FIRE RETARDANTS AND THEIR USE

IN WESTERN CANADA

by

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INTRODUCTION

The operational effectiveness of fire suppression organizations in Western Canada has been greatly improved in recent years through the use of fire retardants. The extent of this improvement has depended to a large degree upon the type(s) of retardant(s) utilized and the method(s) of application. This report describes the commonly used retardants and indicates present and future uses in Western Canada. Emphasis is placed on aerial rather than on ground application of retardants, since the former is most advanced in the region.

FIRE RETARDANTS

Retardants are classified as either short-term or long-term. A short-term retardant relies entirely upon the water it contains to prevent combustion; the material is primarily utilized as a suppressant, i.e., used to extinguish the flaming and glowing phases of combustion by direct application to the burning fuel. Water is commonly used as a short-term retardant. The addition of a thickener

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[1] Based on a paper presented at the Annual Meeting of the Associate Committee on Forest Fire Protection, Quebec City, P.Q., January 27 to 29, 1970.

[2] Research Officer, Canadian Forestry Service, Department of Fisheries and Forestry, Edmonton, Alberta

such as clay, industrial gum, or synthetic organic polymer enhances the retardant properties but the effects are still relatively short-term. These additives result in the formation of a thick, moist retardant film that adheres to the fuels and increases the time and fire energy required to vaporize the water. Bentonite and GELGARD[3] are examples of a short-term retardant (Fig. 1).

A long-term retardant, on the other hand, contains a chemical that effectively prevents flaming combustion even after the water has evaporated; the material reduces or inhibits flammability of combustibles, thereby slowing or retarding the rate of spread of the flame front. The addition of various salts to unthickened or thickened water produces a long-term retardant. Diammonium phosphate and ammonium sulphate dry salts are at present the most commonly used chemical additives. They are cheap, readily available and soluble, are compatible with thickeners and water impurities, and are non-poisonous and do not sterilize the soil (Hardy, 1967). Phos-Chek 202 and 259[3] retardants contain diammonium phosphate; Fire-Trol 100[3] retardant contains ammonium sulphate (Fig. 1). Liquid phosphate concentrates are also becoming popular; Pyro (11-37-0) and Fire-Trol 930 and 934 (10-34-0) are products currently marketed as liquid-concentrate retardants.

The increased effectiveness of a long-term over a short-term retardant is readily visible. For example, a laboratory evaluation indicated that a long-term retardant, <u>when fully dried out</u>, was nearly

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[3] Mention of brand name is solely for ease of identification and does not imply endorsement by this organization.

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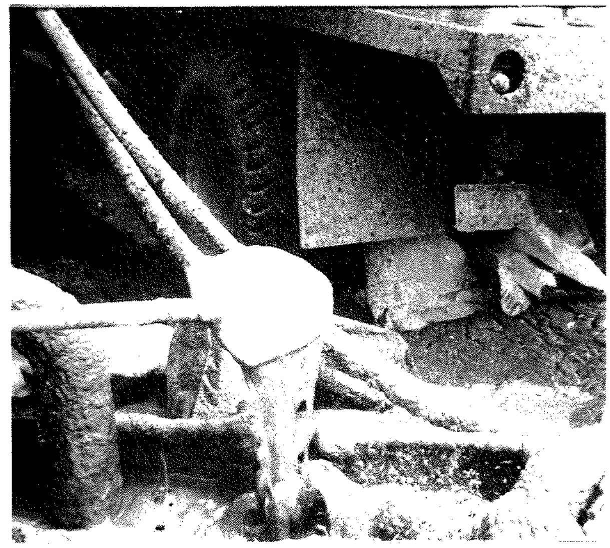

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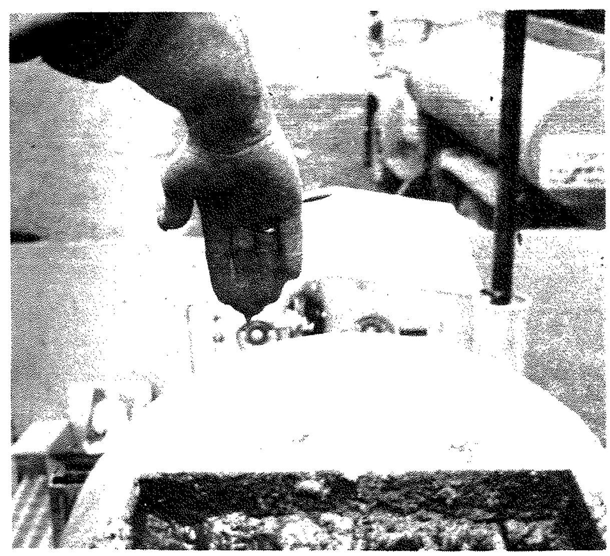

