Fire note

No. 1. December 2005

Background briefings on emerging issues for fire managers from AFAC and Bushfire CRC.

Using chemicals in fire-fighting operations

The bushfire threat posed in many parts of Australia and New Zealand, and particularly in many parts of southern Australia each summer, is potentially very serious. Much of the Australian continent is dry and fire-prone. Its geography, vegetation, and climate combine to produce one of the most severe fire environments in the world. Conversely, fire is also elemental in the maintenance of many of its native ecosystems.

Over the last one hundred and fifty years we have seen in Australia and New Zealand the development of a range of approaches to deal with bushfires. With few large natural water sources available in most bushfire-prone areas, particularly in Australia, techniques have been developed that are generally categorized as 'dry firefighting'. They primarily involve removing fuels from the path of the bushfire using hand tools and/or machinery. The lighting of 'backburns' ahead of a wildfire is sometimes also used in containing its 'head' or flanks. This technique involves firefighters lighting fires, at times of the day or night when fire behaviour is more predictable, to burn fuels ahead of the main fire.

Since the 1920s the use of aircraft to assist in bushfire management has been evolving in Australasia. Since that time, and particularly over the past twenty years, dramatic developments have taken place in all aspects of bushfire related aviation. In an international sense, fire agencies in Australasia and in North America have been particularly active in this field and close liaison between agencies and related national bodies continues in both locations.

In 1967 Australia's first operationally assisted control of a bushfire occurred in the Great Dividing Range in south-eastern Australia, using two agricultural aircraft 'bombers'. Since that time retardants and foams have been found to be increasingly useful in many parts of Australia and New Zealand, particularly in slowing the spread of lightning caused fires in inaccessible terrain, thereby improving the chances and safety of follow-up fire crews. In a 1999 benchmark CSIRO study on the topic, it was estimated that in an average year, fire retardant chemicals were used on around ten percent of all Victorian forest fires.

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SUMMARY

- The long-standing AFAC position, that only fire retardant products first approved by the USDA will be used operationally in Australia and New Zealand, in bushfire control, remains current.
- As at December 2005, the USDA had granted 'administrative approval' for the limited use of three gel-based products. Product testing continues in the USA and Canada, as does more limited testing in Australia.
- The relevant USDA/AFAC arrangement, the USDA will, following a request from AFAC, 'fast track' consideration of Australasian products for which the relevant testing has been completed. Australian and New Zealand based companies with potentially useful retardant products can find the details of relevant scientific and technical testing at: http://www.fs.fed.us/rm/fire/wildland_chemicals

The construction of bushfire 'control lines' (either with hand-tools or bulldozers), 'backburning' and the application of chemicals in wildfire suppression all have environmental impacts. So too, do large uncontrolled bushfires. Bushfire controllers clearly have to make regular judgements about these matters, often in dramatically changing situations. Bushfire control agencies generally have in place over-riding 'wildfire' and 'environmental care' principles that underpin their fire management activities.

Currently Used Retardants and Foams

Chemicals used to assist in the control of bushfires are classified as either short-term or long-term in relation to their period of effectiveness.

Fire suppressant foams are known as **short-term fire retardants**. They contain wetting agents that enhance the extinguishing ability of water by increasing its retention on fuel surfaces and by reducing evaporation. They are used in direct suppression of flames but do not have significant flame retardant properties after the water contained in them has evaporated. These foams are generally composed of a mixture of foaming agents (surfactant) as well as foam stabilisers, corrosion inhibitors and solvents.

Long-term retardants remain effective when the water carrying them has evaporated. A fireline of long-term retardant may hold a fire for up to 18 hours or more, but usually needs to be supported by ground crews to construct a mineral earth trail to secure the fire. These long-term retardants are generally composed of ammonium-based phosphates and sulphates. They also contain additives to thicken and bind the mix, corrosion inhibitors, flowing agents and colouring substances.

Retardants and foams can be applied from the air in fire situations where it is not possible to rapidly deploy any other fire suppression technique. These chemical mixes can provide an initial effective barrier to fires up to a fire intensity of $3000 kW/m$. Fires beyond this intensity will generally breach the retardant barrier through 'spotting'. Strategically placed fire retardant barriers can, however, slow fires of higher intensities and assist suppression by other means.

