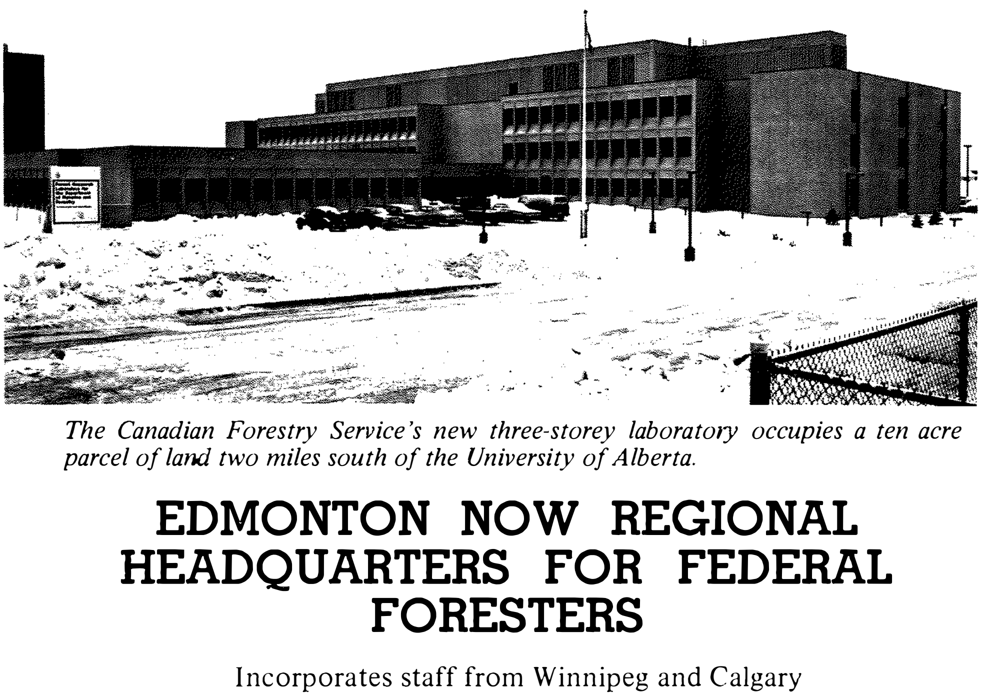
forestry report

PRAIRIES REGION, CANADIAN FORESTRY SERVICE

VOL 1 #1

In This Issue . . .

FIRE



The Canadian Forestry Service's new three-storey laboratory occupies a ten acre parcel of land two miles south of the University of Alberta.

EDMONTON NOW REGIONAL HEADQUARTERS FOR FEDERAL FORESTERS

Incorporates staff from Winnipeg and Calgary

Federal forestry research in the prairies, the Yukon and the Northwest Territories is now being wholly conducted from a new central laboratory in Edmonton. More than 150 scientists and technicians have moved into the new building constructed last year in the south-west section of the city. Facilities are considered to be among the most up-to-date in Canada.

The new region, by far the largest administered by the six federal forestry research stations in Canada, encompasses about 3¼ million square miles, one-fifth of which is forested.

Research conducted by the Canadian Forestry Service in this area covers a wide range of forest-related projects including fire behaviour rating and forecasting, fire suppression, classification of land for forestry and other uses, yield and quality of water, improvement of farm shelterbelts, and maintenance of forest tree nurseries.

The new laboratory brings together scientists from both Calgary and Winnipeg where the federal government had maintained separate regional laboratories for many years. Satellite offices in Prince Albert and Winnipeg however have been established to serve the provincial governments and private industries operating in these areas. The staellite offices will carry out a liaison service to keep the Edmonton laboratory abreast of local problems and research needs.

WITH INK ON OUR FINGERS

This issue of Forestry Report is the first of a series of regular editions our Edmonton laboratory will be issuing in the months ahead.

Our main purpose is to distil the results of some of our research projects — those that are practical and have immediate value — into simple, concise terms, to keep you posted on what's happening in forestry research today.

The greater part of each edition will carry illustrated articles dealing with a central topic. This issue, for instance, includes three articles on the subject of Fire. In each case the material was prepared by our research officers who worked directly on the projects. An editorial board reviewed the manuscripts, but only for style and clarity — the essential facts remain unaltered.

We plan to publish four or five editions of Forestry Report throughout the year, at two or three month intervals. Subjects for the next four issues have been tentatively set at Forest Management, Insects and Disease, Watersheds, and Land Use.

