

Chair: Malcolm Hackett OAM

Presenter: Dr Justin Leonard



### **Justin Leonard**

In opening this forum I thought I'd try to do a bit of framing around bushfire, from a context that really bushfire's driven by not what we managed to tackle or put on the plate, but it's defined more by what we might have missed or overlooked in a preparation, or in the actions we take on a given day.

So, I wanted to really start with the concept of a checklist. And not the traditional checklist that we talk about on what we prepare for and what we do on the day, or how we how we plan our hierarchy of approaches on the day. I'm talking about a checklist of what actions a house might be faced with, and what considerations we might use that checklist of mechanisms that could attack a house to really deeply consider how our house and surroundings might respond.

So, here's my checklist to cover off the various attack mechanisms that could interact with the house.

## House Design & Maintenance What are we up against?

### Attack Mechanisms Check List:

- Large fire front – Radiant Heat & Flame
- Ember attack
- Adjacent buildings
- Adjacent combustible objects
- Surface fire
- Tree and large branch strike
- Wind and wind blown debris
- Smoke (Human exposure)

Now, I've broken it into some deliberate categories.

We've got the large fire front, which is that big archetypal thing that we commonly associate with the fire that brings that radiant heat and potential flame contact.

We've got ember attack and all of that wind-blown debris that is yet to burn. So, that ember storm but also the debris field that comes and fills up everything during the event.

The combustion of adjacent buildings. So that might be your neighbour, might be adjacent sheds.

Adjacent combustible objects. This could be anything, this could be a fence, retaining wall, a wood heap, a wheelie bin, pretty much any combustible object that's either mobile or fixed

that then acts out and acts as another heat source to either your house or your egress paths on your property.

Surface fire isn't spoken about very often, but it's actually a very ubiquitous action, which is the burning of any surface fuels adjacent to, or under, or against your building. And those surface fires are also very challenging because they present real difficulty for you to navigate the surrounding landscape around your house if you're forced to leave your house, if your house happens to burn. So, these surface fires are different to large fire fronts. Large fire fronts move through very big structured fuels but surface fires burn out that low level surface material, it might be dry grass, mulch, tanbark, any combustible surface. And in a sense that debris that comes with an ember attack that blows over the ground can actually build up and cause small surface fires on things like decks and walkways that would otherwise not be combustible.

Tree and large branch strike. The fire actions themselves can play up against trees, they can find and exploit knots and defects in trees, and, if anyone's been through a major bushfire event, the constant sound of trees falling over in the distance, hopefully quite distant, is quite ubiquitous throughout the fire event itself and for hours and hours afterwards, because the fires are acting on the trees. And that's not accounting for the wind and the wind loadings that push those trees around as well. That's another layer of question and issue.

The wind and wind-blown debris has an action and an attack mechanism in itself, and this is deliberately brought out as an individual line item because the winds are always associated with the reason why it's a bad fire day, but the winds themselves and the debris that they can carry with them act on the houses as their own attack mechanism. So the wind-borne debris can impact and break windows, the winds can dislodge and shift any facade or roof tile or system. So depending on the loads they can cause this superficial damage that makes all the other actions potentially quite challenging for an otherwise fairly robust house to get through the process.

I've also included smoke, which isn't really an action that upsets a house itself, but because these houses are inherently a shelter, or potentially a shelter for its occupants, the smoke and how the smoke plays or gets into a house or whether the house itself is a source of smoke plays out in that human exposure dimension. So it's an important factor when considering how we prepare our houses and how we act on the day, and what type of PPE and preparedness and physical health context we consider around that smoke human exposure factor.

## **Justin Leonard**

Now, this checklist, all things aren't created equal and certainly, as Malcolm duly pointed out, everyone's circumstance is not created equal by any stretch of the imagination. And as well as every fire event comes with its own specific level of intensity and direction and how it unfolds.

So out of this checklist, what's really important is to understand which aspects of those actions are actually ubiquitous to every fire.

So what I've done here is really highlighted and emboldened the things on this checklist which you cannot untick. You have to have these, you have to deeply consider these attack mechanisms because they are ubiquitous with every fire event and every process.

## House Design & Maintenance

### What are we up against?

#### Attack Mechanisms Check List :

- Large fire front – Radiant Heat & Flame
- Ember attack**
- Adjacent buildings
- Adjacent combustible objects
- Surface fire**
- Tree and large branch strike
- Wind and wind blown debris**
- Smoke (Human exposure)**

Occurs in all bushfire exposure events

There's always embers, there's always surface fires acting around your property, there's always wind and wind-blown debris context that either is intense enough to be a direct action in itself or simply adds an important additional context to everything else and smoke exposure is ubiquitous to all fires.

