Paper 7A
The BUSHFIRE MANAGEMENT OVERLAY EXPERIMENT

Authorities in Victoria now use one planning instrument, the Bushfire Management Overlay (BMO), to reportedly reduce bushfire impact in new house construction. It includes two main tools - defendable space and BAL construction standards.

The Royal Commission tolerated its parents - the AS3959 and WMO systems despite strong criticisms, but asked for improvements. It requested that (WMO) Wildfire be renamed (BMO) Bushfire. It requested that the mapping systems for both systems be unified and that they rapidly cover the whole state. It was told that government departments were attempting to integrate and unify a site assessment system, and asked them to finalise it (VBRC, 2010). The bureaucracy subsequently amalgamated the two systems into one, called the BMO. The two original planning instruments WMO and AS3959 were based on distance of the house site from nearest vegetation (Leonard et al 2009), and the BMO continues that tradition. The key features and effectiveness of the WMO are summarised in Paper 7B, and Paper 7C summarises AS3959. The amalgamation process and the wall of flame model is addressed in Paper 7D.

BACKGROUND

The WMO process required a Wildfire Management Statement that was in three parts
- Detailed description of existing conditions
- Identify house site location to reduce the "bushfire risk as much as you can by choosing the dwelling site carefully. Bushfire risk varies depending on the slope and vegetation characteristics."
- Site assessment process
  - Identify nearest vegetation type within 100m and make calculations defendable space according to wall of flame in vegetation (includes inner and outer zones)
  - Automatic assignment of BAL depending on nearest vegetation type, ie, BAL 12.5 for cultivated gardens and grasslands and BAL 29 for all others
  - Automatic prescriptions for vegetation in inner and outer zones
  - Standard water supply and access requirements

If the site cannot meet requirements of site assessment process, prepare alternative solution (= Option 3)

AS3959 process excludes parts 1 and 2 of the WMO and implements some of part 3. It simply measures distance to nearest vegetation and calculates BAL accordingly.
- Site assessment process
  - Identify nearest vegetation type within 100m and calculate BAL according to wall of flame in vegetation type
  - No defendable space or requirements for water supply and access

The BMO process requires a Bushfire Management Statement that is in three parts
- Detailed description of existing conditions, including aspects relevant to bushfire hazard
- Identify and justify house site location "To ensure that development is located and sited so that it does not increase the risk to life, property and community infrastructure from bushfire. To ensure that the siting and layout of development reduces the risk to life, property and community infrastructure from bushfire to an acceptable level and prioritises the protection of human life".

- Site assessment process using Table 1 or alternative method
  - Identify nearest vegetation type within 150m. Outer zone defendable space of Table 1 has to fit within separation distance to vegetation. Fit the defendable space of Table 1 within this distance. Table 1 lists inner and outer zone widths, calculated according to wall of flame in nearest vegetation.
  - Table 1 lists BAL according to outer zone width (which is less than separation distance to vegetation).
  - Automatic prescriptions for vegetation in inner and outer zones
  - Standard water supply and access requirements

The aim is to achieve BAL29 or less (PN65, 2011). If the site cannot meet site assessment process, prepare alternative solution. Eg, cannot meet BAL 40 defendable space requirements, or is in Mixed Use Zone or Township Zone or Residential 1, 2 or 3 Zones.

Thus, the BMO process is very similar to the WMO process. There is a description of local site conditions and rationale for site selection, but the main focus is on site assessment process and calculation of defendable space and BAL based on wall of flame in nearest vegetation. WMO allowed alternative method if distance to vegetation was less than defendable space requirement. BMO requires Table 1's defendable space to fit within distance to vegetation because as defendable space reduces, BAL rises. The BMO is very similar to the RFS system. BMO's Table 1 has similar process and concept to the NSW RFS system (RFS NSW 2012).

This Paper therefore focuses on the core features of the site assessment process. In this Paper, we firstly outline the core features of the BMO and then assess them for effectiveness.

