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How houses are destroyed by bushfire

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The second part of my presentation is focused around the house, and what the house actually experienced within that broader context. So, the house, obviously, is presented as a bunch of possibly vulnerable elements, and any detail on the house, such as a re-entrant corner, we're looking at two re-entrant corners here in this inset is a place where debris and embers can lodge and build up, and cause small ignitions that may develop into structural fires and loss. So, we can actually see here where two ember scorch marks have begun to burn. Now, the owner or a neighbour has actually put them out, but even since they were put out and suppressed, further leaf debris has actually fallen into these re-entrant corners. So, any detail like a roof valley, a gutter, a sub floor space, a re-entrant corner, are all the places where leaf debris and embers can exploit and develop into small flame attacks.

If those re-entrant corners are actually rotted or decayed, it simply makes it significantly worse with an elevated chance of ignition and transition to flame. Any gaps and voids, be it a deliberate vent in a structure, is a place where embers can enter. The magic dimension that you need to protect from ember entry is 2mm. So, if the aperture or opening in a fine mesh is 2mm or smaller, the embers that get through that mesh have little to no chance of igniting anything behind it, even if it's fine debris behind that vent. That's why the standards and a lot of advice points to using metal fly screen meshes with apertures smaller than 2mm.

Now, there's many gaps in structures that are obviously significantly larger. But some of the most obvious gaps in our buildings are quite easy to overlook. Such as the large openings above the spool of a roller door.

When we were approaching our post bushfire surveys, particularly in New South Wales, we actually found quite a high number of gutters on houses that were in this state, where the debris and the gutters had actually burned, but the house had not been lost. Which is something we virtually never saw in Victorian based post bushfire surveys. And the reason why that was the case was because in New South Wales there was a prevalence to use metal fascias on their roofs. So, the material or fascia the gutter is screwed to is actually a metal finish fascia, and a lot of the houses up there also benefited from having metal framed roofs under the tiles or steel sheets as well.

Not always the case but the eave and the way things play up onto combustible eave fascias is a really prolific way houses are ignited and lost. And, obviously, quite a challenging prospect to address or even recognize that a roof fire has occurred or begun, particularly when you're looking at two storey properties or you're sheltering within the property itself during the fire event.

I'd always encourage people that are in the unfortunate circumstance of using their house to survive a fire to monitor and roam around inside the structure during the fire event, including accessing the roof space very carefully by popping your head in up through the manhole and having a look. And, ideally, having something like a super soaker water pistol to distribute water throughout that roof space if the framing starts to burn in that roof space.

I was thinking of this picture specifically when I was answering that question about heavy bark mulch. This was a BAL-29 house in Sydney which received a significant fire event but did not have any particularly high intensity presented to the house itself from the fire front. What did happen though was ember attack ignited this bark mulch covering on a garden bed that was immediately adjacent to the house. Now, this was a relatively new build, so the gardens had not actually been planted out, they only had the bark present over the soil adjacent. So, the bark burning out was significant enough to actually melt the blinds through the toughened glass windows, which the house required because it was a BAL-29 build. Now, if this was a building that did not require toughened glass on both of those elements, the glass would have almost certainly broken and the embers from the surrounding landscape would have entered and ignited the house. So, particularly important to address garden beds and fuel loads against house facades and particularly windows and decks.

Fences play a key role and they come in many shapes and sizes. One of the worst offenders is brushwood fencing. It's hard to find pictures of brushwood fences in post bushfire surveys because they've all burnt to completion. Here's the leftover steel frame from the brushwood fence that presented a particular risk to the brick house in the distance, and an acute risk also to the asbestos clad house which had eight active bodied adults defending it. And they saved it but only just, after extensive damage: losing windows, having a roof fire and a subfloor fire, all to contend with concurrently simply from the brushwood fence fire.

Timber fences are a particular issue as well. We've done various experiments on timber fences, and what that actually revealed was that the typical distances that timber fences are built, in terms of where we're building houses as minimum setbacks from boundaries, so that's like 0.9m, is about as close that you can build a house from a boundary without having particular measures like fire rated walls. And, that's actually the perfect distance so that when, and if, the fence falls over as a flaming fence, it'll strike about the center of your window and break it, even if that's a toughened glass or BAL-40 window. That's something that isn't actually addressed in building regulations at all, but it is a very prevalent way that houses are lost.

Decking is best considered as an extensive fuel load attached to a house, where the heat from a decking fire itself is enough to ignite or break windows. And of course, this photo emphasizes how decking and floor elements can actually be intertwined where the fire actually burns up through and under into a floor cavity or space.

The deck itself is an issue, as well as the typical things we store on our deck: furnishings, plastic furnishings, barbecues, you name it. All can present a combined fuel load that can be formidable for a structure.

As well as stairs and stairways, any re-entrant corner or detail is an obvious place for debris to land and start to develop. There are very good behaving decks and deck solutions, and an obvious way to go is to use a steel substructure so the support systems aren't a fuel source themselves, and then either use high durability Class A durability timber top, but even better specific bushfire resisting wood like composite decking systems that are specifically designed and tested to survive bushfires. And this is an example of one of these loaded plastic decking solutions that are specifically fire retarded to resist bushfire.

Now, this deck actually had to put up with a treated pine retaining wall, which was between this garden bed and the deck which burnt aggressively against it, but the deck didn't actually then develop or present any additional risk to the structure.