So we have to keep them all completely ticked and not overlook their importance and ever presence.

And I guess these things are also ubiquitous because they persist for a certain time before the main fire event comes and passes, and during the event, and for hours and hours after the event. So they're ubiquitous for a whole range of reasons and I can't overemphasize these four of the checklist enough.

## House Design & Maintenance

### What are we up against?

#### Attack Mechanisms Check List :

- Large fire front – Radiant Heat & Flame
- Ember attack**
- Adjacent buildings
- Adjacent combustible objects
- Surface fire**
- Tree and large branch strike
- Wind and wind blown debris**
- Smoke (Human exposure)**

Occurs in some bushfire for some circumstances

The other ones are highly contextual, and for a number of fortunate circumstances, some of these ones can be either never ticked because you might not have a close enough or intimate exposure to a large fire front, you might have sufficient separation distance, and there's lots of different ways to have that discussion about how far you need to be from certain types of bush and in certain types of circumstance.

There's adjacent buildings and the fact we might be fortunate enough to have sufficient separation from neighbouring properties and property boundaries, and we may have a good

setup where we're at least 6m or more from other buildings and structures on our actual property, but in some cases we don't and therefore we have to include that and deal with it.

Adjacent combustible objects could be fixed, like fences, or they could be movable, like caravans and wheelie bins and things. And I guess that context of fixed ones means we have to tick it, but also, I guess, those ever present mobile things can't be overlooked, and particularly in that preparation phase where we're really lining ourselves up and getting our thoughts and actions in place around being ready and configured well for a fire season.

I guess trees and large branches is another one that really comes into its own when we're within tree striking distance of adjacent large trees, and obviously it's not that hard to work out whether we're at least one tree height away from these things, so as a tree falls down it doesn't actually physically impact the house, although there is that small context of where, under very extreme wind events you can actually snap a branch off a tree and, even though it's quite a heavy branch, you could travel something like one and a half to two tree heights laterally before it hits your house under those really extreme wind conditions. So a little bit more clearance as always adds a bit of comfort.

Now, what's important out of this list is to really consider that the iconic large fire front and the radiant heat that it brings is certainly the poster child of really what happens in a bushfire. The news and the imagery certainly draws us to that very iconic aspect of the fire, but what's really important to emphasize is that well over 80% of all the houses that are lost in these bushfires is actually lost without any of that large fire front action actually playing a role in the house. It doesn't get close enough to present the radiant heat and it doesn't get close enough for the flames to physically interact with the house.

## House Design & Maintenance

### What are we up against?

#### Attack Mechanisms Check List :

Large fire front – Radiant Heat & Flame

**Ember attack**

Adjacent buildings

Adjacent combustible objects

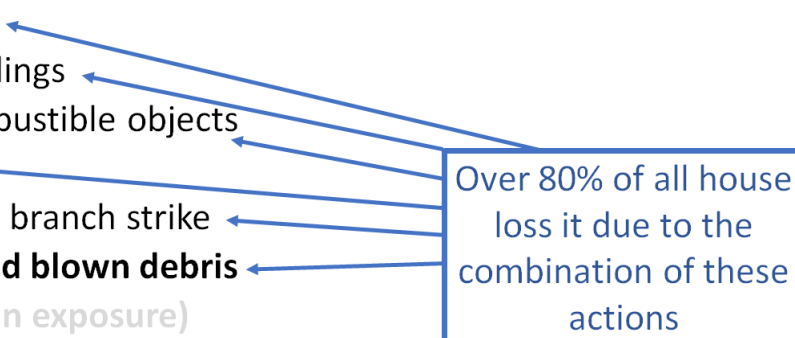
**Surface fire**

Tree and large branch strike

**Wind and wind blown debris**

**Smoke (Human exposure)**

Over 80% of all house loss is due to the combination of these actions

A blue-bordered text box on the right contains the text "Over 80% of all house loss is due to the combination of these actions". Five blue arrows point from this box to the following items in the check list: "Ember attack", "Adjacent buildings", "Adjacent combustible objects", "Surface fire", and "Wind and wind blown debris".

80% of loss actually is left to these non greyed out line items. So ember attack, adjacent buildings, and adjacent combustible objects are all the factors that actually end up playing out and being most responsible for loss in fire. So, once again, these are particularly useful ones to highlight if they're a tick for you specifically.

And I guess what's also quite interesting. Now, there's quite a lot of us in different circumstances, whether we've got a house that's been built to regulation, or we're using regulation as a bit of a guide to what we need to do in our preparations, or we're anticipating building to regulation, what's really important is regulation.