CORE FEATURES

The BMO aims to protect new houses from exposure to bushfire threat in nearest vegetation that occurs within 150m of the house site.

The BMO narrative

A wall of flame advances through unmanaged vegetation as a major crown fire, emitting radiation and throwing embers. BMO inserts a defendable space between house and unmanaged forest to reduce incident radiation from the wall of flame and also fortifies the house with fire retardant materials and design. The aim is to prevent ignition of the house while the fire front passes.

The wall of flame is the only source of danger to the new house, and it generates flame contact, radiation and throws embers. Wall of flame is assumed to be 100m wide and flame height is calculated by the AS3959 equations. The surface area of the wall of flame and the separation distance are used to calculate the incident radiation on the house wall.

The defendable space specifications reduce fuel load on the ground with the aim of reducing fire intensity, and thin out shrub cover and tree cover to prevent crown fire in the outer zone.

The fortification levels of house materials and design increase in proportion to calculated radiation load.

Stated aim of BMO

The stated purpose of the BMO is to:

- Identify areas where the bushfire hazard requires minimum bushfire protection measures for subdivision and buildings and works to be specified
- Ensure that the location, design and construction of development and the implementation of bushfire protection measures are considered
- Ensure that development does not proceed unless the risk to life and property from bushfire is managed to an **acceptable level**. (PN65, 2011)

Acceptable level is not defined in planning documents. It can be deduced from the planning documents that they effectively deem that the BMO site assessment process determines risk level (eg, BAL 40 is higher risk than BAL 12.5) and compliance with "Table 1" is deemed to reduce risk to acceptable level (using BAL and defendable space). Does this relate to Royal Commission wishes? The Royal Commission wanted to actively discourage new houses in highest risk areas. If high BAL is an accurate measure of high bushfire risk, the Royal Commission's wishes are realised. Is BAL an accurate gauge of bushfire risk? AS3959 believes BAL measures "the severity of a building's potential exposure to ember attack, radiant heat and direct flame contact", but this is stretching the truth because AS3959 calculates BAL as radiant heat from the wall of flame. We know that radiant heat is a minor cause of house loss (eg, Paper 3A), which means radiant heat cannot be regarded as a standalone indicator of risk of house loss or damage.

But this is not what is normally regarded as risk. It is not what the Royal Commission foresaw. The body of the Royal Commission's report (VBRC, 2010) includes the following different concepts of risk - risk of bushfire occurrence, risk of damage, risk to peoples' safety and risk caused by vegetation hazard. Neither the BMO site assessment process nor "Table 1" addresses any of these.

Other versions of acceptable or other risk include:
The Fire Commissioner's Office (via Integrated Fire Management Planning definitions) defines it as "the level of potential losses that a society or community considers acceptable, given existing social, economic, political, cultural, technical and environmental conditions"
ISO 31000 defines acceptable risk as a "risk that is tolerated … because the cost or difficulty of implementing an effective countermeasure for the associated vulnerability exceeds the expectation of loss".
NSW RFS (2001) chose to define what unacceptable risk level was – **'unacceptable risk'** when there is insufficient "safe" space to defend the house (identified as being within the **"Flame Zone"** in Table A3.3) and there is no safe escape route for the occupants and fire fighters.
PN65 (2011) said "areas in the BMO are areas that have the highest fire risk and are likely to be particularly exposed to the impact of bushfire. The areas to which the BMO applies are shown on the planning scheme maps as either BMO or WMO... The BMO boundaries are based on the bushfire hazard."

Site assessment process to calculate defendable space and BAL levels

First, the BMO site assessment process identifies the vegetation type within 150m (in any direction) and prescribes maximum fuel loads (no matter what its actual condition is) and worst case weather conditions (FDI 120).
Next it calculates rate of spread and flame length in the vegetation using different equations.
For forest and woodland, it uses the same equations as AS3959 to calculate rate of spread and then flame length.
For shrub and scrub, it uses the same equations as AS3959 to calculate rate of spread, then rate of spread and fuel load calculates Byram's Fireline Intensity and Byram's intensity calculates flame length, again, using the same equations as AS3959.