THE NEW CANADIAN FOREST FIRE BEHAVIOUR RATING SYSTEM

With the publishing of the Forest Fire Weather Index last year, the Canadian Forestry Service has completed phase one of a new system of rating forest fire behavior.

The new tables were made necessary because of demands by several fire control agencies for a more refined and precise fire behavior rating system. The old system was considered inadequate in portraying the effects of heavy fuel moisture, wind, and temperature on fire behavior. Also, the close-ended scale of 0 to 16 was considered by some fire control agencies as too restrictive in it's measurement of fire hazard. Identical ratings, for example, were sometimes reported at widely separated stations causing difficulties in setting priorities for men and equipment.

And so in 1967 work on the new system was begun, co-ordinated by the Forest Fire Research Institute in Ottawa and involving fire researchers from across Canada.

The Fire Weather Index (FWI) is actually a way of rating the potential fire intensity of a standard fuel type numerically, thus providing a uniform scale for rating fire weather severity all across Canada. Stated briefly, it rates the influence of weather on the moisture content of various fuels, then relates this, with the weather, to typical fire behavior characteristics.

Use of the new system requires daily noontime weather readings of temperature, relative humidity, wind speed, and rainfall. It is based on three classes of fuels in a standard fuel type, such as lodgepole pine or jack pine stands:

1) Fine fuels such as litter and moss on the forest floor, weighing about one-tenth of a pound per square foot, or two oven-dry tons per acre. These fuels need only small amounts of rain to approach saturation. They dry readily within a short period.
2) Medium fuels such as the top three to four inches of forest-floor duff and deadwood on the forest floor. This part of the duff layer weighs about one pound per square foot, or 22 oven-dry tons per acre. Such loadings are common under mature lodgepole pine stands in Alberta.
3) Heavier fuels such as the entire duff layer in over-mature spruce-fir stands, many mature white spruce-poplar stands, and almost all stands growing in swamps or bogs. Or it might conceivably include a layer of mineral soil below the duff where drought might have an effect on moisture content of foliage.

The three fuels differ in their water-holding capacities. Their moisture-loss rates are shown in the diagram below. The fine, medium, and heavier fuels lose about 67% of their moisture from saturation in 2/3, 12, and 52 days, respectively. Wetting and drying indices are given in code form with values rising with dryness.

Thus far we have been describing fuel moisture codes. The final index relates these and the prevailing weather to fire behavior, thus measuring the probable rate of spread and intensity of a fire – that is, the energy output rate per unit length of fire-front in the standard fuel type.

Charles Van Wagner, a senior member of the research team that produced the new system, believes it offers six advantages over the old:

1) It places a more realistic value on the effect of wind.
2) It now incorporates, more accurately, the effect of temperature.
3) It takes into account seasonal changes in the hours of daylight.
4) It measures with greater accuracy the effects of heavy fuel moisture.
5) It features a larger, open-ended scale.
6) It provides comparison of fire weather right across Canada.

Use in the Prairies

Forest fire control agencies in the three Prairie Provinces, the western National Parks, in the Yukon, and the Northwest Territories have agreed to start using the system this spring, although some may also continue with the old system for a year or two for comparison.

Each agency has been provided with a set of Fire Weather Index Tables, Monthly Record Forms, and Seasonal Display Charts. Additional copies of the Tables, Forms, and Charts are available from the Canadian Forestry Service in Edmonton.

Calculation of the various codes and indices takes about five minutes. Instruction for each table are given on the same page, and will probably be easily committed to memory within a week or two of use. The FWI and the ADMC (Adjusted Duff Moisture Code) values should be plotted on a seasonal display chart to facilitate preparedness and suppression activities.

The descriptive terms used to classify the FWI and ADMC values are related to fire behavior as outlined on page 4 of the Tables. For parts of the prairies region where the new system was used in 1970, the following FWI and ADMC descriptive classes and ranges were suggested:

Descriptive classes and ranges for the Fire Weather Index and the Adjusted Duff Moisture Code

Class	FWI	Old Danger Index	ADMC
		Ranges	
Very Low	0 - 1	0	0 - 8
Low	2 - 5	1 - 4	9 -24
Moderate	6 -12	5 - 8	25-61
High	13-24	9 -12	62-99
Extreme	25 +	13-16	100 +