# House Design & Maintenance

## What are we up against?

### Attack Mechanisms Check List :

Large fire front – Radiant Heat & Flame

**Ember attack**

Adjacent buildings

Adjacent combustible objects

**Surface fire**

Tree and large branch strike

**Wind and wind blown debris**

**Smoke (Human exposure)**

Considered by  
Bushfire building  
Regulation.

Partially or not  
Considered by  
Bushfire building  
Regulation.

Both planning and building regulations deal with the first two line items. They deeply consider how far we are from the bushfire, so you would have heard of Bushfire Attack Level assessments and BAL assessments and things, all deal with how large could the fire be, and how close I am to it, therefore what have I got to design for.

And they also implicitly try to design for and consider ember attack within some bounds. They certainly only try to specify and do that within 100m from identified problematic fuels and then not really deal with it after, but that's an internal regulation issue.

All the lower line items are only partially or not considered at all by building regulation, so they really fall to dealing with these things on an individual due diligence basis, which is quite a lot of deep consideration to work through really.

Adjacent buildings beyond property boundaries are simply ignored by regulation. Adjacent combustible objects are the responsibility to manage. Relocatable adjacent objects are not a factor in consideration for regulation.

The combustibility of fences and retaining walls is not considered as something that regulation attempts to recognize or design for.

It doesn't really account for surface fires and how they play out, so a mulch garden up against a house is a fire source not really considered within regulation.

Trees and large branch strike not really considered at all.

The wind actions and wind-borne debris are not considered at all in regulation. In fact, they just assume that the Wind Loading Codes and the requirements of how Wind Loading Codes are dealt with for your given region are enough to not deal with that superficial damage to the house. But when you actually open a Wind Loading Code and really unpack it, the Wind Loading Codes are more about preventing your roof being blown off your house, and not dealing with the issues of superficial damage. So, really, that then falls to thinking about additional measures and being quite detailed about how we design the specific aspects and features around our house to deal with that.

Smoke and human exposure is not a factor in building regulations. It's not a design objective when we're looking at building and planning regulations, so once again it falls to individuals and individual circumstances.

## Chair

Let's have a look at our webinar poll results and see what people's priorities are. Would you like to comment on those, Justin?

## Justin Leonard

I guess it's good to see the top poll result being a focus on debris accumulation prevention. And I guess what I'd hope is that that's not necessarily just the traditional thing of, "I'll clean out my gutters," but more of a recognition that the debris accumulation happens extensively during a fire.

Preventing debris accumulation by design, like not having gutters or having non-combustible gutter guards that just don't allow debris accumulation, or having decks that aren't ignitable by debris accumulation, are the types of strategies I hope people consider when they're looking deeply at that kind of approach.

Removing combustible mulch near houses, that's fairly low but obviously an important and ubiquitous one, unless your house is quite resistant.

Second highest looks like reducing the extended vegetation that could spread a surface fire. Yes, I think that's excellent.

The ideas of having more like gravel mulch or fixed pathways immediately around the house I think are really important design considerations for effective maintenance and limiting that surface fire attack. It's great to see that one as on people's radar.

## Justin Leonard

So, let's unpack each of these attack mechanisms and what they can actually do, or what we can do to address these. So, obviously, of the Q&A questions is what can I do with a large area of window exposure to large fire fronts and radiant heat. So, if this is a genuine tick, I guess the intensity of the fire front that the house experiences really comes down to how far we are away from it. So, to gauge and profile that is absolutely critical.

It's important to understand what your maximum radiant heat level might be, and that might come down to learning and understanding how to do your own informal Bushfire Attack Level assessment, seeing where you sit on the spectrum of what your house would need to be designed to, using a BAL assessment tool. And I'd encourage you to speak to various authorities like the CFA and do some web work. Research around how to do those calculations. Once you work out where you are on that radiant heat spectrum, or in fact if you're so close to the bush that you actually have the risk of flame contact, then designing for that becomes particularly important. Because, in the worst case fire events, you can have some very catastrophic rates of failure for your windows or the rate that your house becomes ignited.

Responding to those can be managed and varied and one thing would be to have a very low tolerance for having any exposed timber on your building at all. That might be your eave linings, really can't be timber, any exposed timber window frames, any exposed timber doors or decking are all highly likely to be ignited during the event from that radiant heat and flame contact. And the obvious types of retrofitting responses that are possible are closable shutters over windows and doors, and even things like roller security shutters which are some of the examples pictured here.

It really is a challenging deep dive if this box is ticked. It really means you need to really deeply investigate that context and also work on what can be done in the broader landscape to shield from that risk, or to extend that vegetation clearance, or have a stage vegetation clearance to mediate the radiant heat and flame contact on your structure if that's possible within your landscape and within your property boundary. It always seems to be that the most effective solution, if possible, is

to get a balance between building design and landscape fuel management. But obviously every circumstance is different.

