BACKFIRING AND BURNOUT TECHNIQUES USED IN THE YUKON, 1972

by

G.R. Lait and W.C. Taylor

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INTRODUCTION

A new policy of extended first attack protection of forested areas by the Yukon Forest Service during 1972 has created an even greater need for an efficient method of fire protection.[1] With the increased area of forest protection responsibility, large remote and inaccessible forested areas made traditional methods of fire suppression difficult because of estimated high costs and lack of available equipment and personnel.

Backfiring is an effective method of fire suppression, when used under the right conditions, and has for many years been employed occasionally in 'last ditch' attempts to suppress uncontrollable forest fires. Many times forest fire control personnel have been presented with circumstances where backfiring could have held a fire but was not used because of high risk to personnel. The Yukon Forest Service requested the Canadian Forestry Service (Northern Forest Research Centre) to provide an effective aerial ignition technique to allow backfiring and burnout of large areas of fuel in front of forest fires with a minimum of hazard to personnel.

The study consisted of two stages: (a) testing of suitable incendiaries, and, (b) design and construction of a priming and release mechanism.

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1 E. Nyland, Superintendent of Forestry; Personal communication.

TESTING OF SUITABLE INCENDIARIES

Aerial ignition of large areas of fuels has been carried out by the Australians (Baxter, Packham, and Peet, 1966; Packham and Peet, 1967). Ignition of hazardous accumulation of litter and undergrowth using incendiary capsules dropped from a fixed wing aircraft proved to be a very successful method of preventing disastrous fires in many parts of Australia. Success of the aerial ignition technique prompted further developments for its use in backfiring for fire control (Hodgson and Cheney, 1970). Although our fuel types differ, our forest fire problem in our northernmost forested areas is similar to the forest fire problem in Australia (Vines, 1968).

Incendiaries described herein (Fig. 1) are essentially the same as those used for hazard reduction burning by the Australians.

They consist of a standard polystyrene plastic, 7 dram pharmaceutical vial 1 x 2 inches. Into the capsules, 4.5 grams of potassium permanganate ($KMnO_4$) are measured and capped with tight fitting polyethelene lids. Prepared capsules are then stored in a metal cabinet until ready for use. To activate the incendiaries, 1.4 cc of ethylene glycol (antifreeze) is manually injected into the capsules by use of hypodermic syringe. The capsules are then immediately manually dropped or mechanically ejected from the aircraft. The two chemicals react exothermally and eventually burst into flame (Fig. 1).

Figure 1. Sequence of incendiary 45 seconds after priming.

Components to make the incendiaries cost approximately:

	cents per capsule
Vial	2.5
$KMnO_4$ (Bulk water treatment grade)	.5
$KMnO_4$ (Laboratory grade)	3.6
Labor for hand filling est.	2.0
Capsule with bulk $KMnO_4$	5.0
Capsule with lab grade $KMnO_4$	8.1

A powder measure was used to load the capsules.

Reaction time varies slightly with ambient temperature of the chemicals, but the critical factor is the particle size of the $KMnO_4$. With an 18 mesh[2] particle size the reaction time is approximately 45 seconds, but with a smaller particle size of 60 mesh[3] the time is reduced to 15 seconds. Slower reacting incendiaries are safer but no problems were encountered with the 60 mesh incendiaries. When dropped from 300 feet the capsules take slightly more than 4 seconds to reach the forest floor. Burning briefly at a temperature of 2200 F, the incendiaries then burn for 2 to 3 minutes at a temperature of 1600 F.

For operational testing of the incendiary capsules a hand release method was used. Capsules were primed by hand with a pipetting syringe with a cannister of ethylene glycol attached. The incendiaries were dropped from various helicopters with some success but the best results were achieved when using the drop hatch in the Alouette II helicopter (Fig. 2). From 12 to 20 capsules per minute could be primed and dropped using this method and were successful in ignition of the fuels. This method of priming and dropping the incendiaries is slow and awkward and demonstrated a need for a mechanical priming and release system.

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2 Laboratory grade $KMnO_4$ was used for the 18 mesh incendiaries.