It is possible, and in fact likely, that the FWI and ADMC ranges will need to be modified by fire control agencies in the light of their own experience. To assist fire control agencies in evaluating the applicability of the suggested ranges in their areas, computer analyses are being carried out using past fire weather and fire behavior data. In British Columbia, fire researchers found that man-caused fire occurrence is almost proportional to the FWI value below 35. At higher values, the fire history is so strongly affected by extreme preventive measures and a general awareness of the severity of fire danger, that occurrence may be suppressed. They also found that burned area increases ten-fold as the ADMC doubles. In Alberta, the per cent of days falling into the Very Low, Low, Moderate, High and Extreme FWI classes amount to about 20, 35, 30, 10 and 5, respectively. There is likely to be a 10-fold increase in fire occurrence and a 25-fold increase in average size of fires from the Low to the Extreme FWI class.

Burning Tables for Standing Timber

There are great differences in fire behavior between various types of fuel (or vegetation). Crown fires in pine for instance, burn far faster than those in aspen. This is because each fuel type has distinctive characteristics of weight, size, energy and distribution. Studies are in progress to determine these characteristics, thereby providing a basis for meaningful fuel evaluation in support of fire behavior rating work.

Phase two of the new fire behavior rating system will therefore be a continuing study (until about 1975) of how to predict the intensity of a fire and its rate of spread for four major cover types found in the Prairies Region: pine, black spruce, spruce-aspen, and aspen. Results will be published in the form of Burning Indices (fire spread and intensity tables) for these fuels, and also for certain sub-types with characteristic ground surface fuels such as Cladonia, needlelitter-grass and green mosses, slash counterparts of some of these types, and grass areas. Although there are certainly variations within these broad classes, the fuel components are distinct enough to warrant separate fuel evaluation and fire behavior ratings.

Initial areas have been selected for this study with the assistance of the Alberta Forest Service. A thirty-six square mile area near Lesser Slave Lake was allocated as a general fire-research reserve, and locations for specific plots were determined from a detailed air and ground reconnaissance. Sixteen ¼-acre plots were then surveyed in each of the aspen, pine, and spruce-aspen types. Bulldozing of fire-guards in each area has just been completed and plots will be inventoried in early spring. Aspen plots are scheduled for burning in May, followed by pine and spruce-aspen plots throughout the summer. It is expected that initial fires will be in the low and moderate hazard range and as experience is gained, more vigorous fires are to be conducted. Several related fuel studies will be carried out throughout the duration of the study.

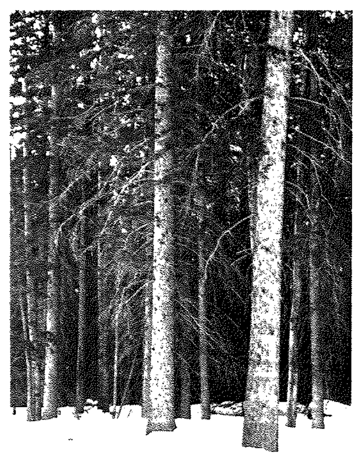
Fuel weight and distribution, fuel moisture, and weather are critical variables which must be measured before each fire. Rate-of-spread and flame characteristics, and wind, will be carefully monitored during the fire, and fuel depletion will be assessed following the burn. Fire activity and accomplishment, then, will