Even the place where we place our boats and caravans and cars is a very important consideration in a bushfire event. These in themselves can present such a high heat load and direct ready flame attack that can take out even a well designed, robust, specifically bushfire resistant BAL house. They're simply not designed to handle those types of adjacent fuel loads.

And that might also be stored building materials. In this case it was a tyre and some timber burning out against the brick. And you can see just how much heat is involved here, where the bricks are actually starting to crumble and break because of the long bake out timeframe of these high fuel loads.

I want to really emphasize the role that treated pine plays in these fires. Treated pine is, as by name implies, made of pine which itself is one of the more highly combustible structural timbers used around houses. The CCA treatment that makes those pines resistant to rot and termites when used against earth that process makes it even more readily ignitable and more likely to burn to completion than the pine that it started out as. And unfortunately, when it does burn out, it releases significant amounts of toxic smoke into the air which is a risk to people attempting to move around during the fire.

Well over 70% of the metal salt treatments that actually went into preserving that wood actually remain in the landscape as a green ash that ends up getting washed into the soil and is very bio persistent. So, it has toxic effects well after the fire, and is a particular risk for people attempting to clean up that area or to fossick through the wreckage after it. Treated pine is simply not a compatible material in a Bushfire Prone Area, and I would suggest not putting it into the landscape, and to progressively phase it out of use on your property if you're in a Bushfire Prone Area.

They presented a particular risk down in Wye River where they were extensively used, and actually burnt so intensely that it actually compromised the support structures which had to be removed, and it was a massive remediation process to even come back from having that treated pine burn out in the event. And it also presented direct risks to the structures.

Stored material under houses is a massive issue. The best design houses are simply not designed to handle the types of fuel loads that are possible to store under them. So, don't do it unless the subfloor space is fully enclosed and ember tight to the same standard as your living area.

The storage and location of gas bottles is always an ever present issue. Gas bottles, when heated, will flare, and they'll flare in the direction opposite to the hose inlet into the gas cylinder. So, when installing a gas cylinder, the direction it flares: be very reticent of what that direction is, and absolutely imperative is to prevent that gas bottle from falling over under any circumstances. If a gas bottle is on its side and continues to be heated, the vent will not flare and it will build up an intense pressure and possibly explode, like the one in the middle of this diagram which is opened. When that goes off, that is an earth shattering explosion that will take out windows for a perimeter of upwards of 50m. So, it itself can compromise many houses simply by going off on itself.

And there's many examples of well intentioned designed houses. This was a BAL-40 house in Wye River, and we're looking down the driveway. And just on the left of the driveway there we can see a number of gas bottles. Now, these gas bottles were very well installed on a concrete slab against the steel support system and chained in place. So, fantastic that they were unable to fall over. Unfortunately, the treated pine retaining walls that supported the earth behind it provided enough heat for these gas bottles to flare, and they flared directly across the driveway, straight into the front door of the structure, and compromised even a specifically built bushfire house.

Structure-to-structure spread is also a major issue in areas where houses are in within reasonable proximity of each other. These are pictures synonymous with the losses in America, where we start to term them as urban conflagration fires rather than actual bushfires. In the Australian context, we've noticed that houses can be compromised at distances of up to 12m.

So, this is actually a BAL-29 built house in the distance, where it was pretty much at the critical point of failure, simply from the heat load from its neighbour's house at a separation distance of 12m. Now, the windows and the glazing in the windows was just intact, and the seals had melted, and the glass had started to drop out in those windows.

This picture was also another house that had experienced the heat load of its neighbour at a distance of 12m. And, this is a particularly interesting house in that it shows the front half of the house heavily scorched, with the eave already charred, and has obviously been suppressed, and the cementitious cladding was quite heat affected. One of its windows, which was plain glass, had broken, that had a fly screen over it. The second glazing element in that same window had not broken, and the rest of the house looks relatively unaffected because the back half of the house was sheltered and screened by a tree that shaded the radiant heat from the neighbour's house, and in doing so pretty much sacrificed itself with that level of intense radiant heat, but did not ignite and present an additional fuel load to the house. So, here's a great example of a very good behaving tree of the right type and structure, that provided a very important strategic radiant barrier in an urban fire context.

And just to finish off, I’ve got an example where regulations more or less have gone wrong. So, this is a BAL-40 house that we couldn't quite understand why and how it actually burned down in Wye River. I couldn't actually understand how it could be a BAL-40 house in Wye River because it was actually clad in timber. And when we looked actually closer to it, they'd exploited a loophole in the Building Standard by building a fire resistant house that had a fire rating. So, it was something like a BAL-FZ construction approach, which then didn't specifically say that you couldn't clad over that in decorative timber.

So you can see the obvious issue that as the decorative timber ignited and burned, it provided direct flame attack on the BAL-40 windows within the same façade, which meant that the house failed. And you can actually see the type of detail in the bottom left of this picture, where we've got a little retaining wall, a fantastic location for leaf accumulation, adjacent to the combustible fascia materials, which would have supported and allowed spread of fire up to and consuming this house. And that's pretty much the aftermath of that particular location on the house.

So, a regulated house does not mean you have a great solution. It takes a lot more than that, and a lot more wisdom and learning to build a really good resilient house.