), and meets the following parameters, after having been subjected to the (accelerated weathering) regime of ASTM D 2898 Method B:

- a) Ignition does not occur when the material is exposed to an irradiance level of 10 kW/m².
- b) The maximum heat release rate is not greater than 100 kW/m² and the average heat release rate for 10 minutes following ignition is not greater than 60 kW/m² when the material is exposed to an irradiance level of 25kW/m².

External timbers are regarded as protected in terms of AS3959 if they are covered by a roof projection (or similar) at 30 degrees to the vertical and they are well detailed and maintained (painted and stained and kept well ventilated) – see figure 3.7.4.5 right. In this case the weathering testing is not required before fire testing.

New & innovative materials

As the Executive Officer of the Alliance for Fire & Smoke Containment, the author has a role that brings together a large proportion of Australia and New Zealand's manufacturers, suppliers and installers of "Passive Fire Protection" products and systems. It also results in a real interface with a large

proportion of architects, consultants and of course end users who enquire about the services of the Alliance. The author is therefore in a unique position where he can in effect provide a conduit between these two respective groups.

In terms of construction in bushfire prone areas, the author, like many others in the fire industry at large, has been inundated with enquiries and problems relating to finding and incorporating suitable materials and systems into the construction of houses in so called bushfire prone areas.

Unfortunately the Regulatory system and technical provisions described in some detail above, do not provide for an easy means for which manufacturers and suppliers can develop and fire test their products. Unlike for commercial buildings, where the defined fire testing standards exist, the lack of fire test standards has proven for many to be barrier to the development, testing and launching of products by some.

However, this scenario not stopped some more innovative and aggressive companies from soldiering on with their development activities. It is these forward thinking companies, who have in the author's view responded to the challenge, that form the basis of the subsequent product development features to complete this article.

These companies should be commended for their initiatives and I hope common sense prevails and the fire test methods and acceptance criteria that are finally developed and become published as future Australian Standard fire test methods, do not penalise those pioneers for being first, by requiring additional testing and expenditure unnecessarily.

Fire testing generally

Although as discussed previously there are no Australian Standards at this point in time, many of the manufacturers and suppliers are proceeding with fire testing by way of exposure to known incident radiant heat fluxes, using either the basic principles of the DRAFT WFRA FSE025 bushfire test methods, or according to other ad hoc radiant heat exposure conditions. This testing is with and without simultaneous or separate supporting data for other mechanisms of attack in a real bushfire, depending on the



manufacturer and their product type. Although this different fire testing is not easy for the approving authorities and consultant to compare the relative performance of competing products for similar applications, it does provide a good basis for which alternative solutions or job specific approvals can be granted and in many cases difficult problems can be solved using innovative and cost effective products.

Garages, verandas, pergolas, awnings and other attached structures

Laserlite Australia has conducted a serious fire testing program to understand the performance of its Polycarbonate and transparent roof sheeting products both for use on boundary conditions adjacent to fire source features and of for use in construction in bushfire prone areas.

Co-ordinated by J-RAK Consulting, this fire test program performed at CSIRO's North Ryde facility, included AS/NZS3837 benchmarking testing of the different proprietary fire retardant product Groups followed by extensive full scale testing of Pergolas structures built using non fire retardant, but treated pine softwood. The fire test results have exceeded the expectations of all involved in this program and at the time of writing Laserlite Australia are in the process of applying for a formal CSIRO Appraisal to endorse the Laserlite 2000, Apollo and XPT series products for compliance with the Building Code of Australia as a viable solution for construction on both boundary conditions and for construction in appropriate levels of bushfire attack.



Laserlite clad timber framed pergola construction with typical accumulated debris including leaves and bracken ready for bushfire fire testing.

Weepholes



Weepa Products is one of my favourite companies in terms of the simple but successful innovative ideas. For those of you who do not know, Weepholes are the gaps left between some bricks in external walls. They serve two important purposes:

1. Ventilation of the internal wall cavity. Without ventilation, mildew, dry rot and damp reduce the life of the internal wall studs and other building materials within the cavity, and
2. Drainage. Water that enters the cavity due to capillary action, condensation, damage, or accidental flooding needs to

escape somewhere. In tropical and sub-tropical areas of Australia it is not unusual to see water flowing from the weepholes on the prevailing side of well-constructed

houses after a 'gully raker' or monsoonal storm.