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Figure 1. Various fire retardants used: a) GELGARD F, b) Bentonite, c) Phos-Chek 202, d) Fire-Trol 100.

twice as effective in reducing rate of spread as a short-term retardant when two-thirds of its original moisture was still present (Rothermel and Hardy, 1965). There are several explanations to describe the effects the long-term retardant has on the combustion process of cellulose. The most satisfactory is that the retardant salt causes combustion at a lower temperature and it redistributes the heat of combustion over a wider range with a resultant lower maximum intensity. Addition of the salt not only reduces the weight loss by volatilization and increases the char, but also suppresses the flammability of the volatilization products by raising the percentage of non-combustible compounds (H_2O and CO_2) at the expense of the combustible tar fraction (Shafizaheh, 1968).

APPLICATION OF RETARDANTS

Much of the original researches on retardants, or airtankers, or both, were in California (Anon., 1955). There, the fuel types like brush and shrub with sparse ground fuels necessitate the use of a thickened retardant to provide adequate coating of the fuels. In addition, the inefficiency of available delivery systems, i.e., inadequate design of tank(s), drop gate(s) and air vent(s), and mountainous terrain requiring high drop heights for maximum safety have promoted development and use of thickened retardants. Phos-Chek 202 is thickened to a viscosity of 1200-1800 cps.[4], Fire-Trol 100 to 2000-2400 cps. and GELGARD to 1000-3000 cps. With the present delivery systems, these viscosities result in a greater portion of the

[4] Brookfield Viscometer Model LVF, 60 rpm, no. 4 spindle.

load reaching the ground, provide heavier impact and thus penetration, and allow a thicker layer of retardant to be retained on the aerial fuels. Thickened retardants are in wide use in Western Canada, particularly in the mountainous regions.

In the Southeastern United States, many of the wildfires burn in the ground and on the surface of deciduous or mixedwood forest stands with considerable understory vegetation. Unthickened retardants are effective in this type of fuel distribution since they not only coat the canopy fuels but also tend to run around, down, and through the surface fuels, restricting the tendency of the fire to creep under these fuels. Liquid phosphate concentrates are receiving widespread use in this region (Myler, 1969) and are currently being operationally tested in the Northwestern United States (Anon., 1969) and Alaska[5].

In much of the boreal forest region of Canada, unthickened retardant may likewise be superior to thickened retardant. That type of forest cover is typified by deep duff layers, which may favor the use of unthickened material to permit greater penetration into the fuels.

TYPES OF AIRCRAFT

The lack of water or the poor location of available water supplies favors the use of land-based airtankers in a large part of Western Canada, although water-based operations are carried out effectively in some regions. This emphasis on land-based operations has resulted in the use of both short-term, i.e., GELGARD and bentonite, and long-term retardants, i.e., Phos-Chek 202 and Fire-Trol 100. The

5 Personal communication. C.W. George, Research Forester, Northern Forest Fire Laboratory, Missoula, Montana.

recent trend, however, has been towards the application of long-term retardants exclusively. In contrast, on water-based operations, either water or GELGARD is used almost exclusively.

The types of aircraft used to apply these retardants range from the smallest of converted agricultural spray planes to the largest of surplus military aircraft, as noted in Table 1. Not all of these aircraft have been utilized as airtankers in Western Canada to date; those receiving common use are shown in Figure 2.

Table 1. Airtankers (water-bombers) commonly used in aerial fire-suppression operations

AIRTANKER	CAPACITY (GALLONS)	NO. OF TANKS	GALLONS PER TANK
Land-based			
Snow Commander	250 Imp.	1	250
Thrush Commander	330 Imp.	1	330
TBM Avenger	500 Imp.	2	250
B-25	1000 Imp.	2	500
B-26	1000 Imp.	4	250
B-17[6]	2000 U.S.	4	500
		2	1000 (trail door)
P4Y2[7]	2400 U.S.	8	300
P2V[8]	3000 U.S.	6	500
Amphibious			
PBY Canso	800 Imp.	2	400
CL 215	1200 Imp.	2	600
Martin Mars	4500 Imp.	4	1125
	6000 Imp.	4	1500

The tank capacity of an airtanker is not necessarily an indicator of its relative effectiveness or its cost/benefit performance.