If we go to ember attack, the challenges around where embers act is really ubiquitous. There's just so many details and elements on houses that play out as a way ember attack can reach houses. The way it builds up in gutters and gets into roof cavities and causes ignitions that are in many cases completely unaware to an occupant until that building cavity is well alight and starts to threaten the integrity of the house. Brick buildings, even double brick buildings, are susceptible, given the way that those wall cavities are ventilated. So screening all of the entry points down to gaps smaller than 2mm, which is quite a formidable task when you think about house and building tolerances and the way window frames are fitted to building facades. It's quite rare to actually find such attention to detail that a genuine 2mm tolerance is met.

It's also worth noting that things like timber features on houses, or timber facades on houses, shrink in, whereas their moisture content varies and shrink and expand. So, actually maintaining dimensional tolerance to 2mm or less is impossible with some building designs as well. Every once in a while, I do find an incredible effort to achieve ember mitigation and tolerance, and probably the picture on that bottom right is an example of a very well considered and structured enclosure of what was otherwise previously an open carport. So, it's actually very fine punctured steel that's been very very precisely cut in and fitted to enclose, and this tilt panel door is one of the few types of roller doors that is actually quite tight fitting when it closes. You notice there's not a gap across the top like a traditional roller door that the gap grows as the spool unwinds in the roller door.

And this particular tilt panel door actually has those high temperature nylon brushes along the base and along the track edges and along the top edge, so that as it closes those brushes are pulled up and act as an ember screen. So, it is achievable, but it is a real question of detail and understanding about "can a 2mm object get through and into either a building cavity or into the occupiable space of your home," is really the only way to unpack it and spend a lot of time understanding where all these features are.

Adjacent building and adjacent combustible objects are put into one broader category because, I guess, in a traditional urban setting, houses are packed in quite close and the fences are put in between, and all the traditional objects we put around our houses not only act on our own houses but act on our neighbour's houses. So it's this collective aggregation of all of these potentially combustible objects that are very significant and burn down for not just the 10, 20 minutes, half an hour, 40 minutes that a fire front classically can pass by. These burn for hours and hours and act on your home if they're close enough.

So, they're absolutely critical to deal with. Very difficult to mitigate. The types of barriers you need to mitigate a structure from an adjacent structure is really tough, but you can build or retrofit houses, walls and windows to actually handle the potential of a neighbouring house ignition. But probably one of the best ways to think about house-to-house ignition risk is to have a really deep discussion and a strategy with your neighbour. Because one thing you can do is if two houses have the potential to burn each other down, one of the key ways is ensuring neither house ignites in a bushfire so you don't have that mutual risk problem. But either way, your chances are elevated because you don't have to just get one house through the fire, you've got to get two or more houses through that fire, so it is a real question of a discussion at the streetscape level. And probably a good way to hopefully bring neighbours to together around a common issue.

Surface fire. I'd like to elevate that in the discussion because it doesn't actually get touched on that often. But it's something really common, and a common oversight I see. I guess the bottom picture is an obvious oversight where mulch and tanbark and things have been used right up to a combustible subfloor enclosure, the treated pine subfloor enclosure on the house. So, the house certainly isn't up to a surface fire action itself and the local landscaping is certainly not offering any attempt to reduce or manage surface fire risk.

The two problems are you just can't have combustible elements down to ground level, because even if this was concrete pathway, the debris that would blow up against those combustible elements would be enough to ignite the house. But, this combination pretty much puts it in the certain "sign off this house in a bushfire" type scenario.

Now the top picture was a reminder to consider things like low level lawn or managed lawn as not necessarily a problem, particularly if it's green. But a lawn that dries out in the most extremes of our fire seasons becomes a combustible surface. So, we do need to think about not having a look for what's dry and ready to go in our preparation season, we need to think about how things transition. And that might also mean manage gardens up against houses which are not really in a flammable state in the off season, but could be quite water stressed and desiccated and be quite a problem in a fire season itself.

And, of course, tree and large branch strike in proximity of house is obviously a really major challenge and issue. It also is a major question around reliability of egress, either off your property and through the local neighbourhood to a place of relative safety. And I'm certainly not predicating that egress should happen during a fire event, because obviously using your house to shelter during the peak of a fire front's key. But, in the event that the house becomes untenable, you then have to consider egress and transitioning through the landscape. And that is really where tree and large branch strike become problems, not from just the context of hitting a house but blocking a driveway, falling on a car, blocking off major traffic routes and causing traffic jams and entrapments on roadways. So, it's really that question about an onion ring approach of considering all the trees and potential actions.

And certainly I'd encourage you to talk to tree experts and arborists around the types of trees and the state they're in, and the likelihood that they could fall. There's a lot in the tree type and their age, and the degree of imperfections in them that help to find the likelihood that they could fall and be problematic in a bushfire.

