Mr. Schori: Thanks a lot Bob. I think we're going to have a few new problems with some of our old problems. You've stuck a note of hope in this metric conversion business.

Our next speaker is John Muraro, a Research Scientist in the Fire Research Group at the Canadian Forestry Service, Pacific Forest Research Centre in Victoria, B.C. John exemplifies the international flavour of our meeting. He was born and raised in British Columbia. He worked for the B.C. Forest Service from 1951 to 1955 on fire suppression and timber cruising in the Nelson Forest District. John then went to school at Missoula, Montana where he got his B.ScF in 1959 and MScF oriented to fire in 1960. While he was at the university he worked for the U.S. Forest Service on the Clearwater National Forest and the Aerial Fire Depot at Missoula.

Since joining the newly established Canadian Forestry Service Research Centre, in 1960, he has concentrated his efforts on the improved use of prescribed fire, on fuel appraisal and fire danger rating. John's going to talk to us about new ignition systems. John.

IMPROVED IGNITION SYSTEMS

By

S. J. MURARO

Pacific Forest Research Centre
Victoria, B.C.

The ability to provide ignition at the proper time, sequence and place has long been recognized as a prime requirement for successful prescribed burning.

In Prescribed Fire Planning in the Intermountain West, Beaufait 1966, emphasized the importance of ignition devices with the following statement "Proper ignition devices should provide rapid controlled lighting of lines of fire along predetermined routes. The success of the burn frequently depends upon the speed and efficiency of ignition crews". In "A Guide to Broadcast Burning of Logging Slash in British Columbia", Annon. 1969 the stated objective for the ignition phase is to ignite the entire area in one burning period and to complete the burn as rapidly as possible. The need to adjust the pattern and rate of ignition and to maintain flexibility in the ignition pattern is strongly emphasized.

Background

In British Columbia the requirement for improved ignition systems was strongly emphasized in the early 1960's with the use of prescribed fire for post logging treatment in the interior of the province. Large cut blocks, generally level terrain (requiring more ignition per acre than slopes) and less available manpower emphasized the need for better ignition techniques in order to improve the use of prescribed fire. To respond to this need the PFRC fire research group established an informal surveillance, testing and development study. Similar studies of varying degrees of formality were being conducted by a number of agencies involved with prescribing burning in the U.S. and Canada. Through the course of these quasi-operational trials virtually anything that could carry fire or be ignited was carried, thrown, launched, propelled or flew was tried. Incendiary bullets fired at strategically located bottles of fuel, the bow and flaming arrow and even the slingshot resulted in some successes but more often embarrassed burners.

Our particular interpretation of ignition needs in British Columbia suggested that cost, safety, and availability largely dictated the users acceptability. From the outset it was obvious that the drip torch was by far the most efficient, safe and versatile direct ignition tool. It was also obvious that devices that deposited burning material were far more efficient than systems that only provided an open flame. If ignited fuel was deposited, such as with a drip or drag torch, the rate of ignition was influenced primarily by the rate of transport. With non-deposition devices such as a fusee or propane torch the ignition rate is further limited by the time required to preheat and ignite the fuels being treated. For this reason we rejected all such devices as being uneconomical for a sustained operational prescribed burning program.

Another early conclusion was that users did not want to be involved in fabrication of devices. They were willing to fabricate on a trial basis but would never seem to allow enough time to fabricate for operational use. If a system could not be purchased off the shelf it was generally non-acceptable.

Operational Cost Analysis

A rough estimate of expected operational costs of the various components that together form an ignition system emphasized that improved ignition devices themselves was only part of the answer; and that consideration of each aspect of a system was required to isolate and compare the costs of various alternatives.

For the purpose of these estimates capital costs for specialized non-comsumptive equipment such as torches, pumps or dispensers were not considered because of the unknown and variable use that they would experience. We felt that capital costs could best be justified by the user based on their individual needs and expected use a factor that was unknown to us.

To compare the costs of various systems we estimated the cost of the various components per 1000 ft. of ignition line. We thought a cost per length of ignition line was more appropriate than a cost per acre because it considered the variations of ignition requirements due to slope and shape of area. More importantly the planning phase of prescribed burning and resulting crew allocation is based on the total length of ignition line required and time constraints rather than the number of acres.

We considered an ignition system to consist of at least three components that could be assigned a cost on a use basis.