COMPONENTS OF FOUR MAJOR FUEL COMPLEXES

Stand views

Lodgepole pine

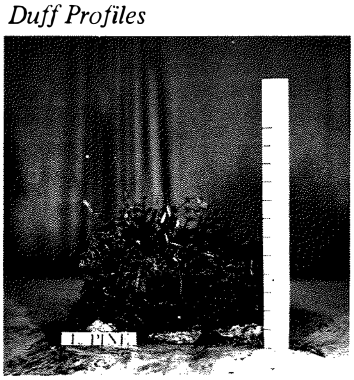
Black Spruce

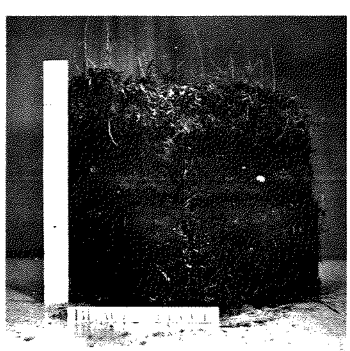


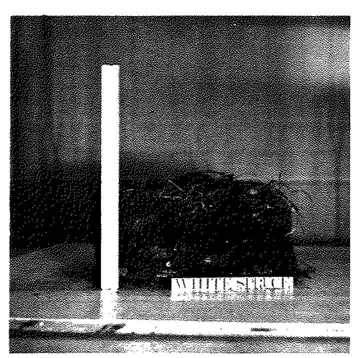
White Spruce-Aspen

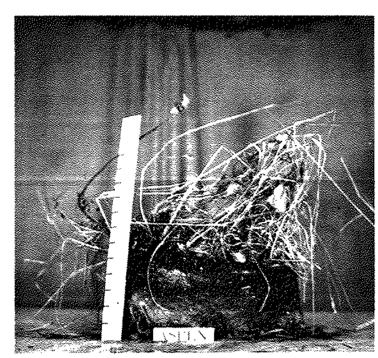
Aspen

Duff Profiles









	Lodgepole pine	Black Spruce	White Spruce-Aspen	Aspen
Duff depth (inches)	*3.3*	*8.8*	*4.3*	*3.8*
Duff weight (pounds/sq. ft., includes mineral soil embedded in samples).	*1.4*	*2.5*	*2.1*	*2.0*

be well documented for each type up to the crowning threshold. Since the study of the crowning phase is beyond the scope of the present project, an attempt must be made to observe and evaluate this phenomenon on wild fires and by use of simulation techniques. Observation teams will travel to the fire front to obtain accurate rate-of-spread, fuel moisture, and fuel consumption measurements which can be related, to the controlled study results.

Burning Tables for Slash

Burning Indices are already being prepared for the slash counter-part of the lodgepole pine cover type. Studies in this fuel type began in 1969 at the Kananaskis Forest Experiment Station, fifty miles west of Calgary. Two 25-acre areas were commercially clearcut to provide typical slash distributions, and one-acre experimental blocks were isolated by 20-foot bulldozed fireguards. The one-acre rectangular blocks have proved ideal for experimental slash burns, as they provide equilibrium headfire behavior with a minimum of suppression outlay. Fifteen of these blocks have been systematically burned over an extended drought range, during the summers of 1969 and 1970. Fire behvaior is documented for each burn as well as fire residence time, slash consumption, and duff consumption. Preliminary analysis indicates a good correlation between the FWI and the above variables. At least six more burns are planned for 1971, within predetermined wind classes. Sufficient data will then be available to complete a Burning Index Table for lodgepole pine slash.

Hinton Burning Trials

Between 1966 and 1969, a co-operative research program involving the Alberta Forest Service, North Western Pulp and Power Ltd., and the Canadian Forestry Service was carried out near Hinton, Alberta, to determine whether prescribed burning could be used in spruce-fir clearcuts to prepare a more receptive seedbed and to reduce the slash-fire hazard. A total of seven 10 to 25-acre plots were burned in a range of burning conditions and yielded useful information on fire behavior, fuel consumption and techniques and procedures of prescribed burning in this fuel type. A 12-minute, 16 mm. colour movie with sound track dealing with some of the highlights of these large-scale burning trials is available upon request. Silvicultural aspects of this work will be described in the next issue of forestry Report.

Burning of a cut-over stand of jack pine prior to seeding. Note the intensity of the flames which substantially reduces humus depth.

SILVICULTURAL USES OF FIRE

The rational use of fire as a tool of silviculture is gaining wider attention in industry today than ever before.

It's use after a cut-over operation can prove valuable in many ways to prepare the land for healthy conifer regeneration. It burns up the slash, rids the area of parasites, reduces raw humus, and inhibits rapid takeover by deciduous vegetation. Furthermore it can be much less expensive than attempting the same job with mechanical equipment such as tractors, barrels, and chains.

Post cut-over burning methods vary, depending on whether regeneration will be by direct planting or by natural or artificial seeding. For direct planting the burn is conducted in such a way that the raw humus depth is only moderately reduced. Unless the raw humus is exceptionally thin, a superficial burning of litter is seldom adequate for the reproduction of aspen. For natural or artificial seeding the objective is to substantially reduce the depth of raw humus.

Fire can also be used to clear old cut-over areas from brush, or from diseased and poorly-growing aspen. Once cleared of this deciduous vegetation the area can then be maintained with occasional applications of herbicides as needed.

