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THE POTENTIAL OF GROUND APPLIED RETARDANT AS AN ALTERNATE BUSHFIRE CONTROL SYSTEM

By Daryl Scherger

Summary

Ground Applied Retardant (GAR) using a high speed tracked carrier has the potential to significantly reduce both the size and cost of bushfires. When compared to conventional suppression techniques, GAR costs more per kilometre but the faster application speed could significantly reduce the size of fires resulting in lower suppression costs and reduced impact on the community. Tracked carrier maintenance costs are high but would be justified by the reduction in suppression costs. GAR could become a valuable addition to conventional control systems especially in open forests close to population centres.

Introduction

In the 22 years since the 1983 Ash Wednesday bushfires there have been numerous large fires resulting in the loss of many lives and property totalling billions of dollars. The various agencies responsible for fire control in SE Australia have invested huge sums in upgrading equipment, training and management structures but large destructive fires are still occurring. With Climatologists predicting even more severe fire weather conditions as a result of global warming, fire control agencies must rethink the way they fight fires.

"The safest, most effective and efficient way to control large fires is to put them out while they're still small." Successful initial attack is the key to reducing the impact of fires on the community and the most important factor in determining the success of initial attack is the speed of the control operation.

Fires develop exponentially. That is they increase in size at an increasing rate, even if conditions remain constant. Without any suppression activity, a bushfire that has burnt 5 hectares in the first hour will cover at least 20 hectares in the second and over 80 in the third. This exponential growth means early control is vital. If you halve the time taken to bring a fire under control you will at least quarter the size of the fire. The fastest ground based system for establishing control lines at present is Ground Applied Retardant (GAR).

In recent years aircraft have played and increasing role in fire fighting and there are some that see them as the solution to controlling large fire. While an important resource they have four major faults: -

1. They are very expensive.
2. They are inaccurate (fire bombing is a very difficult job and even experienced pilots regularly miss their target).
3. They cannot operate at night (this is when fires are usually the quietest and control measures most effective).
4. They cannot operate in smoke (the wisdom of relying on a fire fighting system that cannot be used in smoke is questionable).

Bushfires are normally controlled by the construction of a control line. This is usually a narrow line where vegetation and overlying debris is removed exposing mineral earth. Mineral earth control lines are built either by hand or machine. The alternative to a mineral earth line is to treat the vegetation and debris with a chemical retardant that renders the coated material non-flammable.

Chemical retardants have been used to combat bushfires successfully for many years. They are usually applied from aircraft but can be even more effective when applied from the ground. Ground application is much more uniform and can be varied to suit fuel type and quantity as well as fire behaviour. GAR can be successfully applied to elevated fuels such as stringy barks or heavy ground fuels such as heath. The application rates are altered according to fuel type and load (1 litre per square metre is typical).

A table showing the components of the principle control line systems as well as their average speed and cost per kilometre are set out below. Information in the table is based on the DSE publication *Park and forest firefighting resources guide* and is for flat ground with a high fuel hazard (15 tonne/hectare).

System	Hand trail	Dozer line – D4	Dozer line – D6	GAR
Components	20 firefighters with hand tools	D4 bulldozer 3 slip-on units 6 crew	D6 bulldozer 3 slip-on units 6 crew	Tracked carrier Retardant mix 2 crew
Output – m/hr	200m per hour	400m per hour	700m per hour	5000m per hour
Cost per km	$5,500	$615	$380	$2026

Apart from hand trail, GAR is more expensive per kilometre than conventional methods of fire control however when the above outputs and costs are applied to various fire scenarios the true cost of each system can be seen.