[6]Limited operational use; [7]Limited testing; [8]Not used in Canada

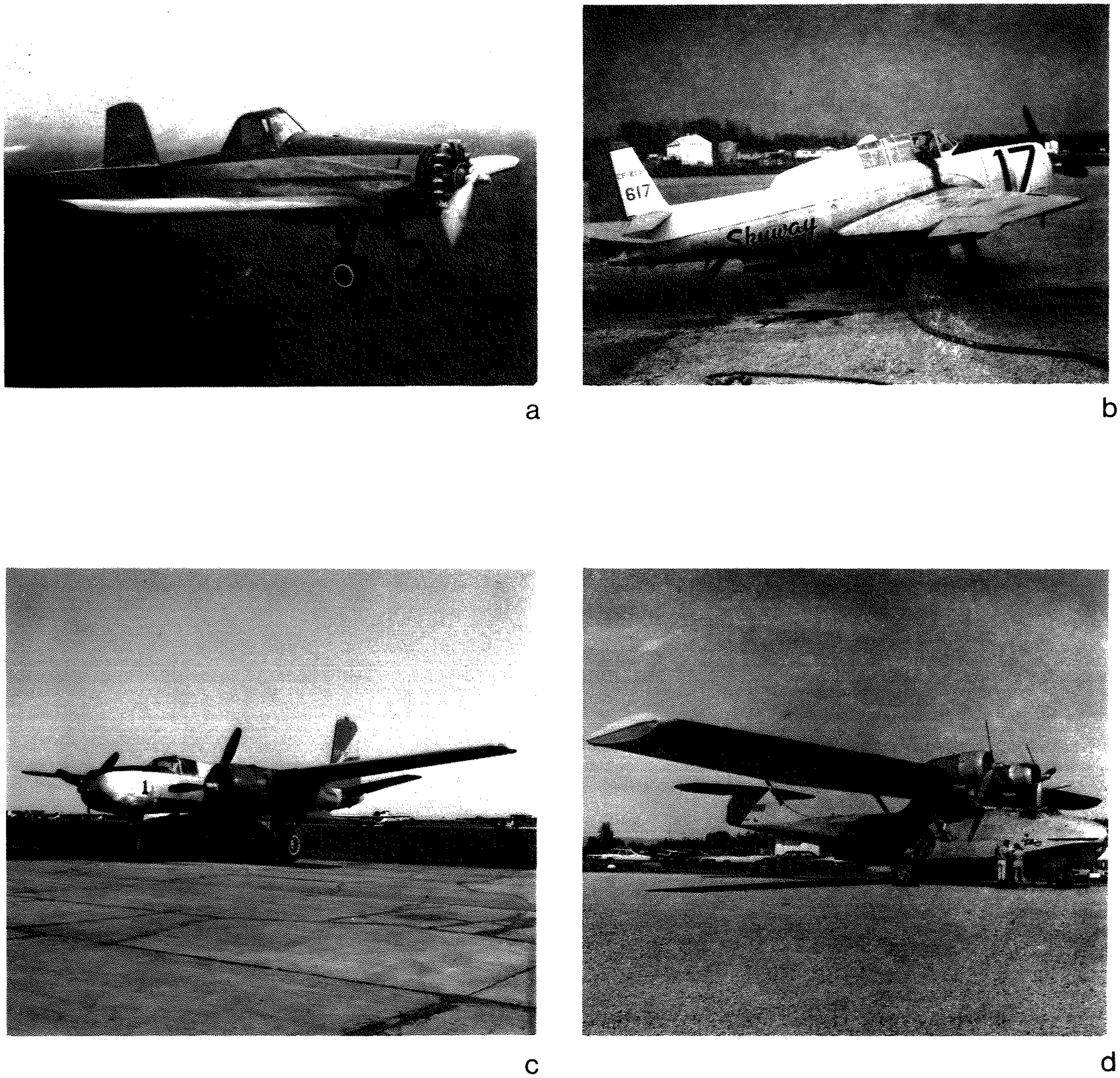

Figure 2. Airtankers currently used in Western Canada: a) Snow Commander, b) TBM Avenger, c) B-26, d) PBY Canso.

In addition to the various operational requirements, the design of the delivery system is very important. Most of the larger airtankers contain multiple tanks; thus, in adaptability they are equivalent to several small airtankers. For example, the 500-gal load in the TBM Avenger can be released in two single 250-gal loads, in one 500-gal train drop, or in a single 500-gal salvo (Fig. 3); the 1000-gal load in the B-26 can be released in four single 250-gal loads or a train drop, in two single 500-gal loads or a train drop, or in a single 1000-gal salvo (Fig. 4); the 2000-gal load in the B-17 can be released in either 500-, 1000-, or 2000-gal drops -- in the case of the trail-door system, in either two single 1000-gal drops or one 2000-gal salvo, or trailed out for either 900 ft or 1700 ft; and the 2400-gal load in the P4Y2 can be released in multiples of 600 gal and is controlled by an intervalometer which permits accurate timing of a train drop(s) up to a distance of 2200 ft.