Burning has been tried in several localities throughout the Boreal Forest Region but, apart from consistently good results in slash disposal, the reproduction of conifers has proven difficult. Some progress, however, has been made by the Canadian Forestry Service in Central Ontario where a series of burning and seeding treatments resulted in successful jack pine regeneration after cutting. The Ontario experiment clearly demonstrated that the object of burning for seedbed improvement is not necessarily the total destruction of all surface-raw-humus materials present, but rather for their reduction to a degree sufficient for prompt re-establishment of favourably stocked stands from seed. There are, however, two important treatment requirements. The first is the selection of a suitable drought condition for the desired reduction of raw-humus depth by burning. The second is the regulation of seeding intensity in relation to the quality of fire-produced seedbeds and the soil materials present, taking into consideration the desired number of trees per acre at more or less uniform spacing. Practical guidelines for assessing and meeting both these requirements on clear-cut jack pine sites in central Ontario are already available, and the relevant information can be obtained from published reports.

It is difficult to say whether or not the results from central Ontario are applicable to the conditions in Manitoba, Saskatchewan and/or Alberta. Because of significant differences in weather patterns, one would be inclined to think that this is a problem of adaptation rather than of some indiscriminate application. However, little is known in the Prairie Provinces about the minimum drought requirements for burning the desired amount of fuels involved and, without this knowledge, the chances of successful and economical use of fire for any well-defined silvicultural objective are extremely small. Equally important is to know the effects of burning on the immediate environment, both physical and biological, and its relationship to the establishment and growth of forest reproduction. Information pertaining to these effects is often incomplete, contradictory and of little specific relevance to the conditions found in the Prairie Provinces. Therefore, a research program has been implemented by the Canadian Forestry Service to correct these deficiencies and thus to provide means for rational uses of burning as one of the basic, post-cut, silvicultural treatments.

When completed, the program will yield information on the minimum drought requirements for adequate burning of cutover areas to achieve a series of practical management objectives such as slash disposal, pest control, stand reproduction, stand conversion, and so on. Using 0.4-acre plots as treatment units, the experimental burns will be of varying drought-affected intensity, carried out in spring, summer and fall, and replicated by major climate, forest and site types that occur in the Prairie Provinces. Various weather, fuel, site and vegetation studies associated with the individual burns will aid in the evaluation of the burns themselves, and post-burn seeding of conifers will often be required to make the findings more meaningful. Other related studies will include the determination and evaluation of effects on seedbed quality, tree reproduction, plant succession and certain physical and chemical soil properties. The results will be published as they become available for each of the climate and forest types tested. They will be in the form of tables, prediction curves and recommendations for practical field use by resource managers. Finally, a number of large-scale operational trials, each complete with a comprehensive cost analysis, will be carried out for demonstration purposes.

The program was initiated late in 1968, and since then all efforts have been concentrated on clear-cut, dry to moist, jack pine sites. So far, 35 experimental burns have been carried out, 17 in south-eastern Manitoba and 18 in east-central Saskatchewan. The Manitoba burns are already seeded to pine, and the Saskatchewan burns will be seeded in the near future. The burning and seeding operations will continue on jack pine sites in Saskatchewan for another year or so and, immediately thereafter, we hope to extend the work to black spruce sites. Eventually, the program will also include aspen, white spruce-aspen and possibly other major forest-site types as needs arise.

The provincial forest services in both Manitoba and Saskatchewan actively support this program by providing men and equipment during all burning and seeding operations at their own expense. It is hoped that this splendid participation will continue in the years to come.

The dominant trees in this young jack pine stand have grown to a good height after seeding six years ago.

Photo taken immediately after a burn in central Ontario.

SHORT & LONG - TERM FIRE RETARDANTS

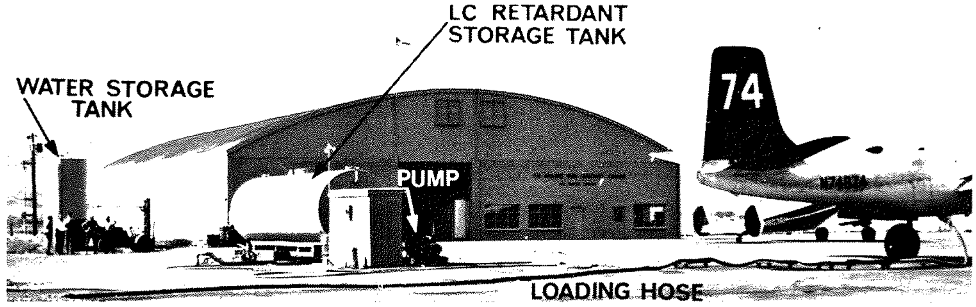
— both have advantages, but long term works best.