The ignition device or material – is the material or chemicals that either ignites or is ignited by the dispenser. The device or material including its containers is the direct cause of flame transfer to the fuel complex, i.e. liquid hydrocarbons, grenades, contained chemicals.

The dispenser – is the specialized equipment required to meter and or charge the ignition device or to cause ignition in the case of free flowing liquids. The dispenser is part of or carried by the transporter, i.e. torches, dispersing charges, AID dispensers.

The transporter – is the means by which the other ignition system components are located to achieve the desired ignition pattern, i.e. personnel on foot, all terrain vehicles, aircraft, or launch systems. The component cost of obtaining a 1000 ft. of line fire by a variety of techniques are shown in Table 1.

TABLE 1. Cost estimates for ignition system components, $/1000 feet of ignition line.

IGNITION DEVICE OR MATERIAL type	unit cost $	rate of use per + 1000 ft	container number and cost	total cost /1000 ft of line
Hydro Carbons				
Liquid, Gas-Diesel	.60/gallon	0.5 gallons	Free flowing	.30
		1.0 gallons	Free flowing	.60
		2.0 gallons	Free flowing	1.20
Jellied Gas	.61/gallon	1.0 gallons	10 at .15=1.50	2.11
Solid, Fire Starter	.09/cube	20 cubes	Fuse 1.20 (40′ at .03/ft.)	3.00
Chemical Devices				
D.A.I.D.	.18 each	10 units	Self contained	1.80
Grenades	3.00 each	5 units	Included	15.00
$KmNo^4$-Glycol	.07 each	15 units	Included	1.05
or	.02 each	15 units	15 at .02=.30	.60
DISPENSING EQUIPMENT				
Hand Drip Torch	60.00 each			
Flying Drip Torch	800.00+			
AID Dispensers	1500.00 est.	100,000 units		.22
Electrical Wire	10.00/1000′	1,200 ft.		18.00
Caps	65.00/100	10 units		
Fuse - B Line	46.00/1000′	1,200 ft.		55.20
TRANSPORT METHOD				
Person on Foot	6.00/hr.	1 mile/hour		1.13
ATV	20.00/hr.	4 miles/hour		.95
Helicopter				
47G3	150.00/hr.	15 miles/hour		1.88
		40 miles/hour		.71
		60 miles/hour		.47
206	300.00/hr.	15 miles/hour		3.77
		40 miles/hour		1.41
		60 miles/hour		.94
Launch Systems	4.00/shell	5 units/1000		20.00

Development of Flying Drip Torch

We recognized that superheated droplets of diesel or other liquid hydrocarbon was the most economical ignition material. The dispenser or drip torch was a simple tool. On small accessible areas a man could provide adequate transport to achieve an efficient ignition system. However, on large areas, the slow rate of manual transport required large, highly organized crews which in most cases did not satisfy considerations of safety, time constraints, and overall fire behaviour observation. The problem was one of transportation.

The helicopter was the obvious answer especially after our cost estimates shows that at 20 miles per hour a G47B helicopter could be moved 1000 ft. for $1.42 whereas a man at 1 mile per hour would cost $1.13[1].

Consolidation of the entire ignition task into a moving space platform that provided complete surveillance of fire behaviour, and oversee control needs seemed a bargain for the extra $0.29 per 1000 feet.

We determined that an ordinary drip torch could drop fire from a height of at least 40 feet, (determined from the roof of our laboratory building). From our experience with drip torches from moving vehicles we knew favorable burning characteristics at the torch could be maintained at least up to an air speed of 10 miles per hour. We thought we could maintain flame characteristics at high air speeds and provide protection from rotor wash with protective coverings at the torch.

In the summer of 1973, after advancing the concept of a flying drip torch to a number of skeptical users, Northwood Pulp and Paper in Prince George provided the staff of their Service Centre to construct a prototype. After a few embarrassing demonstrations we achieved a protective shroud for the torch that allowed constant combustion at the torch with enough superheated fuel remaining to carry fire to the ground. The prototype flying drip torch is very similar to a hand torch consisting of an angle iron frame which supports a ten gallon fuel drum, vented and secured by shock cords. Fuel is conducted from the drum via a one way flapper valve, a manual valve, a quick couple into ¼ inch black iron pipe with flash back hoop. Upon entering the hooded torch the fuel conductor is "U" shaped to provide a heating coil for the fuel with the exit at the top of the shrouded torch. A conventional asbestos pad provides a combustion area. The original torch also had a solenoid valve to shut off the fuel flow; however this was discarded because of power cord breakage when the torch was twisted. The torch is suspended approximately 20 feet below the helicopter by fore and aft lines attached to a ring which is hung from the helicopter hook. The prototype drip torch was first operationally demonstrated on a 200 acre slash burn on the Summit Lake District in 1973. Subsequent to this Northwood, using Northern Mountain Helicopters, burned approximately 2200 acres with a record performance of 30 minutes to prescribe burn a 250 acre block and for a direct ignition cost of about $0.35 per acre.