OPERATIONAL PROGRAMS

The variety and availability of fire retardants and airtankers have results in diverse aerial fire suppression programs in Western Canada. The trend has been, generally, towards use of long-term retardants and large-capacity airtankers. Regardless of the retardant/airtanker combination(s) employed, the key to an effective air attack operation is swift initial attack. An air-attack program that has been most effective is currently in use by the British Columbia Forest Service in the Kamloops Forest District, and involves the TBM Avenger/Fire-Trol 100 combination. This program closely adheres to the one-strike concept, which consists of the initial drop(s) on a fire

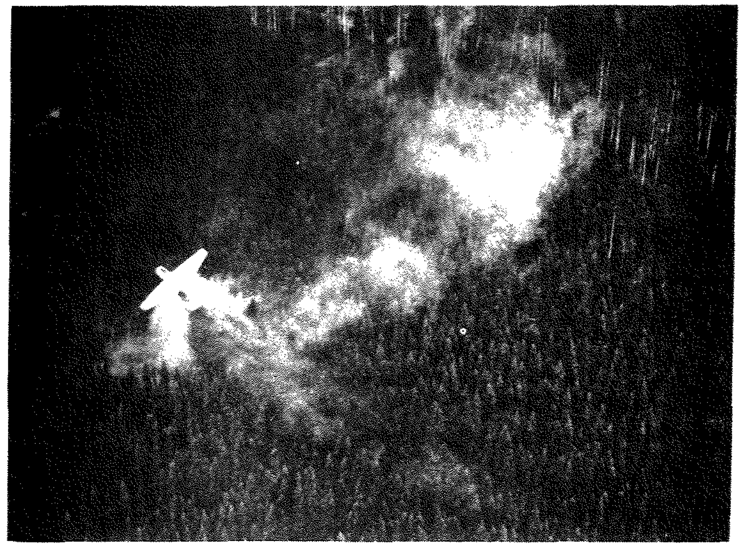

Figure 3. A TBM Avenger releasing 500 gal. of **Phos-Chek** **202** in a salvo drop.

Figure 4. A B-26 dropping an 800-gal. load of **Fire-Trol** 100 in a train drop.

dispersing enough long-term retardant to control the fire without the airtanker(s) having to make a second trip (Linkewich, 1968).

The TBM Avenger aircraft are used primarily as initial attack tools, although they are occasionally called upon for tactical support on large fire, i.e., for reinforcing a fire-line or fire-proofing. In 1969, the average distance from main base to fire, one way, was 61 miles. The following operational statistics for the Kamloops Forest District show the value of fast initial attack:[9]

Year	No. of sorties	Average no. of loads per action
1967	151	4.5
1968	81	4.8
1969	103	7.2

The application of short-term and long-term retardants from the ground is uncommon at present, although some use of long-term materials is recorded. Phos-Chek 259, a long-term retardant especially formulated for ground application, is being operationally applied in British Columbia[10], and this department is also utilizing the product in Alberta. Fire-Trol 934 liquid phosphate concentrate shows good potential as a ground retardant; it contains a wetting agent that improves penetration into ground fuels.

The ground application of these retardants should be increased. The greater cost of a gallon of long-term retardant over that of water

[9] Personal communication. J.A.D. McDonald, Forester i/c Forest Protection, Kamloops Forest District, British Columbia Forest Service.

[10] R.L. Fielder, British Columbia Forest Service, Protection Division, Victoria, B.C. Personal communication.

is more than compensated for by the increased effectiveness of the chemical retardant.

FUTURE USE OF RETARDANTS

In Western Canada the use of fire retardants, especially the long-term materials, will increase greatly in the future. The aerial application of these retardants will be made with large-capacity airtankers used primarily in initial attack. Use of these larger airtankers will increase the efficiency of aerial fire-suppression operations and reduce the cost per gallon of retardant delivery to the fire. Overall fire-suppression costs will be reduced as a result. On larger fires, helicopters will supplement or replace fixed wing aircraft for applying long-term retardants.

The size of the aircraft and the type of retardant applied will depend upon the objectives of the fire-control agency. For flexibility, an air attack fleet should be comprised of a combination of airtankers rather than one particular aircraft. Large investments in equipment for mixing the currently popular dry salt retardants may be unnecessary if the liquid phosphate concentrates prove applicable. Retardant mixing on a contract basis can provide some of this flexibility, and at the same time permit maximum utilization of forestry personnel. It is likely that ground-applied long-term retardants will become an integral part of the fire-suppression operation.

Retardants have been extremely useful to fire protection agencies and their full potential has not yet been realized. The expected increase in the use of fire retardants in the future will necessitate the improvement of many phases of the fire-suppression operation in order to obtain the greatest benefit from the material.

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