Short and long-term retardants both play an important role in fire suppression operations in the Prairies, there's little doubt about that. But matching the correct retardant with the fire and equipment at hand has not always been a simple matter. Knowing the facts helps; so let's see if we can sort them out.

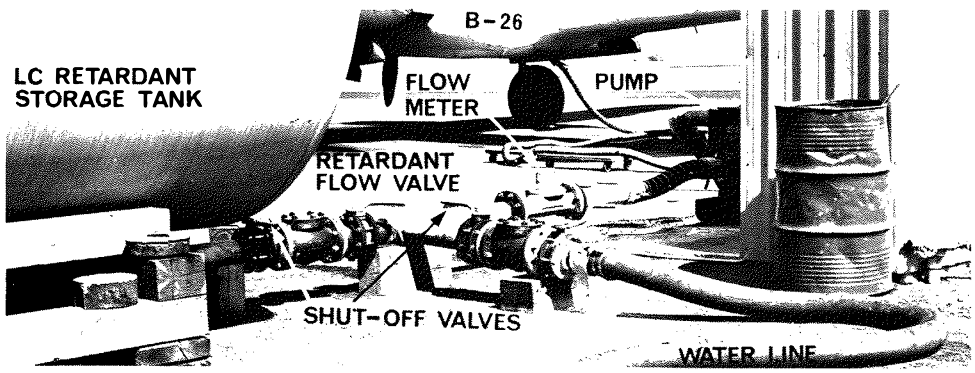
A short-term retardant is usually a clay, industrial gum, or synthetic organic polymer, which when added to water forms a thick, moist, retardant film. This adheres to the fuels and increases the time and fire energy required to vaporize the water. Such retardants rely almost entirely upon the water they contain to prevent combustion. They are primarily used as a suppressant, to extinguish the flaming and glowing phases of combustion by direct contact with the burning fuel. Bentonite, Tenogum, and Gelgard are examples of short-term retardants. So, of course, is untreated water itself.

A long-term retardant, on the other hand, continues working even after the water it contains has evaporated. This is accomplished by the addition of a chemical that reduces or inhibits flammability of combustibles, thereby slowing or retarding the rate of spread of the flame front. Stated simply, a long-term retardant is really a short-term retardant (thickened or not) to which has been added an anti-combustion type of chemical to give it longer life. The most commonly-used chemicals are diammonium phosphate and ammonium sulphate. Both are dry salts. Long-term retardants containing diammonium phosphate include Phos-Chek 202XA and 259; those containing ammonium sulphate include Fire-Trol 100. Liquid phosphate concentrates are also being used a great deal today and include such products as Pyro (11-37-0) and Fire-Trol 931 and 934 (10-34-0).

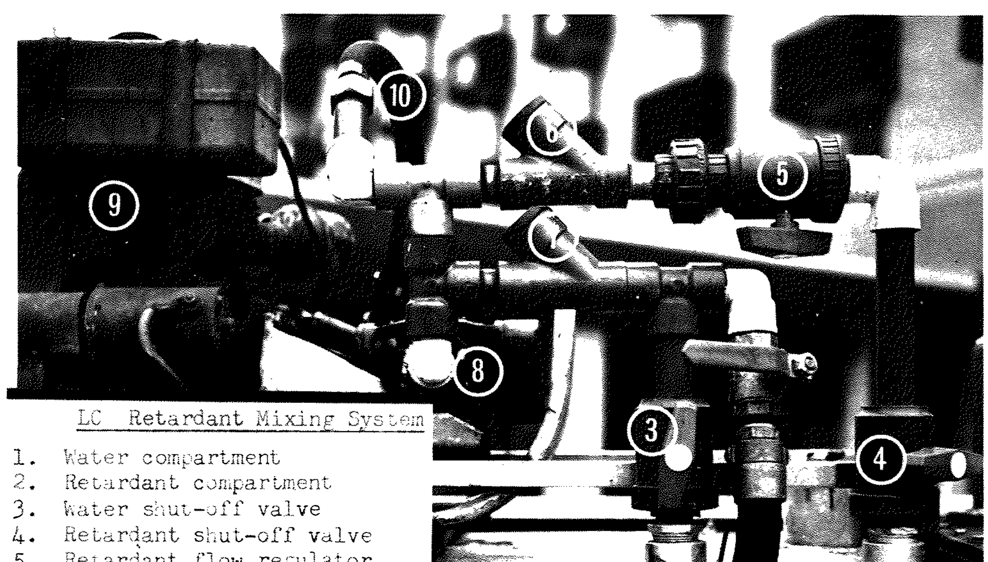
Now if you've surmised that a long-term retardant is far superior to the short-term type, you're absolutely right. For proof, we'll refer you to a recent laboratory evaluation. It showed that a long-term retardant, when fully dried, was nearly twice as effective in reducing the rate of fire-spread as a short-term retardant when two-thirds of its original moisture was still present.