3 Bulk water treatment grade $KMnO_4$ was tested approximately 60 mesh size, it was considerably less expensive than laboratory grade.

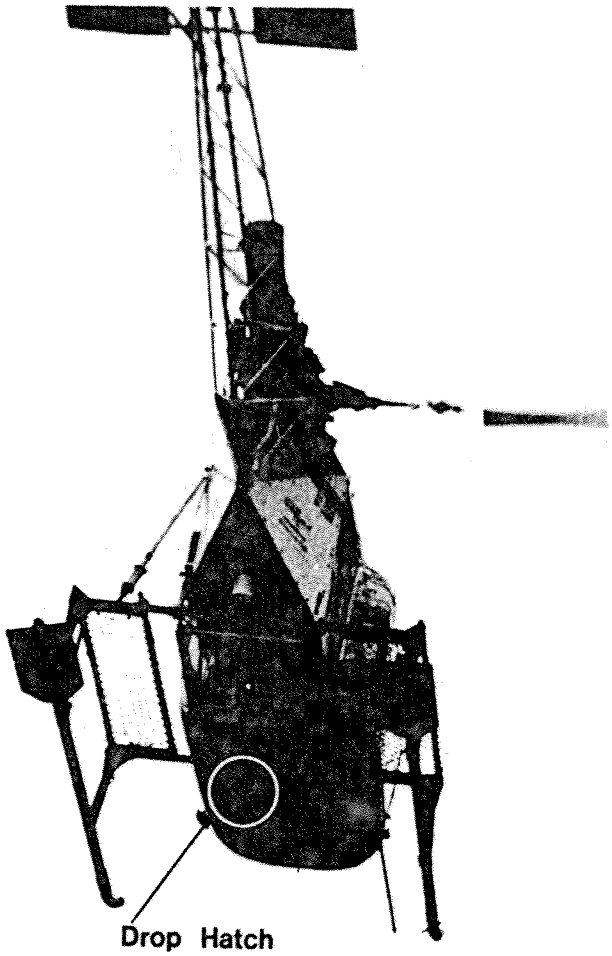


Figure 2. Alouette II helicopter showing drop hatch.

PRIMING AND RELEASE MECHANISM

Work was thus started on a mechanical priming machine (Fig. 3) The machine was mounted in a Bell 47G-3B-2 helicopter (Fig. 4). No alterations to the helicopter were required and three small bolts held the priming machine in place.