The problem is weep holes provide an avenue for embers in bushfire prone conditions to enter into the sub floor of houses that can obviously cause the house to burn down.

Weepa Products developed the Weepa Spark Arrester Grate in response to requests from building authorities to overcome the practical difficulties involved in installing mesh in weep holes.

They have conducted numerous iterations of fire tests at CSIRO North Ryde to develop a cost effective and high performance product to meet the requirements for construction in bushfire prone areas

Door and window seals

Lorient Australia is a leading supplier of door sealing and glazing products and has a long association within the specialist field of fire and smoke containment as well as sound and energy and weather

Their company draws upon a wealth of knowledge and is able to provide innovative solutions to ensure that doors and windows can meet the stringent Fire Resistance (FRL) requirements of the Building Code of Australia and related International fire resistance codes.



Laserlite clad timber framed pergola construction under bushfire fire test using a full scale radiant heat exposure panel



Picture showing a pilot scale fire resistance test on a fire door incorporating a Lorient Integrity® automatic door seal

The new Australian bushfire requirements, which are relatively new and without a documented fire test methodology to date, when compared to other related areas of

fire risk compliance, have not deterred Lorient's product development and commercial efforts in the bushfire area. The company offers proven solutions and is currently undertaking a comprehensive fire testing program to refine products that can stop embers passing through gaps around doors and window frames in different simulated bushfire conditions.



Close up picture of fire resistance test on the same door as picture above, showing the full integrity of Lorient Integrity® door sealing system with in excess of 800 Degrees Celsius fire exposure on the other side of the door leaf

Windows

The Australian Window Association, (AWA) has recently completed Stage 1 of a research project relating to the relative performance of different window frame materials at different incident radiation exposure levels. To provide an accurate comparison all glazed opening contained 5mm nominal toughened glass. This project was co-ordinated by J-RAK Consulting and the indicative fire testing was performed at CSIRO's North Ryde fire test laboratories.

The fire testing program incorporated different species of timber frames (both hardwoods and treated softwoods), aluminium frames and uPVC (plastic) frames. Results at incident radiant heat fluxes of 12.5, 31, 40 and 60 kW/m² with and without simulated ember attack as appropriate.

The results have provided AWA, its technical committee and of course its

members with an invaluable understanding of the relative performance of different window frame types at different exposure conditions that might be experienced



Timber framed window assembly ready for indicative bushfire fire testing

during various levels of bushfire attack.

This data will allow the AWA and its members to have some confidence to co-ordinate some full scale fire testing once Australian Standard fire test methods are agreed.

Discussions are continuing regarding additional Stages of research to look at other variables such as the performance of wire screens with different glazing options.



Timber framed window assembly during indicative bushfire fire testing. Note - Radiometer in foreground and radiant heat panel in background.

Skylights

VELUX Australia has completed extensive product development, including fire testing of their roof window and skylight products. The testings have resulted in an understanding of the performance of the VELUX product range for use in dwellings in bushfire prone areas.

Testing has been conducted using the basic exposure conditions as outlined in the DRAFT WFRA FSE025 series of bushfire test methods, to incident radiant heat exposure levels of up to and including 60kW/m². VELUX have proven in their proprietary framing system, that with their toughened laminated IGU configurations, it is not necessary to use wired glass to achieve acceptable performance. Multiple glazing options for their product range are available to ensure compliance with the Regional regulatory requirements.

The product development team in Australia also draws on experiences from the other 70 VELUX offices around the world. This experience together with the fire testing portfolio, give users the peace of mind utilise the benefits of natural daylight that VELUX products provide, whilst conforming to important design criteria relating to fire and in particular bushfire prone areas.



Picture showing aesthetically pleasing, Velux Australia, bushfire resistant skylights incorporated into a house constructed in a bushfire prone area

Fire retardant coatings

Cease-fire Technologies is quickly becoming a serious player in the supply of fire retardant products. To the best of my knowledge and to the frustration of industry generally, there are no compliant Fire Retardant timber coatings available in the Australian market that meet with the full fire test requirements of AS3959.

Cease-fire Technologies have recently completed a fire test program at CSIRO North Ryde whereby its Cease-Fire FRT (Fire Retardant Timber) System has met the requirements of AS3959 after testing to AS/NZS3837 at both 10 and 25 kW/m². These test were not after ASTM D2898 weathering testing as required for fully exposed areas, however does allow its use in areas covered by the exemption given in AS3959 for protected external area.