Then, flame length is used to calculate incident radiation at the house site from an assumed 100m wide flame front.

The combinations of defendable space and BAL are listed in Table 1 of Planning document - Clause 52.57. In practice, BAL level is dependent on the available width to accommodate the outer zone width. An adjustment process applies. If gap between house and vegetation patch exceeds defendable space, BAL must be increased until defendable space reduces enough to fit within gap. Eg, If the a potential defendable space is > 100m, incident radiation and therefore BAL will be lowest, but if potential defendable space is say, 20 - 30m, incident radiation and therefore BAL will be highest.

BMO Specifications

- **Defendable space**

Inner zone Key specifications of the inner zone are grass height must be less than 5 cm tall, and all leaves and vegetation debris must be removed at regular intervals. Tree canopy separation of 2 metres and overall canopy cover of no more than 15% at maturity

Outer zone Grass must be no more than 10 centimetres in height and leaf and other debris mowed, slashed or mulched. Trees may touch with an overall canopy cover of no more than 30% at maturity without shrubs in the understorey. Shrubs and trees should not form a continuous canopy.

Note: Both inner and outer zones are, by default, continuous fuel bed, ie, the specifications do not require discontinuity.

- **House construction standard** AS3959 lists the construction requirements for calculated BAL level.

- **Access** is to enable safe fire tanker access

- Provide supplementary **water supply** for tankers

ANALYSIS

Is the BMO narrative realistic?

The narrative proposes an image of a house site in the middle of threatening vegetation. The BMO concept encircles the house with a protective ring of reduced fuel load (= defendable space). The approaching fire front is a crown fire and when it hits the defendable space, it becomes a low intensity surface fire with a low flame height, and the crown fire comes to ground. This is said to protect the house.

But it may not. The BMO concept allows defendable space from a huge wall of flame in a forest to be as narrow as 31m if the BAL level is 40. The fire front sweeps through the defendable space as a low flame and through the forest (assume it is at maximum fuel load) on both sides of the house site as a crown fire. This exposes the entire house site and defendable space to 1000^0C or so. Survival of anything is dubious, but becomes even more hopeless when we realise that the house is battered at the same time by flame contact and massive ember attack.

The narrative's landscape scenario may occur in a few areas, but the more common one is a mixture of forest or shrub patches, dispersed among paddocks with scattered trees. The house site is commonly among scattered houses or within urban clusters. There are two aspects that make the BMO narrative irrelevant here. Firstly is the BMO concept of a single fire front, and secondly is the location of the nearby vegetation. (1) The single advancing fire front scenario may well occur in grass, heath or mallee vegetation where the fast moving fire front overtakes the spot fires ahead of it, but when the landscape includes forest or woodland patches, there are multiple fire fronts caused by leap frog spot fires, each with their own fire front. The individual fire fronts within the forest travel at slow speed, eg, 1 kph, but the spread rate of the leading leap frog spot fires can be up to 15 kph. They can be narrow or broad. This has been well reported in the literature and was personally observed by the author on Black Saturday. Eye witness evidence given to the Royal Commission is consistent with this phenomenon. (2) The BMO concept requires the nearby vegetation to be the fire front, but this can only occur if it is up wind or down hill from the house site. In a mixed forest / farmland / urban fringe area, the chance of this is low. In reality, ember attack is of more concern because it generates spot fires, and the fire front itself often does not arrive.

Conclusion: The BMO narrative image addresses one of the range of bushfire attack possibilities. It does not address the most common worst-case bushfire scenarios. It has a fantasy world view of a bushfire attack. The BMO concept relies on a broad fire front occurring in the nearby vegetation, but this usually does not occur in mixed landscapes.