And wind and wind-blown debris is another one of those really key factors that can drive embers up. And I've purposefully put a skylight in here because they're probably underrepresented in our broader context, and it was great to hear a question specifically about them. Addressing the details of how wind actions can play up, it might disturb a skylight or it might blow debris up against it that's readily ignited from an ember attack. And just looking at all of those actions in combination I think is really key. And I thought this was a really great photo set that actually showed a recognition that a skylight by design could be an inherent weakness on the roof. And the top picture is actually the drop over protection box that's put over these skylights during the peak summer season as a direct way to address that factor, from wind actions acting on it, and I guess it's also an effective radiant heat and ember attack factor. It's a real multifaceted design mitigation feature for this particular element.

And then, of course, the last one, but not least is around really having a deep think about smoke and what it would be like to have to deal with the steady accumulation and build up of smoke within a house that slowly builds up, and if you can keep the house closed and tight as much as possible, obviously, the rate that that builds up is quite managed. But the really noxious and toxic smoke actually not only just comes from bushfire, but it comes from when urban fuels and synthetic things, like plastic and whatnot, burn either as an aspect of the house itself or from adjacent things in your broader landscape.

And that really noxious smoke really takes the exposure question to the next level. And that's a question for you getting through in relative comfort and safety within your house, but also that question of whether what you're genuinely exposed to if you need to leave a house, if it's going to become untenable because it ignites.

The top picture here is actually a prompt for me to highlight some more novel ways of thinking about not only having a house that's relatively airtight and well designed to limit the rate of smoke ingress, but to actually consider novel things like hair scrubbers and air purifiers that, if used in



designated rooms that are obviously rooms that are also exits from your house, they can help to improve and extend the tenability and limit that smoke ingress. And particularly useful if you're susceptible to smoke. If you're asthmatic or not as physically fit as the rest of the population.

## **Chair**

What's your thoughts on those poll questions?

## **Justin Leonard**

Hey it's only limited to three priorities for reducing your house and property risk, that's a bit of a tough question. If you picked your top three, yes I'm really glad to see those highlighted ubiquitous attack mechanisms, like ember attack, really coming to the fore and being the focus. It's great to see that idea and approach coming through in the priority mitigation actions.

I think it's really good to think about those actions as a hierarchy, and if you solve things like ember entry and gap consideration you're really thinking about being prepared for not just the worst fires but also the whole range of fire intensities that could turn up and being prepared for the fact that embers are ubiquitous with them all, so that's fantastic.

Second highest seems to be "remove dead material thinned fine fuel around and near the house," so, yes, excellent priority. I'd largely agree that that's where the three priorities are and I would probably answer identical to those. So, well done audience.

## **Chair**

I'm particularly interested in embers because it was it was embers that got our house. I wanted to ask you about is whether much is known about the way people think about embers, because I must admit I tended to think of embers as a single thing that might get in and start a fire. But in fact, the idea of embers that come like a sandstorm and they build up against things and so, in the end, you've got this red hot stuff that's actually what's going to ignite your window frame, or your mulch, or whatever it happens to be. Has there been much research on how people think about embers.

## **Justin Leonard**

I guess the ember work and investigations is more like a disconnected technical deep dive into what embers can and can't do, but you do raise a very important question around the difference between human perception of embers and what's technically possible that embers can do, and how you work with them. And I think there's probably something in there to investigate people's diversity of attitudes and assumptions around ember attack.

In reality, ember attack is everything fine that's become airborne that's essentially combustible. So leaves, twigs that are either not burnt yet or are burning and flaming while they fly, or they're glowing while they fly. And they turn up and lodge in and get through gaps and build up in corners and crevices and are continually fanned by the wind, and just create prolific combustible debris build up and localized flame sources on everything external, particularly where there's a complex corner, like everywhere where leaves blow and accumulate in a normal windy day is where these embers and small flame sources build up.

And of course, what can an ember do and how small does it have to be before it's not a problem anymore, and the magic number is certainly down around 2mm. So an ember less than 2mm if it gets into something, let's say a rat's nest in your roof. A 2mm glowing ember is not quite enough to get a rat's nest going if it lands on something perfect as an ignitable source. Larger embers certainly are and the larger they are the more likely. And of course the larger the gaps the more large embers get through, and the more large embers get through the probability of ignition happening increases.

So it is a highly probability driven question. The only absolute certainty is there'll be embers there when there's a bushfire. It's just how many and how big the flame sources are and how many simultaneous things are happening all at once.

## **Chair**

This person has a terracotta roof with sarking underneath, and they see lots of light and possible ember entry points when they're up in the roof area, and they're interested in suggestions to minimize the risk of ember entry.