The Cease-Fire is coating system consists of three parts; a primer, an intumescent basecoat and a weather resistant (APAS Approved) external top seal. It is the result of a number of years of research and development and Cease-Fire Technologies are proud to report that it is an Australian made product.

At the time of writing, samples had been submitted for weathering testing and Cease-Fire Technologies is confident, due to the proven performance of the external top seal, that the subsequent fire results will be successful and the product will be approved for unlimited use as a fire retardant timber as defined in AS3959.

The fire retardant coating system will be in full production in early December 2004.



Cone calorimeter test to AS/NZS3837 on non fire retardant timber showing extensive flaming and significant heat release rate



Experimental indicative bushfire fire test on a non fire retardant treated timber fascia / gutter assembly in the early stages of radiant heat exposure

Eaves, fascias and gaps between rafters

Promat Australia is a leading supplier of fire rated calcium silicate building board technology. Unlike fibre cement boards, which are prone to cracking and spalling in the advent of fire, calcium silicate technology remains stable and is not affected by the flames radiant heat of fires.



Promat's Promatec calcium silicate board material incorporated into eave linings on a home for construction in a bushfire prone area.

Promat Australia has a wealth of experience and fire test data from which to provide recommendations for construction relating to the eave linings. Their Promatec range of high-density calcium silicate board material is ideal in this scenario.

Promat have also adapted it patented Promaseal® IBS flexible foam material for use in construction in bushfire prone areas and specifically to deal with the fascia or gaps around the rafters which is a problematic area as embers can easily be blown into the combustible roof cavity if these gaps are not adequately sealed with a proven fire sealing material. Promaseal® IBS flexible foam system can be used in conjunction with Promaseal® intumescent acrylic mastic to provide a complete sealing system impervious to the ember attack in bushfire situations.

Underfloor spaces

Alsynite Specialty Products manufacturers an innovative product called Paraphen®. This product is a glass reinforced phenolic sheet material manufactured locally in Australia on a continuous process in their Sydney factory. Phenolic materials are well known for their low flame spread properties and low smoke and toxicity

emissions.

Although Paraphen's principle use is as a wall & ceiling lining material, often as part of composite panels, for use on marine vessels, train, road tunnels and in other confined spaces, it also has application as a thin, flexible and cost effective lining material for protection of underfloor

spaces on suspended timber floors. It can be easily cut and fixed over the entire surface of timber flooring, bearers and joists. By nature of its phenolic chemical composition, it will not rot or be affected by the elements.

Paraphen can also be manufactured into corrugated or other profiles that would have an application as external wall cladding materials and Alsynite Specialty Products have targeted their ongoing development program for

bushfire related applications in this important area.



Alsynite Paraphen® phenolic sheet material being subjected to stringent spread of flame testing with radiant heat source and simultaneous pilot flame

Conclusions

- Bushfires are something we need to accept as history has shown they occur regularly
- The Building Control Regulatory system varies from region to region, as each State and Territory tries to improve the resilience of construction in bushfire prone areas
- Although we operate in a performance based Building Code environment, AS3959 and associated technical provisions are still very much prescriptive
- Bushfires are a complex phenomena and we are slowly learning more about the prevailing fire conditions and their effects on building stock
- Although in the minds of some, progress is slow, fire test methodologies and acceptance criteria are being developed and should be published in the relatively near future
- Contrary to the lack of uniform technical provisions for fire testing, many manufacturers and suppliers are

developing and fire testing innovative and cost effective products and a trying to introduce these into the construction of houses in bushfire prone areas. They have most certainly responded to the challenge in a positive and aggressive manner.

- Councils and private building surveyors, as well as other authorities such as Regional Fire Services need to gain a better understanding of the recently developed fire test methodologies for bushfires and need to step out from behind the "security blanket" afforded by AS3959 to look at the new, innovative and cost effective products and systems that have been fire tested and are being promoted, with a view to allowing their incorporation.
- We all have a great deal to learn in relation to bushfires and the performance of different products and materials, and manufacturers and suppliers are urged to continue their product development, fire testing and promotion, as this helps us all as a community develop more innovative and

ultimately safer building stock against the effects of a ravaging bushfire

- It is difficult for us to know where to start when looking for suitable products for construction in bushfire prone areas, and the Alliance for Fire and Smoke Containment's web site at www.pfpa.com.au has a "find a product" area, where consultants, approval authorities and end users can find some innovative products.



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