Long-term fire retardants are now considered essential for efficient fire suppression in many parts of Australia and New Zealand. For example, small fires in inaccessible terrain can be contained for many hours by aerial application of retardant, until ground crews can arrive. Short-term retardants and foams however are not effective for this purpose.

Gel-based Fire Retardant Products

In recent years a number of manufacturers have developed super-absorbent polymer based products that mix quickly with water to provide a gelled water product. Once the water has gelled, it can withstand very high temperatures before turning to steam. The gel product can be sprayed onto a structure, or onto vegetation to provide a protective coating to insulate the object from radiant heat or direct flame contact from a bushfire. Gel-based products are currently being promoted for their ability to provide lengthy protection and for their cost-effectiveness.

There are a number of matters related to the use of polymer-based gel flame retardant products that require further resolution, prior to their widespread uptake by fire agencies in Australia and New Zealand. These include:

- the effectiveness of the products in providing thermal resistance to increasing radiant heat levels, and the flame retardant capability of the various products available,
- the effective performance for flame retardation in terms of how long it remains effective after the product is applied to the structure,
- whether there are occupational health and safety issues associated with the handling of the various products available. For example, is protective clothing necessary during application?,
- safety where they are used in conjunction with other equipment, and particularly with aircraft,
- some products have been found to be extremely persistent once they have been applied. How easy is it to wash the gel off structures after application?,
- whether, after drying, the products rehydrate when the user attempts to wash them off the structure, resulting in very slippery conditions around the structure, at least until the surrounding soil dries out,
- the situation whereby some of the products tend to penetrate porous building materials, dry out, then rehydrate again when they become wet again.
- In laboratory tests, the most successful way to remove a number of the available products has been found to be by using a salt water solution. This option is often not readily available in rural locations. In addition, salt water solutions can create environmental implications in some situations,
- the situation whereby a number of the products currently have unknown toxicity impacts on aquatic species, a concern if the product runs into streams, lakes or other water bodies,
- potential detrimental effects on some building materials, such as metal window frames, as the products are salt based, and
- the need to clarify information regarding the 'shelf life' of a number of the currently available products in terms of their effective use period for structure protection.

The United States' Department of Agriculture (USDA) National Materials and Technology Development Centre in Missoula, Montana, is currently testing a range of the more recently developed gel-based retardant products. Recently, several products have received initial approval for restricted use in the USA and several operational trials are underway in both the USA and in Canada. Limited gel-related field trials have also commenced in Australia. The Australasian Fire Authorities Council (AFAC), with advice from the Bushfire CRC, will continue to closely monitor the developing situation.

The Health and Environmental Effects of Fire Retardants and Foams

For a number of years the 'Australasian Fire Authorities Council' has maintained the position that only fire retardants approved for use by USDA would be recommended for use by member agencies in Australia and New Zealand. The USDA maintains a very comprehensive laboratory and field based testing capability, and it is well placed to evaluate relevant tests conducted by various manufacturers. It also maintains a website that deals with a range of matters related to the use of chemicals in fire suppression.

The site: http://www.fs.fed.us/rm/fire/wildland_chemicals includes an up to date listing of 'qualified' and 'approved' products. Additional details relating to the products listed, and particularly relevant recent Australian and New Zealand experience with particular products, can be obtained from AFAC.

The fire retardant Phos-Chek D75R is a long-term type of fire retardant that is approved for use in natural environments by the USDA. This retardant is currently in widespread use in Australia by bushfire control agencies. It is most effective when applied to fuel surfaces prior to the arrival of a fire. The effective retarding ingredients in Phos-Chek are sulphate and phosphate salts of ammonium, that coat the surface of the fuels, and which are converted to sulphuric acid and phosphoric acid, with a loss of ammonia when heated. This reaction suppresses complete flammability of the fuel and promotes charring or carbonisation. The effectiveness of Phos-Chek depends upon its method of application, time of application in relation to fire, and the amount applied to cover the fuel surfaces. Therefore, its proper application in front of the fire at a sufficient application rate is critical.