Here is the way an air base might be set up for handling the liquid concentrate (LC) retardant.



Close-up view of the mixing-loading system shown in photo above.



This is the slip-on tank system for blending LC retardant for ground application.

Is there a catch? In a way, yes. You can only use the long-term retardants with land-based aircraft. If you lease or operate float planes you're limited to using either of two retardants, Tenogum or Gelgard – both short term. On the ground, however, using conventional fire equipment you can employ whichever type of retardant you wish, long or short-term (and we'll have more to say of this later).

Fire retardants, of course, receive their greatest use through aerial application. Amphibious aircraft like the PBY Canso water-bomber scoop their load while skimming the water surface. When the short-term retardant is added, it must be injected into the water tanks during this water-loading process. Added to the water in small quantities, the powder retardant produces a thickened mixture extremely quickly.

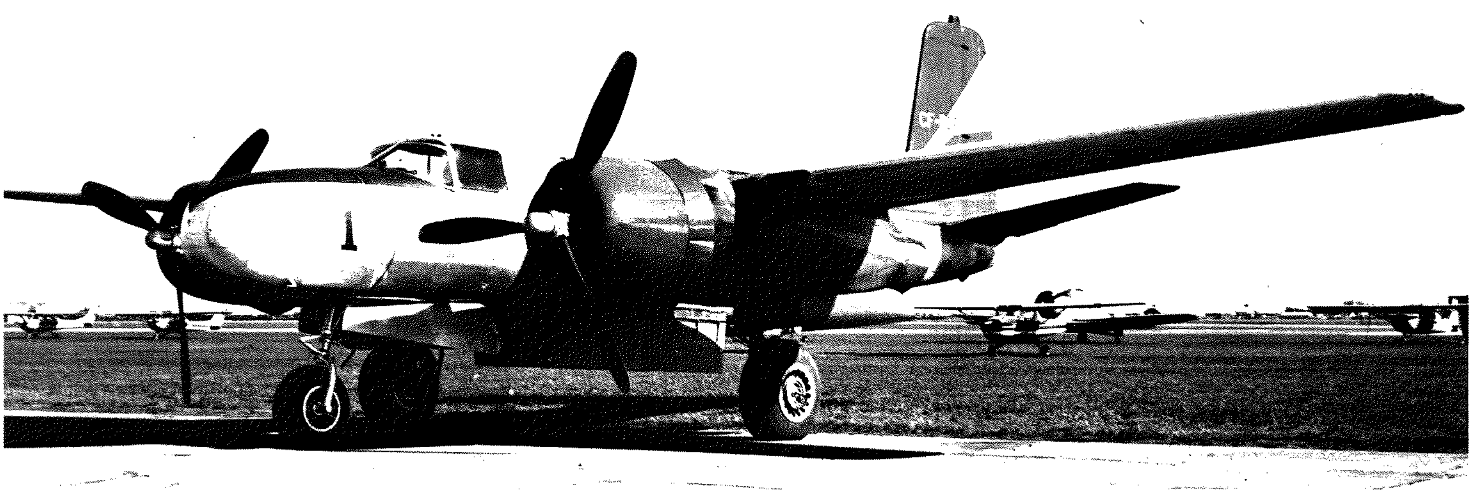
With land-based aircraft a long-term retardant is used almost exclusively. This type of operation is increasing in popularity as word of the effectiveness of long-term retardants spreads. Larger and faster multi-tanked airtankers are now delivering this retardant to distant and remote wildfires previously attacked only by water-based airtankers. The use of long-term retardants is especially effective where bodies of water are too far removed for float-equipped or amphibious aircraft.

Long-term retardants must be mixed and loaded at the airtanker base. Thickened retardants require more mixing, handling, and storage facilities than do those that are unthickened. Liquid phosphate concentrate (more familiarly known as LC) is added one part to four parts of water, then blended and loaded into the aircraft all in one operation. Thus the need to handle dry powder, as with thickened products, is eliminated.