The mode of operation was to select a landing at the edge of each area to be burned where the control crew and ground support crew with extra helicopter and drip torch fuel could rendevous with the helicopter. The torch was ignited on the landing and vertically lifted in excess of 200 feet so that burning fuel would be extinguished in the air. The aircraft would then fly to the start of the ignition pattern and descend to operational elevation. The procedure was reversed to return to the landing. If additional drip torch fuel was required the quick connections and shock cord tie-downs required only a few minutes to replace the empty fuel drum. Normally the torch would be flown from 15-20 feet above the slash at an air speed between 15 and 20 knots. A 50-50 percent gas-diesel fuel mix provided the best performance from this torch. The greatest operational problem was to maintain the torch in a steady flight attitude; oscillations and twisting tended to disrupt the fuel flow or cause complete combustion of fuel within the burning chamber.

The performance of the flying drip torch was so encouraging that two additional models were constructed by the Prince George and Kamloops forest districts in the fall of 1973. Although little operational use was made of these units they allowed further non-operational trials. A co-operative development project was initiated by John Young of the B.C. Forest Service, Prince George and Okanagan helicopters in the fall of 1973. This program resulted in a larger torch with a fuel capacity of 45 gallons, remote fuel flow control using a motorized gate valve and an electrical ignition system for in-flight ignition. The most important contribution however was the design of an aligning arrangement that provided in-flight stability to the torch. This consisted of a "hockey stick" shaped pipe that acted as a spreader on the two supervisor cables and locked into the wheel well of the skid pad. This design prevented twisting and held the torch at right angles to the helicopter to provide better torch visibility from either side.

The increased fuel flow allows use of a 40% gas to 60% diesel fuel mix and an increased operational altitude. Torches of this design, requiring a Bell 206 or equivalent helicopter, were used extensively through the province in the 1974 and 1975 prescribed burn programs. There are presently at least 15 flying drip torches throughout British Columbia; most of which are owned by Okanagan helicopters, the remainder owned by the Forest Service, other helicopter charterers and forest operators. Working drawings are contained in the final report by Fielder 1975, available from Protection Division, B.C. Forest Service, Victoria, B.C., V8V 1X5.

Through the development and use of this new ignition tool we learned some valuable lessons; the most important being:

(1) Efficient use of the drip torch required good planning and ground support to provide extra fuel for both the torch and the helicopter.
(2) Aerial ignition should be planned to include as large an acreage as possible in the same trip to write off ferry time – either on single large blocks or a number of small blocks.
(3) The person in charge of the burn or his delegate must accompany the pilot in order to operate the torch controls. This removes the responsibility for the ignition pattern from the pilot and allows him to concentrate wholly on the flying. The torch operator can provide instructions via the intercom on course changes, altitude, air speed and general torch performance while maintaining communication with the control crew.
(4) Extreme care must be exercised on perimeters, to avoid rotor wash from scattering fire across the line and also to avoid inadvertent ignition by the torch.
(5) Critical perimeters such as top edge should be ignited by hand drip torches to ensure a good downslope burn. It is virtually impossible to

make a second pass along the perimeter without blowing fire across the line.

(6) Small modifications are necessary to allow the torch operator to estimate the amount of fuel remaining so he can plan his ignition pattern in phase with refueling requirements. Either a fuel gage or a selsyn system on the motorized gate valve would provide this refinement.

Development of the AID system

The flying drip torch adequately provided an aerial ignition system for line firing on clear cut areas or areas not obstructed by trees. Interception and shattering of the superheated droplets and the additional altitude required to clear tree tops did not allow effective use of the drip torch in tall, dense forest canopies. Neither would it be particularly desirable for ignition to occur in the crowns, if the objective was to underburn.