## **Justin Leonard**

Yes, so their intuition about recognizing that as a major ember egress problem is right, and that's seeing light streaming through into your roof space is one really clear and obvious thing. Roofs that are sarked or even quite completely sarked with conventional sarking that you can't see right through is also just as big a problem if they're under traditional terracotta tiles or traditional tiled roofs. The problem with tiles are they're not tight fitting enough to prevent the embers from getting into your roof space. And what you'll notice with those tiled roofs is when you get up inside them, there'll be a certain amount of leaf debris or fine debris already building up over the years. And that's another indicator that the embers will come in through those same paths and ignite those things.

The debris sits on top of sarking as well, so it can be a problem that's hidden from view even if you get up into your roof space, and you only really find out how bad your problem is when you start to lift or repair your roof tiles and see how much debris is actually sitting on top of your sarking. And what you'll also notice is that the tile battens that your tiles are tied down to, or are sitting on, is actually over the top of your sarking, so you've actually got combustible timber battens on top of sarking. The sarking isn't a flame barrier. So, it's actually a really major problem that to move from that to an ember proof scenario or a roof that isn't going to burn due to embers in a fire is a major retrofitting process involving a lot of roofing components.

## **Chair**

I know from my experience with my neighbours that many who had corrugated iron roofs and sarking still found embers had managed to get in. Perhaps the tin distorts or the wind is just that they were never particularly well sealed in the first place. But I presume tin roofs have their own challenges.

## **Justin Leonard**

Yes, certainly do. So tin obviously doesn't have any issues within the roof sheet itself, or even with the roof sheets that overlap over multiple ribs the way they lay across. So that tends to stay quite settled and a well put together roof. That's too fine a gap and too much of a torturous path to get between the roof sheets. But every roof sheet has an end, either at the ridge line of a house or at the gutter line of the edge of the roof, and that's where you have significant potential ember entry.

And now fortunately for a steel roof, those areas can be readily addressed by putting ember screening systems either along the ridge capping and along the gutter line. That addresses that ember ingress process and it's more of a "leave your roof sheets in place but retrofit things to that roof" rather than have a really more significant dilemma of a tiled roof, where not only at the edges are a problem but between each tile is also an ember entry problem.

## Chair

We've got a question here about bushfire proofing skylights. What do we know about that?

### Justin Leonard

Well, skylights come in every shape and size but, unfortunately, they create an inconsistency in the roof profile. So, any inconsistency or protrusion is a place for debris to build up on and prop against. So it's another potential place where localized flames can start to play on the adjacent sky lighting elements. And I guess skylights are made from a whole gamut of weird and wonderful things, from acrylic plastic to polycarbonate plastic to different types of glass and glass framing and whatnot. So, it's a little bit like looking at the diversity of windows and approaches with windows, that you can have many different design elements that's part of a skylight that then play out as potential issues if flames can attack it, radiation from an adjacent fire front. So we really have to put that on the table as a sensitive or vulnerable element to whatever the house is being dished up with.

## Chair

We've got a question here from someone who has a lot of windows facing north, not double glazed. What's the cheapest way they can do something to help reduce the risk of them breaking and letting in embers. They can spend more in the long term, but they want to know something that's quick and affordable and a way of doing something now. Perhaps window and door screening that's removable and storable, and they could bring it out on extreme days when they leave the area. What do you think about that?

### Justin Leonard

There are DIY homemade metal mesh screens, like flywire screens. A flywire screen, when you buy the flywire itself, it gives you a shading factor. So, a percentage shading factor might be 30%, might be 50%, well that's actually the percentage of radiant heat that will prevent reaching a window. So that already gives you some degree of protection, and in the event that the window still breaks, you've got an ember screen trying to prevent rapid ember ingress into the house itself, so it gives it that angle.

And, I guess, next level up from that is actually the DIY non-combustible robust shutter that gets clipped in place as well. Either way, it should be all metal in terms of framing the element that's held in with the framing, and the fixings that hold it to the windows. And, I guess, the question of "take them all out of the shed and put them on," that's quite a bit of work. Even better are the types that kind of fix to the house and they're readily deployable, and out there invisible, but not necessarily suitable for all house designs.

## Chair

How does double glazing and safety glass help or hinder fire protection. And how much do window frame materials matter?

### Justin Leonard

Yes. really good questions. Interestingly, double glazing itself doesn't necessarily offer significant more protection than single glazing. It's actually the type of glass that has the most influence on the likely survival of that window to radiant heat. So, plain or normal float glass, the common plain glass, doesn't really stand up to more than around 12kW/m<sup>2</sup> of radiant heat before it cracks, and can crack so prolifically it can fall out. So if you think of a double glazed window that's simply got two layers of plain glass, the first one will take most of the heat and crack and fall away, and if the radiant heat persists it simply then acts on the second sheet and it eventually cracks and falls away

as well. So, a double glazed unit is a marginal improvement because it's a two stage process. But, in reality, the most important thing is that you've got a more robust type of glass in place.