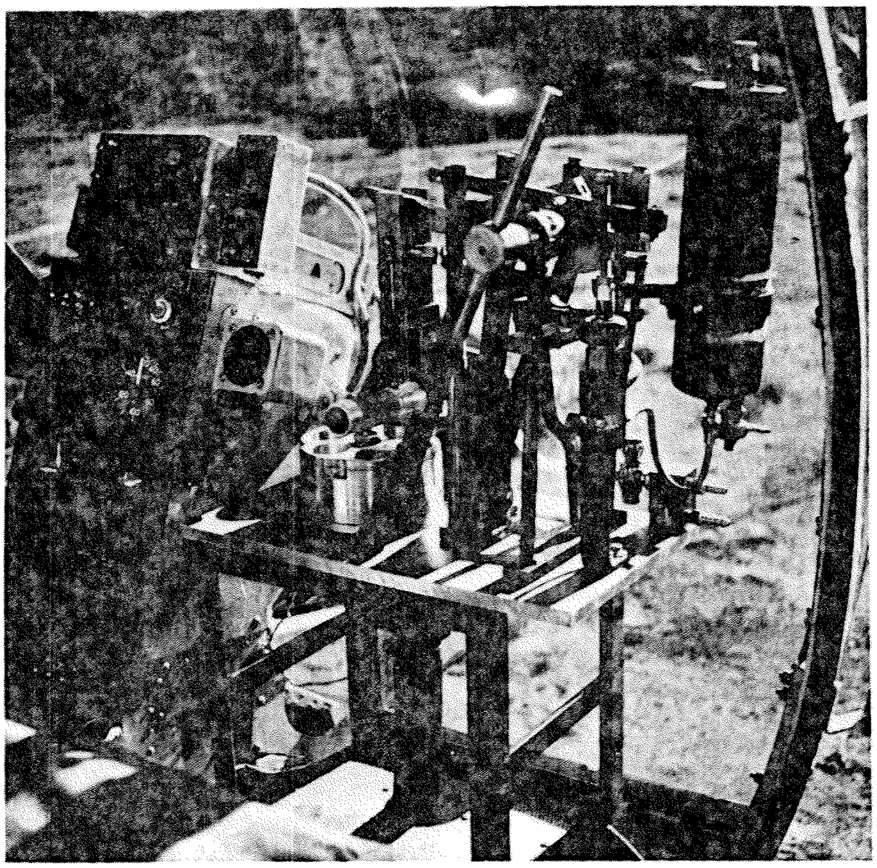


Figure 3. Prototype mechanical priming machine.

While sitting in the right hand seat the operator directs the pilot and operates the priming machine (Fig. 5). The machine is loaded by placing the capsules in a rotary turntable and can prime and release the capsules as fast as they can be placed. Sharp edges and protrusions will be covered by a protective shrouding in the operational model.

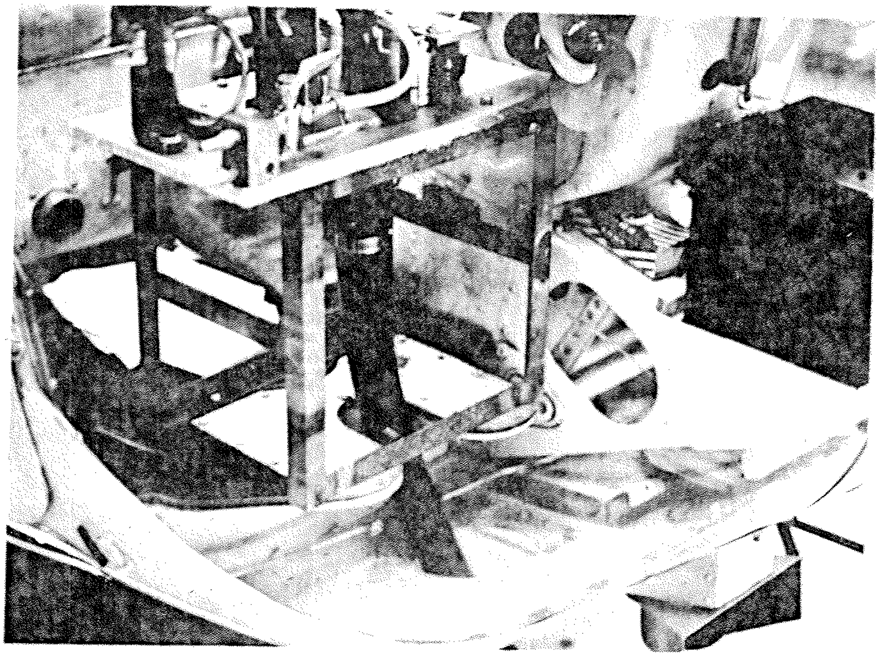


Figure 4. Installation of priming machine in Bell 47G-3B-2 helicopter.