In essence, how do authorities believe BMO will protect the house?

Creation of defendable space around a structure is the key means through which the impact of bushfire can be reduced (PN65, 2011). The inner zone is said to prevent ignition by radiation from inner and outer zones, prevents flame contact from outer zone by preventing crown fire in it and reduces ember attack from inner and outer zone. The outer zone is said to reduce fire intensity and prevent crown fire (PN65, 2011)

The house is said to be protected by fire resistant materials and construction design standards that increase with incident radiation. BAL corresponds to a modelled level of bushfire exposure considering factors such as embers, flying debris, radiant heat, wind and exposure to flames. As a development's potential exposure to bushfire increases so does the BAL (PN65, 2011). The aim is to try to achieve development outcomes of BAL-29 or less (PN65, 2011). Access for fire truck and a reserve tank of water presumably make it safe for fire brigade to attend, and provide further protection for the house.

Are the BMO beliefs realistic, ie, do they identify actual threats and treat them?

Wall of flame The authorities assume the nearby vegetation generates a broad wall of flame that is the sole source of all danger to the house when in reality it may be a part of the threat or not a threat at all. They assume it is at peak fuel load, so that it calculates the tallest flame. They have no regard to its actual condition. They assume it is not manageable. Thus the BMO concept is based on an artificially inflated wall of flame that often has no relevance to the actual sources of bushfire danger to the house. Also see Paper 7D.

Defendable space The BMO model has an unrealistic understanding of fire behaviour science. It claims to protect the house from wall of flame in the nearest vegetation by lowering flame height in defendable space. But, like the WMO, it misses the vital specification of protecting the house from the flame in the defendable space. (Refer Papers 7B and 7D). Whilst we accept that radiation and flame contact can be reduced on the house site if flame is stopped at a reasonable distance, the specifications do not include a fuel free zone to stop the flame. Therefore, the flame is allowed to run up to the house. The flame may only be 1m tall, but is 1000^0C of unhelpful heat.

It claims to protect the house from embers from the wall of flame with a wide defendable space, and from ember generation in the outer zone by preventing crown fire there, but embers from it will only be a threat to the house if upwind. If the wall of flame is downwind, the BMO concept does not envisage embers coming from other upwind sources, as happen in real life severe bushfire attacks like Black Saturday.

House protection by BAL level The BAL concept (see AS3959, Paper 7C) is to prevent piloted ignition by embers during the passage of the fire front, yet BAL materials are tested on fire retardancy, ie, how quickly the fire spreads in calm conditions at medium radiation levels. This point was strongly criticised by the Royal Commission, who asked that testing be related to actual bushfire conditions.

Table 1 assumes a narrow defendable space and a high BAL rating is as acceptable as a wider defendable space and a low BAL rating. This assumes the BAL specifications are effective, yet evidence to the Royal Commission found no evidence of reducing house loss in the Black Saturday fires. Furthermore, a narrow defendable space has no safety factor to avoid flame contact by flame rollover or flame swirl into the house. Flame contact has a greater risk of ignition than radiation specifications of AS3959. Thus Table 1 allows the wall of flame to be very close to a house whose only protection is specifications of questionable effectiveness. This appears to be putting the house at a much higher risk of loss than a more distant wall of flame.

BMO uses AS3959 specifications which list many cladding and structural components and gap sizes for specific parts of wall or roof. It assumes the building has no imperfections like cracks, or splits or roughness or build-up of flammable debris. It may well be effective for the listed components, but it cannot possibly cover every possible ember ignition site. One unattended ember ignition site can burn a house down. Thus, the house retains an inherent vulnerability to ember attack, which is the known cause of almost all house loss in a severe bushfire attack.

What fire behaviour changes will the specifications deliver within defendable space?

Reducing fuel load will reduce flame height in both zones and thinning shrub and tree cover in the outer zone will prevent crown fire.