And the obvious and most common one is toughened glass, which survives to a much higher radiant heat. So we're talking about more like  $40\text{kW/m}^2$  of radiant heat before it could crack. And it seems to do that because the edges are all ground nice and smooth and it's got a special treatment in it which is the reason why it's called toughened glass. So it breaks into small crumbs, and for some unusual reason the way they heat treat that glass gives it its special performance to the radiant heat from the fire.

There's some pretty other really cool glazing elements that do really well, and that is things like glass bricks and wired glass, are very high performing and even much higher performing than toughened glass and can be actually quite cheap depending on the application. And it's also worth, on that topic of glass, saying that laminated safety glass, the glass where it's two layers of plain glass with a plastic between it to make it a laminated safety glass, isn't any significantly better than plain glass.

## **Chair**

What about the frame materials?

## **Justin Leonard**

So, obviously the frames, as you've mentioned before in your example with it, the debris can build up on it and act on the frame and cause it to burn. The localized burning is another heat action on the glass, which can cause early failure. So it's much more important to move to a non-combustible framing material than a combustible one. And, if you're really looking for the ultimate performance, a non-combustible one with high temperature seals in that non-combustible framing gives you the ultimate protection.

We've seen quite conventional aluminium windows with toughened glass in them, they can actually start to fail because the plastic beading between the aluminium and the toughened glass melts and allows the glass to drop. So there's certain window manufacturers actually offer a higher temperature seal to really make that a complete system.

## **Chair**

Someone has asked: if they're caught at home on a high fire danger day, is it best to leave interior blinds up and does that make a difference?

## **Justin Leonard**

It's very important to maintain complete awareness of what's happening outside. And that's to recognize when the fire's arrived past its peak and moved on. Because that really helps set the context of whether, if the house starts to burn, that you've recognized that the fire front's passed and that at some point you might be able to move outside as the house becomes untenable. So that awareness is absolutely critical, so closing all the blinds and losing that awareness is definitely a negative.

There's not a lot of evidence in post bushfire loss scenarios to suggest that the blinds inside the windows actually contribute to a reduction in the likelihood of things igniting inside. In fact, things don't tend to ignite inside the windows prior to the window, say, breaking. So, it really doesn't seem to offer any additional protection. External blinds and processes are potentially different.

## Chair

Is there any merit to pre-cutting cement sheets to fit on top of a timber deck to stop embers igniting when there's an extreme risk?

## Justin Leonard

Yes, that sounds like a really useful idea. The way the embers fall between the gap to boards on a traditionally designed timber deck and land on the bearers is a really common way that ignition happens. And the way the wind blows through the deck then propels those small flames to track and burn along the bearers and involve the deck significantly. It doesn't completely rule out the idea that the deck will burn down because you still get surface fires attacking the stumps and burning up under the deck, if the deck's close to the ground. And the embers can still blow underneath and lodge on those bearers, although it's less likely. But I guess the sheeting does offer some extended time frames that that deck might be navigable if you have to leave your house. But, I wouldn't say it'd completely rule out the deck being lost.

## Chair

Is there any such thing as a safe garden mulch except for small rocks and scoria, which this person's concerned about? It makes plant roots hot, in summer especially. And also then, how do you manage the leaf litter in rock mulch? If you're going to have wood chip mulch, how far away from the house should it be?

## Justin Leonard

Yes, I guess it's a two-fold consideration and the first thing to consider there is what house elements are immediately adjacent to the mulch bed. So, if we're talking about no windows and a double brick wall up against the mulch bed, well, you could probably tolerate tanbark mulch, noting that you actually have vents that might be low and flames could play up and travel through those vents. So, you really have to think about what can a house tolerate and what kind of fuel source am I putting.

The tanbark and wood chip mulches under the middle bushfire conditions, and that dry climate that the bushfires are most problematic in, mean that virtually the entire depth of your wood chip bed is available fuel and burns for a long time and provides a lot of heat to its adjacent elements. So that's the inherent problem. So, moving to fine leaf debris build up is a problem, but it burns out relatively quickly. And you can also consider that even a gravel bed will have new leaf debris blown onto it during a fire, and that will ignite and burn on top of that scoria. So, you don't actually completely remove the potential for flames to act on the adjacent elements, so you really have to do a significant amount with the house itself. And, I guess, what you're doing in the garden bed is then considering how to keep that down to a reasonable level, and really separation is what's needed.