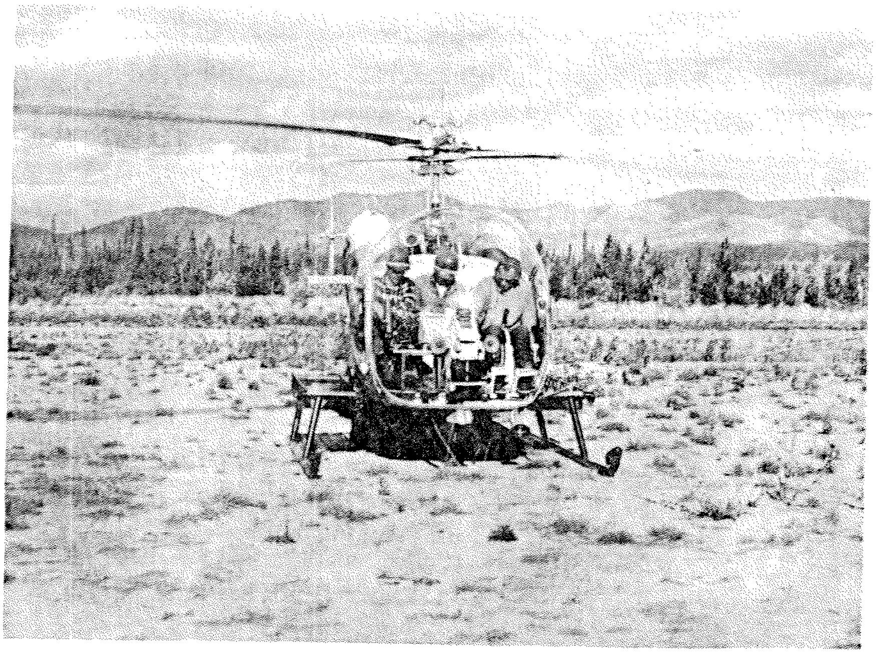


Figure 5. Bell 47G-3B-2 helicopter ready for backfiring.

APPLICATION OF AERIAL IGNITION TECHNIQUE

Backfiring involves the ignition and burnout of flash fuel along a control line a strategic distance ahead of the main fire front. Speed and method used to ignite the backfire is very important as fire behavior may be manipulated to advantage during short periods when conditions are optimum. Ignition of the fuel between the headfire and the control line must be done when conditions and topography are such that sufficient depletion occurs and the fire spread is retarded or halted. Aerial ignition gives the fire fighter a definite advantage in fire manipulation and can be successful without ground support personnel.

In Fig. 6, is shown how a section of a large fire in the central Yukon was backfired in strips from a helicopter using a small stream for a control line. Several similar operations were carried out on sections of other large fires, uncontrollable with conventional methods, with excellent results.

The Yukon and Northwest Territories and northern portions of the western provinces have conifer fuel types with extensive cladonia and barren land ground cover. These fuel types have a high rate of spread characteristics particularly in the months of June and July when fire danger is often high to extreme. Fires in these areas frequently burn so rapidly that main fire fronts can be a mile wide or more and burning through continuous forest cover. Situations such as this present a problem of inadequate natural barriers suitable for a control line from which to backfire. With modifications and new developments in fire retardants and new and larger airtankers and helitankers, suitable control lines could be constructed from the air from which backfires could be anchored.

Figure 6. A sequence of a backfire south of Mayo, Yukon Territory.