There was a clear need for an aerial system suitable for prescribed fire treatment under forest stands. Variable spacing of point source ignitions were required to manipulate fire intensity to satisfy a variety of land management objectives through the use of underburning. In addition to the increased future requirements of prescribed under burning the potential for aerial ignition systems for wildfire management had already been demonstrated by Hodgson and Cheney, 1970 in Australia and by Lait and Taylor, 1972 in the Yukon. Alaskan use of a military air to ground system has also been documented by Ramberg, 1974. The immediate need for an aerial ignition system for use under a canopy was expressed through a request to provide ignition capability for aspen eradication burns in the Peace River area of B.C. All indications, including our component cost analysis, suggested the Australian technique described by Baxter, Packham and Peet, 1966 and Packham and Peet, 1967 of injecting a container of potassium permanganate with ethyl glycol offered most advantages. The size constraints of the particular job and anticipated future use suggested a helicopter rather than a fixed wing operation. The weak point for our application was the dispersing component of the ignition system. Neither the hand powered and hand loaded prototype constructed at the Northern Forest Research Centre nor the Australian hand loaded but motorized dispensers satisfied our needs. We instinctively felt that an automated feed system was required so that the operator could sustain a long term operation and also achieve a high rate of dispensing for future back firing application.

Our first model, designed to meet the immediate need utilized a pressurized glycol reservoir accessed by way of a solenoid valve which was energized when the hollow needle penetrated the top of a styrene vial containing potassium permanganate. The vials were contained in a 100 vial capacity magazine and gravity fed into the dispenser, charged and allowed to drop through the tube.

The second unit incorporated a centrifugal pump to force glycol through the needle on valve opening and provided for a slightly faster drop rate of 1.5 devices per second. At about this time Roy Kruger of the Alberta Forest Service Equipment Development section became interested. After consultation with the staff at PFRC, they turned their attention to designing an automatic feed system. It was not long before the idea of using a spherical container for the permanganate, rather than a sylindrical vial, was proposed. The Alberta people then initiated development of a gravity feed system that supplied single spheres to a rotating arm which caused them to be impinged on a hinged needle, injected and then ejected from the unit. This dispenser is hung from the hook of a helicopter and is self contained. It has been operationally tested in Alberta.

In the meantime we had designed a prototype dispenser utilizing a hopper feed system for spherical containers. Basically this dispenser consists of four metal slippers moving back and forth in a horizontal plane through an eccentric drive. As each slipper moves forward an internal cavity was aligned with an opening, allowing a sphere to fall into the cavity. As the slipper continues to move forward the captive sphere is impinged on a secondary needle and a mechanical valve opens to allow glycol flow. The slipper then reverses direction carrying the captive sphere past the point of pickup to the rear extremety of travel where the sphere exits through an aperature in a lower plate. The spheres are stored in a rotating hopper above the machine and fed through the chutes to the slipper assembly.

The hopper has a capacity of about 400 — 1¼ inch diameter spheres and is easily refilled from auxiliary containers in the helicopter. The previous models were mounted externally on the skid of the helicopter; whereas this model sits on the floor of a Bell 206 but will adapt to other machines. It can be used from either rear door, which must be removed, and is powered directly from the aircraft supply. It has a gravity fed fire extinguishing system and is secured in the aircraft by an external belly band and by the seat belts. The top loading assembly is quickly detachable in the event of feed problems which occurs occasionally with a fractured sphere. A softer but stronger styrene will be used to reduce the frequency of fracturing. Maximum dispersal rate is 4 spheres per second with a maximum aircraft speed of 60 knots. The 50-50 glycol-water solution allows approximately 24 seconds before ignition.

The important aspect of this development is the entire system can be purchased. Five production models of the dispenser have been manufactured by a local machinist[2]. Three of these units were constructed under contract, two for the Yukon Forest Service and one for the Ontario Ministry of Natural Resources.

The 1¼ inch styrene spheres either in the half shell for user charging or in the charged and sealed mode are produced by a Victoria Company[3]. The charged and sealed spheres have been designated as AID, standing for Aerial Ignition Device.

Conclusion

I am personally satisfied that the problem of ignition has ceased to exist. As long as fuel costs don't price us out of use, the conventional drip torch, the flying drip torch and the AID systems should satisfy the majority of prescribed and wildfire management ignition requirements.

[1] Helicopter and crewperson cost based on $150.00 and $6.00/hour, respectively.

[2] Quentin C. Wilson, Fulford Harbour, B.C.

[3] Premo Plastics Engineering, 863 Viewfield Rd., Victoria, B.C.