Will the specifications achieve the BMO aim?

In regard to ember protection, specifications will not reduce ember attack on the house site because they come from sources other than the wall of flame.
In regard to flame contact and radiation, the specifications cannot guarantee protection because they do not require fuel bed discontinuity.
In regard to building vulnerability, the specifications cannot guarantee that ignition is prevented on all flammable sites.

Conclusion so far The BMO beliefs are not realistic because the scenario it purports to treat has no basis in bushfire attack reality. They assume that BAL specifications are effective in preventing ignition and cover all ignition sites, but the AS3959 testing is not related to ignition under bushfire conditions, and logically, they cannot possibly cover all ignition sites. Overall, the AS3959 specifications are based on incident radiation levels. If radiation was a major cause of house loss in bushfires, they would be relevant to preventing house loss. However researchers have repeatedly shown that radiation is a very minor cause of house loss (see Paper 3A)

Equations used for calculating radiation levels

BMO uses the AS3959 vegetation types and AS3959 equations. The scientific flaws in using the extrapolated McArthur-based equations and Byram's equations have been discussed in

Paper 7C and 7D. The same conclusions apply to BMO - that the use of these equations leads to contrived estimates of rate of spread and flame height. They have no scientific validity or relationship to actual on site risk. There is no requirement for them to be verified or related to reality. They probably attempt to incorporate a safety factor, but its value is an undisclosed secret. Yet they are the basis of government policy decisions.

Another technical concern with BMO is that worst case weather conditions has been redefined as FDI 120 and the wall of flame is prescribed to have radiation emission level of 120kW / sq m. This creates wider defendable space and results in higher BAL's, which means higher costs to house builders. Because the science to support hotter bushfire flames in Victoria than NSW has not been provided, these changes are scientifically unjustifiable and put Victorian house builders at a financial disadvantage compared to interstate.

Which causal threat agents does the BMO treat?

Paper 3A specifies two types of causal threat agents in severe bushfires – primary (flame and embers from the fire front) and secondary (flame and embers from the urban flame). Official documents say the BMO is designed to mitigate two of the casual agents - flame contact and radiant heat only (AN44). But PN65, 2011 specifies that embers are also dealt with. Thus, BMO is said to mitigate all three of the casual agents from the fire front, ie, it addresses the primary causal agents.

How does BMO mitigate primary threat agents?

A Fire front

Fire front - flame contact and radiation

BMO regards the wall of flame in the adjacent vegetation as the fire front, ie, the major source of danger to the house site, ie, flame contact, radiation and ember attack. It addresses flame contact and radiation from the wall of flame by reducing fuel load within defendable space. If the fire front is another source, it no doubt assumes that defendable space will mitigate its flame danger.

Fire front - embers

Unlike WMO, BMO expects embers from the wall of flame to fall onto the house. It believes the width of defendable space will absorb most of these embers. BMO does not contemplate embers from other sources, but it no doubt assumes that the specifications will be effective against all embers.

B Building design provisions

Building design provisions - ignition by radiant heat and flame contact

BMO uses the AS3959 design specifications. As the AS3959 analysis (Paper 7C) shows, the specified timbers are based on burning resistance rather than ignitability. Moreover, the tests for ignitability and resistance are very different, and neither includes wind as an input. Therefore, it is not known if the specifications provide proper protection from ignition.

Building design provisions - embers

BMO specifications for ember attack increase in protection as BAL level rises because the lead time for piloted ignition decreases as incident radiation increases. The specifications cover many ember ignition sites, but there are many sites and scenarios that they do not cover. Thus BMO specifications can never provide complete protection against ember attack.

The systemic flaw in AS3959 continues, however. BAL levels rise as the fire front comes closer, and the higher BAL appears to give extra protection, ie, embers fall on fortified materials. But when the fire front is distant and BAL level is low. In this case, embers will be falling on an unfortified building. Also see Paper C.