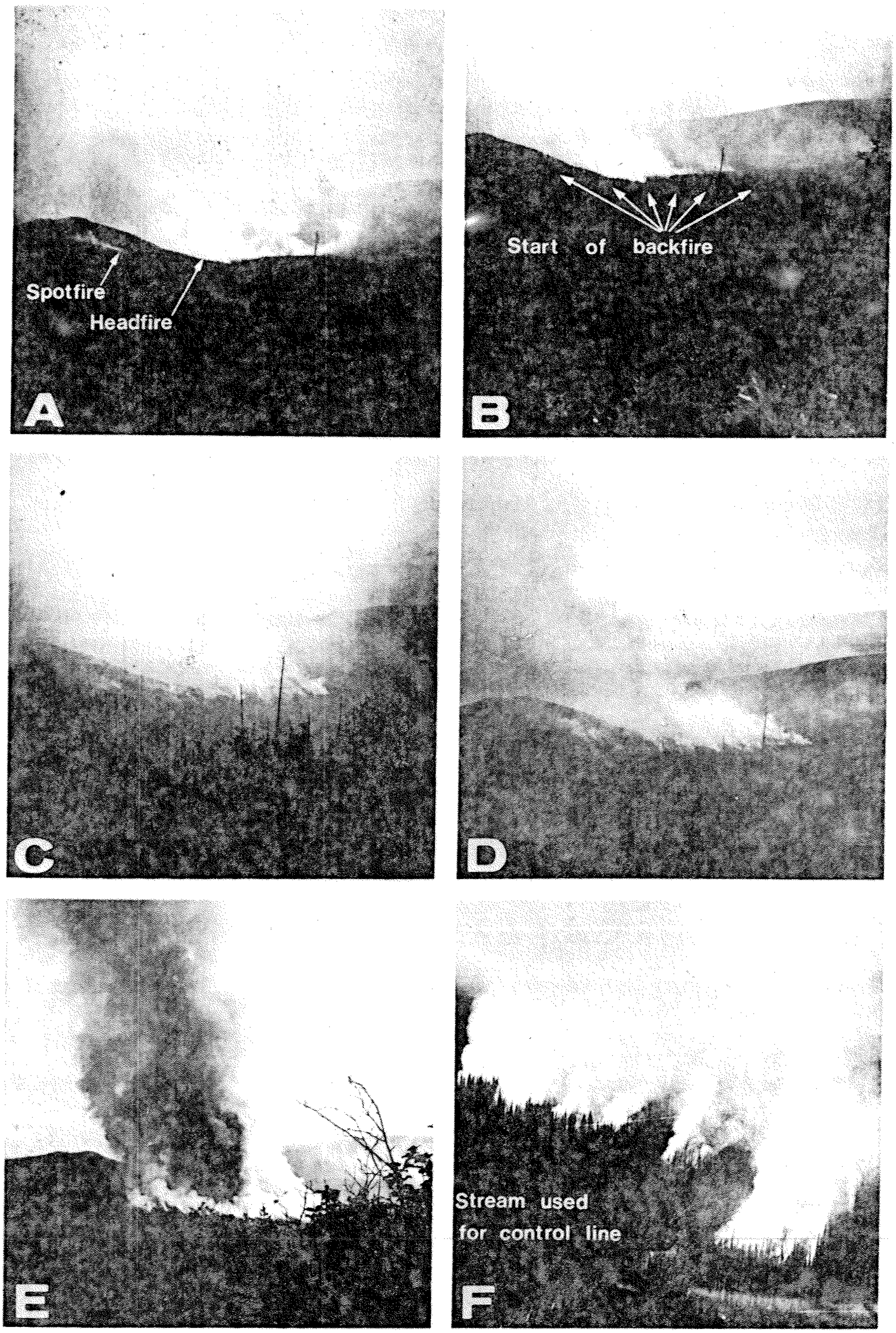
A. Shows headfire building up intensity and spotting ahead over a slight ridge as it approaches a small stream.

B. Shows the start of backfire operation. Line of incendiaries dropped from a helicopter approximately 200 yards ahead of the headfire.

C. & D. Shows successive lines of incendiaries placed approximately 100 yards apart as the fuel is being exhausted between the headfire and the control line. Individual fires are evident by numerous small smoke columns.

E. Shows the strong thermal updraft created when the backfire is drawn into the headfire. The time between the start of the backfire and the meeting of head and backfire is approximately 45 minutes.

F. Shows the backfire slowly moving toward the small stream used for a control line. Further incendiaries were used to ignite fuels close to the stream.


Spotfire
Headfire
A
Start of backfire
B
C
D
E
Stream used
for control line
F

CONCLUSION

Aerial ignition for backfiring and burnout is now an operational fire suppression technique in the Yukon Territory. Consideration has been given to the possible use of trained backfiring crews for the purpose of utilizing this method when conditions are suitable.

Aerial ignition of fuels is not limited solely to suppression techniques. Large areas could also be ignited on fuel hazard reduction and site preparation types of operations. It is recommended, however, that personnel with a thorough knowledge of fire behavior be selected for or trained in the application of this technique.

ACKNOWLEDGEMENTS

We wish to express our appreciation to Yukon Forest Service Resource Management Officers, John Klassen, "Smokey" Guttman, and Bob Studds for their co-operation in the operational testing of this method of fire suppression. Our appreciation is also extended to Glen Grady (Assistant Resource Management Officer), for his valuable assistance in the actual operations and to Pilots Ray Brackenbury (Klondike Helicopters), Bob Dunbar (Trans North Turbo Air), and Jim Innes (Haida Helicopters).

The mechanical priming machine was designed in 1972 and constructed by Peter Bihuniak, Electronic Technician at the Northern Forest Research Centre.

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