I don't have any magic materials and go-to's that are better, but I really encourage people to it's a relative common sense thing. If it can't burn, you're not adding fuel to the problem. But there aren't any fire retarding treated magic wood chips that I can put in the mix here. So, no magic bullet. Apologies for that.

## Chair

Last year, different speakers had different opinions about gutter guard in our series last year. Are there any new recommendations about the best way to stop debris getting into gutters with gutter guard and how to seal the end of the roof edge? Particularly on a metal roof.

## **Justin Leonard**

So, obviously, absolute rule number one is make sure your gutter guard's not made out of anything that can burn itself, because the last thing we want to do is put more fuel on the gutter. The way that it has to be sealed, obviously, has to form an intimate connection to the roof sheet itself, and then to the lip of the gutter. So you actually form a complete enclosure between the gutter, the fascia and the roof sheet. And the most appropriate ways to do that is using some form of metal fixing rather than a bonded polymer based approach, because as the debris lands on and acts on it, it could actually burn the polymer and cause it to disconnect.

Things like fine metal mesh with things like stainless steel, fine mesh, or gel fine mesh, at the higher performing temperature metals, is probably a preferred approach. But, also noting a bit like closing up all your cavities, putting fine mesh over your gutters in a high rainfall, high discharge area, you're actually also potentially disturbing the rate that the water can get through the mesh and fall into your gutters as well. So there's a whole lot of challenges and trade-offs, but, I guess I'd encourage you to explore all the weird and wonderful ones but still apply the 2mm threshold ember test to it and it should all be tight fitting and robust to that 2mm tolerance if it's really going to become an ember barrier.

## **Chair**

Does landscaping or a row of trees acting as a windbreak provide some level of protection against ember attack? Or is it more likely to contribute to the bushfire threat?

## **Justin Leonard**

So, the question of contribution to a bushfire threat really comes down to the species and the nature of the bark on that particular type of tree. So, once again think about the actual vegetation type and if you don't have a deep knowledge of that, things like the CFA Plant Key are quite valuable in that respect.

The wind breaks question about screening embers. Yes, it can screen some embers and it might halve or cut the ember attack on your house by three quarters or something like that, but it won't eliminate ember attack. So as we mentioned at the onset, ember attack is a probabilistic process and you might improve your odds that you don't have an ember ignition, there's no magic approach to put in a windbreak that eliminates ember attack.

What wind breaks and things do do though, quite significantly, is they can limit your house's direct exposure to wind actions and debris impact, if things aren't flying off the wind break itself, and the wind break isn't too close to actually collapse and fall on your house. And the benefit of limiting the severity of the wind actions on your house is probably a far more significant benefit than those wind breaks offer to your house than screening embers than the notion of screening embers, and I guess the other thing that trees and wind breaks like that offer is they help to shade and keep moisture in the landscape proximal to your house as well, which means that your gardens and things are the last to dry out in the landscape or dry it at a far later stage than if those wind breaks and protections and environmental protections weren't there.

## **Chair**

Is fire resistant canvas suitable to provide some protection over windows?

## **Justin Leonard**

I've actually seen the really old school traditional roll-out canvas blinds that come out at a projected angle when they unroll. Reasonably resilient to ember attack, so they can get some spot burns in them but we don't really see them igniting and burning as a fire source on the windows.

So, I would agree that those traditional canvas projected awnings, particularly the ones that either are vertical or at a quite a sharp incline angle, which actually helps to prevent the embers building up or lodging on them or any significant debris getting against them end up being quite a reasonable ember and debris shield, and offer quite significant radiant heat mitigation.

But, obviously there's some ultimate limit to where the canvas gets so hot because of the radiant heats on it that it will end up flashing and igniting. And then in that circumstance the canvas could offer some additional heat load to the window. But, it's a really a subjective question about all the benefit it's offered before it's actually flashed off and burnt, might in fact be more of a heat mitigation than the fairly rapid process of it burning in that ultimate exposure scenario.

## **Chair**

If you're working with an older home, is it viable to use fire resistant silicon to address those small gaps and openings?

## **Justin Leonard**

Yes, silicon is quite a useful go-to material. Go for the higher temperature ones or the fire rated ones. They're better than the typical ones, although all silicon products are reasonably good. A useful thing for you to try is actually, when you get a dab of silicon hanging off your silicon gun and it's cured, you can actually light it and it actually burns. So it's not completely innocuous to burn, but what you'll actually find is when it's beaded into a crevice, the silicon doesn't burn into the crevice. It's not that flammable. And if it's beaded into a re-entrant corner as a corked bead, it doesn't tend to burn into that corner. So while it's being cooled by the surfaces it's bonded to, it can oxidize and burn a little bit on its surface but it actually acts like a barrier even when there's significant flame and radiant heat applied to it.