References

1. ANNON. 1969. A Guide to Broadcast burning of logging slash in British Columbia. Forest protection handbook No. 2. Forest Protection Division, B.C. Forest Service, Victoria, B.C.
2. BAXTER, J.R., D.R. Packham and G.B. Peet. 1966. Control Burning from aircraft. July 1966, Chemical Research Laboratories, CSIRO, Melbourne, Australia.
3. BEAUFAIT, William R. 1966. Prescribed fire planning in the intermountain west. Research paper INT-26 Intermountain For. & Range Exp. Station, U.S. Forest Service, Ogden, Utah.
4. FIELDER, R.L. 1975. The development and use of a remote control helicopter sling torch. Final report project #141, July 4/75, B.C. Forest Service, Protection Division, Victoria, B.C.
5. HODGSON, A. and N.P. Cheney. 1970. Aerial ignition for backburning, Australian Forestry. pp. 268-274. Vol 33.
6. LAIT, G.R. and W.C. Taylor. 1972. Backfiring and burnout techniques used in the Yukon, 1972. Information report NOR-X-43, July 1972, Northern Forest Research Centre, CFS, Edmonton, Alberta.
7. PACKHAM, D.R. and G.B. Peet. 1967. Developments in controlled burning from aircraft. October 1967, CSIRO, Melbourne, Australia.
8. RAMBERG, Richard G. 1974. A field evaluation of helicopter mounted grenade dispenser and incendiary grenades, EDT 1710, August 1974, U.S.D.A., Forest Service, Equipment Development Center, Missoula, Montana.

MORNING SESSION

December 3, 1975

DAVID RADCLIFFE, Chairman, Presiding

Mr. Radcliffe: We will start today's session with the reports from the regional forest fire councils:

CALIFORNIA-NEVADA FOREST FIRE COUNCIL

GEORGE ZAPPETTINI, Chairman

In October of this year the California-Nevada Forest Fire Council met at Cal-Neva Lodge overlooking the deep blue waters of Lake Tahoe. The first few freezing flurries of fall snow provided an inspiring sight that made it difficult for some 125 council members to keep their minds on wildland fire protection. Nevertheless, they grudgingly turned to two days of considering the theme of the meeting, "What's New in Fire Protection?" It turned out that there are plenty of "new" things developing both in the fire laboratory and in field operations.

New fire prevention programs were described including the Red Flag Warning System for critical fire weather conditions in southern California, the CDF's 5-point teacher training package, and that hot issue – the catalytic converter.

New developments in monitoring and telemetering fire weather data included one study by the U.S. Forest Service's Riverside Forest Fire Laboratory in southern California and another study being conducted jointly in the north coastal region of California by the CDF and NASA's Ames Research Center.

Several new efforts to improve fire management and fuel management programs were described. The Council learned, for example, that sheep are capable of digesting tanoak if you can only force the animals to eat the stuff, and that Angora goats do a terrific job of keeping scrub oak and toyon shrubs under control. The only problem encountered in the last study was in distinguishing the old goats from the old forest rangers in the area: both had long white beards and smelled like they needed a bath.

As a final item, the Council considered revision of its by-laws and expansion of the Council to include the state of Hawaii. We need to contact Hawaii about that possibility first and then present the proposal to this Committee or to Western Forestry and Conservation Association, if either of these steps is needed. So, next year we may be known as the California-Nevada-Hawaii Forest Fire Council, or the "C-N-H" Council.

(Report presented by Mike Schori, California Division of Forestry)

PERMANENT ASSOCIATION COMMITTEES PROCEEDINGS

1975

"GLOBAL FORESTRY AND THE WESTERN ROLE"

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(A Panel)
Moderator: RICHARD H. LYSTER
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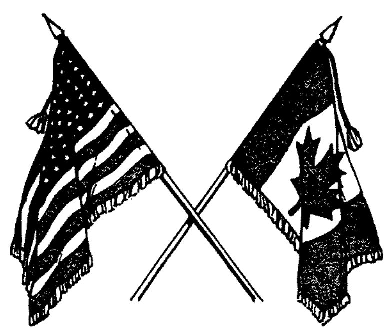
DAVID RADCLIFFE, Chairman
BRIAN CLARK, Secretary



One Forest Under Two Flags

Hotel Vancouver
Vancouver, British Columbia
December 2-3, 1975

A PERMANENT COMMITTEE
of
WESTERN FORESTRY AND CONSERVATION ASSOCIATION
American Bank Building, Portland, Oregon 97205