If we use a typical fire burning on flat ground in mixed species forest with a fuel load of 15 tonnes per hectare and weather conditions that equate to a Fire Danger Index (FDI) of 20 (High) then we get the following results:

System	Hand trail	Dozer line – D4	Dozer line – D6	GAR
Size of fire when crews arrive	1.6 hectares - Hand crews not suitable	1.6 hectares	1.6 hectares	1.6 hectares
Controlled size	N/A	99 hectares	7 hectares	1.9 hectares
Controlled cost	N/A	$4,120	$638	$1,722

If we raise the FDI to 30 (Very High) then the following is likely to happen:

System	Hand trail	Dozer line – D4	Dozer line – D6	GAR
Size of fire when crews arrive	3.1 hectares - Hand crews not suitable	3.1 hectares	3.1 hectares	3.1 hectares
Controlled size	N/A	Control only achievable after conditions moderate – over 200 ha.	51.3	4.3 hectares
Controlled cost	N/A	>$10,000	$2,584	$2,614

At an FDI of 40 (Very High):

System	Hand trail	Dozer line – D4	Dozer line – D6	GAR
Size of fire when crews arrive	5.4 hectares - Hand crews not suitable	5.4 hectares	5.4 hectares	5.4 hectares
Controlled size	N/A	Control only achievable after conditions moderate – over 200 ha.	Control only achievable after conditions moderate – over 200 ha.	7.9 hectares
Controlled cost	N/A	>$10,000	>$5,000	$3,586

These figure show that GAR is very effective at reducing fire areas and it becomes cost effective as the fire danger increases. Sloping ground reduces the speed of conventional control systems making GAR even more cost effective at a lower FDI.

It should be noted the above theoretical examples are only to compare costs and outputs of minimum initial attack numbers. In reality additional resource would be used in the conventional control system examples to control the fires sooner but at increased cost.

If a GAR system was applied to recent serious fires then it's likely these fires would have been controlled early with significant reductions in both the size of the fire and the losses caused.

An example is the Linton fire. A Departmental crew arrived at the Linton fire approximately one hour after it started. The fire was around 32 hectares at that time with a forward rate of spread of about one kph. If this crew were using a GAR system they could have checked the fire in less than 20 minutes and had it controlled in less than an hour. The final size would have been around 40 hectares with a controlled

cost of approximately $5,000. This would have prevented the loss of 5 lives and a huge cost to the community.

Ground Applied Retardant has been available to agencies for over twenty years. In 1985 the US Forest Service Roscommon Equipment Center published report No. 41A, *An Analysis of Ground Application of Retardants*. This report concluded that retardants are effective in controlling wildfire but expensive. This report did not analyse the effect of application speed.
Monsanto, a major manufacturer of retardant, has done extensive research on the use and effect of retardants. In their publication, *Fire Retardants in Prescribed Burning: Application Guide*, a maximum application speed of 15 kph is recommended for effective application. Five kilometres per hour (walking pace) is the likely average speed for fire fighting but higher speed are possible if conditions suit.

A GAR system would consist of the tracked carrier and transporter.
Tracked carriers are essentially an armoured personnel carrier without the armour (Figure 1). They are widely used by armed forces including the Australian Army and are very good at carrying loads across country. Their flexible track system makes them better than bulldozers for this type of application. GAR machines would normally be fitted with a dozer blade and with a similar weight, longer track frame and more powerful motor they would have similar or better pusher power compared to a D4 bulldozer.
Along with a blade, the carrier would have an air-conditioned ROPS/FOPS cabin and a 4,000 litre tank for retardant. The cabin would have forestry guarding including heavy steel mesh on all windows. The crew would be two people, a driver and a spray monitor operator. The retardant would be applied using a remote controlled monitor mounted on the front of the cabin (Figure 2).

Figure 1 - M548/M1015 full tracked fire fighting vehicle developed at Roscommon Equipment Center.

Figure 2 - Remote controlled monitor - Roscommon Equipment Center project No. 58

The transporter would be a heavy machinery float with sufficient capacity for the fully laden tracked carry together with an additional 4,000 litres of water and 2 tonne of retardant powder (18 to 19 tonne in total). The transporter would act as a base for the carrier and have enough water to refill the carrier once and enough retardant for two further refills using water delivered by convention tankers. This would give the unit sufficient capacity to establish up to four kilometres of control line with minimal support.
The transporter would carry an eductor mixing system and the carrier crew could mix retardant as required.

Possible reasons for Fire Control Agencies not using GAR are: -

Retardant Cost
A retardant line costs around $0.50 per square metre or $2,000/km for a four metre wide line. As shown above, a simple per kilometre cost comparison makes the use of GAR unjustifiable to managers and this is the most likely reason agencies don't use it.