In northern forests where thick forest floors are often the principal fuel for ground fires, unthickened LC retardant will probably be the most effective; it allows a deeper penetration of salt into the fuel. Testing of this retardant is presently being conducted in Alberta.

Fire retardants are seldom applied by conventional ground equipment in the Prairie Provinces, but this may soon change. Both short and long-term retardants can be incorporated into present ground fire suppression programs with little difficulty. Good blending systems too, are available. Although LC may cost more to apply per gallon than water, it's a safe bet that savings on your overall ground fire suppression operation will more than make up for it.

Today you'll find long-term fire retardants suitable for use both in the air and on the ground. We recommend you try them.



With a cruising speed of 235 mph, the B-26 can reach a fire 100 miles away in just over 30 minutes, including landing and take-off time.

THE B-26 AIR TANKER

Now in use in Alberta Forestry Service

The use of larger land-based aircraft for the aerial suppression of forest fires in Western Canada has been minimal until recently. But with the acceptance of long-term chemical fire retardants, the use of these airtankers has become more practical. The B-26, one of the larger airtankers, is now an integral part of the Alberta Forest Service contract air attack fleet.

The 1000 Imperial gallon capacity B-26 airtankers operating in Alberta have four interconnecting 250-gallon tanks, each of which is equipped with a drop gate (see photo). The normal retardant load however is 900 Imperial gallons. Cruising speed loaded is 235 mph and normal drop speed approximately 140 mph. Airstrips in the vicinity of 5000 feet are required for safe operations.

The tank design of the B-26 permits the compartments to be activated in salvo, in pairs, individually, or trailed, i.e., 2 – 450 gallon or 4 – 225 gallons drops in sequence. This versatility allows the airtanker to be easily adapted to a particular fire situation. The table shows the length of fire-line established in an open area by the B-26 at a drop speed of 140 mph and drop height of 75 - 95 feet.

The .04-inch application rate represents the amount of retardant required for the "average fire in most fuel types". For action on low-intensity fires or those burning in lighter fuels, an increase in the drop speed with increase the length of fire-line built, likely at the expense of the retardant depth.

Drop type		Length (feet)	Avg. Width (feet)
900 gal. salvo		260	60
450 gal.		180	30
225 gal.		90	20
900 gal.	2 - 450	380	30
	4 - 225	540	20

Retardant fire-line to a minimum width of 10 feet established by B-26 airtanker (Fire-Trol 100, 2600 cps; application rate .04 inches or 2.1 Imperial gallons per 100 square feet).

Close-up of the B-26's four door tank system.

Perhaps the largest problem associated with the introduction and efficient use of the B-26 airtanker is the need to adapt the fire-suppression operation to the high speed of the aircraft. The B-26 can arrive at a fire located 100 miles from the retardant base in just over 30 minutes, which includes time for both loading and take-off. It can arrive back at the same fire with another retardant load in one hour. This example, of course, merely displays the initial attack capability of the airtanker and not the optimum operating distance.

A word about the mast head

The colors normally to be used to print the report are blue and green. Two colors are necessary to attain the desired background effect in the mast head. The first issue, however deals with fire. If we used blue and green the fire picture on page 4 would have been blue. Hence the red in this issue. If the symbolism in the mast head isn't clear in this issue, we hope it will be in the next. If not write and ask.

Two 450-gallon loads of Fire-Trol 100 being released in sequence (trail drop) from the B-26.

FORESTRY REPORT

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For further details concerning articles in this issue address the Fire Editor.

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Fire Editor: A. D. Kiil

We appreciate the hard work of Frank Nokes, CFS Information Services, for his help with design, format, in launching the first issue.

For further information .....

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Contributors:

Z. Chrosciewicz (The silvicultural uses of fire) has investigated the use of prescribed burning in forest management in Ontario and Manitoba, and is now conducting similar work in Saskatchewan.

J. E. Grigel (The B-26 airtanker, short and long-term fire retardants) is responsible for the regional research and development program on fire suppression methods.

A. D. Kiil (The new Canadian forest fire behaviour rating system) is responsible for investigations on fuel evaluation, fire behaviour rating and prescribed burning.

D. Quintilio wrote the sections on development of burning tables for standing timber and slash. Dennis specializes in investigations of fire behaviour in major fuel types.