In its 1999 report the CSIRO concluded that when Phos-Chek is used in accordance with scientifically based procedures "…The potential risk to public health is considered to be very small. From the published literature and chemical data sheets available, Phos-Chek components can be considered to have low short-term toxicity and very low risk of long term/delayed toxicity to humans…." The report went on to state that with the exception of one component, for which it had not been possible to locate data on its environmental fate, none of the chemicals in Phos-Chek had a propensity to accumulate in biological systems.

The report cautioned, however, that the actual risk from fire suppression chemicals must be addressed on a site by site basis, depending on local characteristics.

The report noted that many of the potential risks could be mitigated by careful mixing and application practices, and through local restrictions on its use in sensitive environments, such as areas with a presence of endangered or threatened aquatic species. Further, the report noted that some risks may not be eliminated, but these risks must outweighed, and evaluated, against the necessity for fire suppression activities.

The report concluded that Phos-Chek D75R had been used over a long period by the USDA and appeared as safe as any alternative long-term retardant and probably less harmful than many short-term retardants currently available. Finally the CSIRO report stated that "…. proper management of its (Phos-Chek D75R) use will assist [...fire agencies...] in [their] legal responsibility to manage both fire and the natural environment…"

Since the 1999 CSIRO work, several Phos-Chek D75R related research projects have been underway in Australia, with investigations including its:

- impact on native aquatic organisms,
- impact on heathland communities on nutrient poor soils, and its effect on soil properties, and its
- impact on selected species considered rare or endangered, and on invertebrate communities.

In relation to short-term retardants, or foams, a number of Australian fire agencies have undertaken trials and their use, particularly by rural fire agencies, is now fairly widespread, in accordance with scientifically based operational protocols. As with the use of longer-term retardants, agencies seek to balance any potential risks with the necessity for fire suppression.

Newly Developed Retardants, Foams and Gels

With any new products developed in this area, potentially complex community and occupational safety issues can arise, as can related environmental, legal and operational matters. The current arrangement between AFAC, and the USDA, sees Australian and New Zealand agencies benefiting from the much greater 'critical mass' available in the United States and Canada when it comes to these aspects of bushfire management. Canada, while it develops its own product specifications, also relies heavily on the USDA's scientific and technical testing capabilities.

Australian and New Zealand based companies with potentially useful products should be urged to visit the relevant USDA website: http://www.fs.fed.us/rm/fire/wildland_chemicals

The site contains details of the necessary scientific and technical tests that lead to 'qualification' and 'approval' of new products.

Under the USDA/AFAC arrangement, the USDA will, following a request from AFAC, 'fast track' consideration of Australian and New Zealand based products for which the relevant testing has been completed.

References

Loane, I. T. and Gould, J. S. (1986), *Aerial suppression of bushfires: cost-benefit study for Victoria.* CSIRO Division of Forest Research

CSIRO Forestry and Forest Products (1999), *Assessment of the Effectiveness and Environmental Risk of the Use of Retardants to Assist in Wildfire Control in Victoria*, Research Report No 50. Prepared for DNRE, Victoria

Bell, T (2003), *Effects of fire retardant on vegetation in eastern Australian heathlands – a preliminary investigation,* Research Report No. 68, DSE Victoria

Collett, N.G. and Schoenborn, C (2003), *Effects of fire retardant on heathland invertebrate communities in Victoria,* Research Report No. 69, DSE Victoria

Hopmans P and Bickford R *(2003), Effects of fire retardant on soils of heathland in Victoria*,Research Report No. 70, DSE Victoria

Leitch, C.J., Flinn, D.W. and van de Graaff, R.H.M (1983) *Erosion and nutrient loss resulting from the Ash Wednesday (February 1983) wildfires: a case study*, Australian Forestry, 46: 173-180.

Gill, A.M. (1996), *How fires effect biodiversity,* In 'Fire and Biodiversity: the effects and effectiveness of fire management'. Dept. Environment, Sport and Territories,Biodiversity Series, Paper No. 8: 47-55.

Bradstock, R. ,Sander, J. and Tegart (1997), *Short-term effects on the foliage of a eucalypt forest after an aerial application of a chemical fire retardant,* Australian Forestry'. 50(2): 71-80.

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AFAC is the peak representative body for fire, emergency services and land management agencies in the Australasia region. It was established in 1993 and has 26 full and 10 a liate members.

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