Safety
Agency managers are unfamiliar with the product and the risks involved with using both GAR and the high speed tracked carriers required for its effective application. The retardant itself is essentially the same as that used in fire bombing and poses no greater risk to personnel using it.

The restrictions on land clearing, phasing out of logging and the increased use of excavators has meant the numbers of experienced dozer operators available for conventional fire control systems is becoming less. The opportunities for dozer operators to gain or maintain the skills needed for effective control line construction,

particularly in steep country, has become very limited. This is a significant operational and OH& S issue for agencies. GAR doesn't involve ground disturbance so gaining approval for operators to practise their skills is likely to be easier.

A GAR system would be essentially the same as conventional control systems but replace a mineral earth break with a chemical one. In direct attack, GAR would be applied immediately in front of the fire edge so the carrier crew would be "taking the black with them" as with conventional systems.

In the event of a break down or other problem the crew have burnt out ground immediately behind them. In addition they would have roll over (ROPS) and falling object (FOPS) protection. Protection crews in the slip-on units or tankers supporting a dozer in conventional fire fighting do not have. Falling trees and branches or rolling over on steep ground are major hazards face by fire fighters.
A GAR system reduces the numbers of people needed to control a fire and provides them with better protection while they do it.

Handling and mixing retardant
In the past, retardant use was associated with handling unpleasant, messy chemicals in large mixing facilities. In recent years induction techniques have developed to the point where retardant can be easily mixed in the field, in large quantities and on demand with minimal equipment or exposure to the chemicals.

Purchase and maintenance costs of the tracked carrier
This has been raised as a reason for not using GAR. Tracked carriers are made by a number of companies to various specifications. The Russian Company Altai produce a purpose built machine (Figure 3) for GAR use with a list price of $90,000. Together with a transporter and retardant mixing equipment the total cost of a GAR unit would be around $240,000 (about 20% more than a conventional 4 X 4 tanker).

Figure 3 - Altai Tractor Company TLP-4M Forest Extinguishing Machine

High-speed tracked vehicles do have high track maintenance costs. According to personnel involved in the use and maintenance of Australian Army tracked carriers they have a track life of around 10,000 kilometres. Mackey Consolidated Industries in Melbourne carry out track maintenance for the Army and provided costing details that amounted to around $10 to $15 per machine hour or about $5 per kilometre of a control line. This cost has been included in the figures in the above tables.

Environmental Impact

Chemical retardants have been used for a long time and their effect on various vegetation communities has been well researched. There are no known long-term effects on land plants but they can be toxic to aquatic communities so care must be taken not to apply them directly into streams, lakes, etc. The environmental impact of mineral earth control lines can be severe and long term. The rapid control of fires using GAR would result on much shorter control lines than with conventional systems so the environmental impact would be significantly less.

Effectiveness

GAR is an alternative to dozed mineral earth control lines. It can be used over a wide range of terrain but there are places where it would not be suitable. These include very steep and or rocky terrain and very heavy vegetation such as plantations or Ash regrowth. Traditional methods such as hand trails or using heavy dozers to construct control lines would have to be used in these situations. GAR could improve the effectiveness of these methods by allowing increased use of hose lay for hand trail situations and a lower standard of heavy dozer line.

As previously stated, chemical retardants have been used in fire control for many years and their effectiveness is well known. Mineral earth control lines have been used in the past to ensure fires do not continue to burn undetected and escape later on. The advent of Thermal Imaging technology allows fire fighters to be certain there is no residual fire activity (hot spots) making mineral earth breaks unnecessary.
With its speed of operation any spot overs or misses can be quickly picked up when the GAR unit does follow up patrols.

GAR can also be effective in swamps and other ground conditions were conventional fire control systems are unable to be used.

Conclusion

Ground Applied Retardant has the potential to significantly reduce the size of bushfires and their impact on the community. At the same time this system could reduce the risks to fire fighters and the cost of suppression operations.
It would not replace conventional fire fighting systems in all situations but could have a dramatic impact in areas where open dry sclerophyll forests adjoin urban or rural residential development. In these environments full advantage could be made of the systems speed of action.
All Australian Fire Control Agencies should make GAR part of their suppression capabilities

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