How does BMO mitigate secondary threat agents?

A Urban flame

Urban flame - flame contact and radiation

The urban flame is not contemplated by BMO. The only possible exception is this strange specification for the inner zone - "within 10m of building, flammable objects such as plants, mulches and fences must not be located near vulnerable parts of the building – such as windows, decks and eaves". The proximity to the house is assumed to be highly managed, which implies non flammable or low fire intensity (Douglas, 2011). But because grass or litter or shrub or any flammable material is permitted (ie, not prevented), flame contact can occur at the house. Flame radiation emitted by urban flame is 100 kW / sq m, which means the house is exposed to (ie, not protected from) excessive radiation load. The probable source of the flame is ember attack. If the wall of flame is distant, BAL level is low. Thus, flame contact and excessive radiation from urban flames can occur on a low BAL house.

Another potential source of flame in the urban zone is the defendable space itself. Specifications for inner zone do not make provision for fuel bed discontinuity. Applicant properties in urban areas could have had established flammable shrubby garden beds in close proximity. Therefore flame contact and excessive flame radiation from urban flame is to be expected.

Urban flame – embers

Ignition by urban embers is not contemplated by BMO. If flame from a garden or shed is close to the house, radiation loading will be very high. If embers are thrown from these flames onto the house, piloted ignition occurs under very high radiation. Ignition will be rapid. AS3959 does not contemplate heat or embers from these sources. If the identified wall of flame is tens of metres away, the house site will be classified as low BAL. The house will be unprepared for ember attacks at high BAL levels

B Building design provisions

Building design provisions - ignition by radiant heat and flame contact

If the fire front is distant, BAL is calculated as low, and the building specifications have low fire resistance. If embers ignite flammable urban fuel near the house, the flame may contact the walls or the radiation may damage the house because it is not fortified.

Building design provisions - ignition by embers

Urban flames can generate embers and the house will be showered with live embers. As before, the house has been classified low BAL, and again, it is unfortified and therefore vulnerable.

Conclusion

BMO claims to prevent flame contact, excessive radiation and ember attack from the wall of flame in the nearby vegetation, but it fails the score card test.

BMO Score card for fire front flame	**BMO Score card for urban flame**
Flame contact - fail	Flame contact - fail
Radiation – fail	Radiation – fail
Ember attack - fail	Ember attack - fail

The score card of the amalgamated BMO continues the abysmal pattern of failure by the parents:

Threat Agent	Contribution to house loss	Score card for dealing with Threat Agents		
Primary causal agents (from fire front)		**WMO**	**AS3959**	**BMO**
Ember attack	90%	fail	partial	fail
Radiation and flame contact	10%	fail	unknown	fail
Secondary causal agents (from urban flame)				
Ember	substantial	fail	fail	fail
Radiation, flame contact	substantial	fail	fail	fail

VERDICT ON THE BMO

The BMO does not address the actual causes of house loss and therefore cannot neutralise them. It is difficult to see how it can provide any bushfire protection benefit to the new house. Instead, it continues the flaws of the WMO and AS3959 by proclaiming the danger is the imaginary flame in the nearest vegetation and prescribing treatments to deal with it.
We are very concerned that the authorities' obsession with blaming the nearest forest or vegetation is diverting their focus from the real sources of bushfire threat to the new house.

We recommend that it be replaced urgently with a system that identifies actual bushfire threats to the new house as well as the surrounding existing houses, and provides a means of neutralising them. This achieves our goal of protecting houses from damage, new and existing. See Paper 10.

GLOSSARY OF ACRONYMS

BMO	Bushfire Management Overlay
WMO	Wildfire Management Overlay
AS3959	Australian Standard 3959
RFS	Rural Fire Service
BAL	Bushfire Attack Level
FDI	Fire Danger Index
CFA	Country Fire Authority

REFERENCES

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