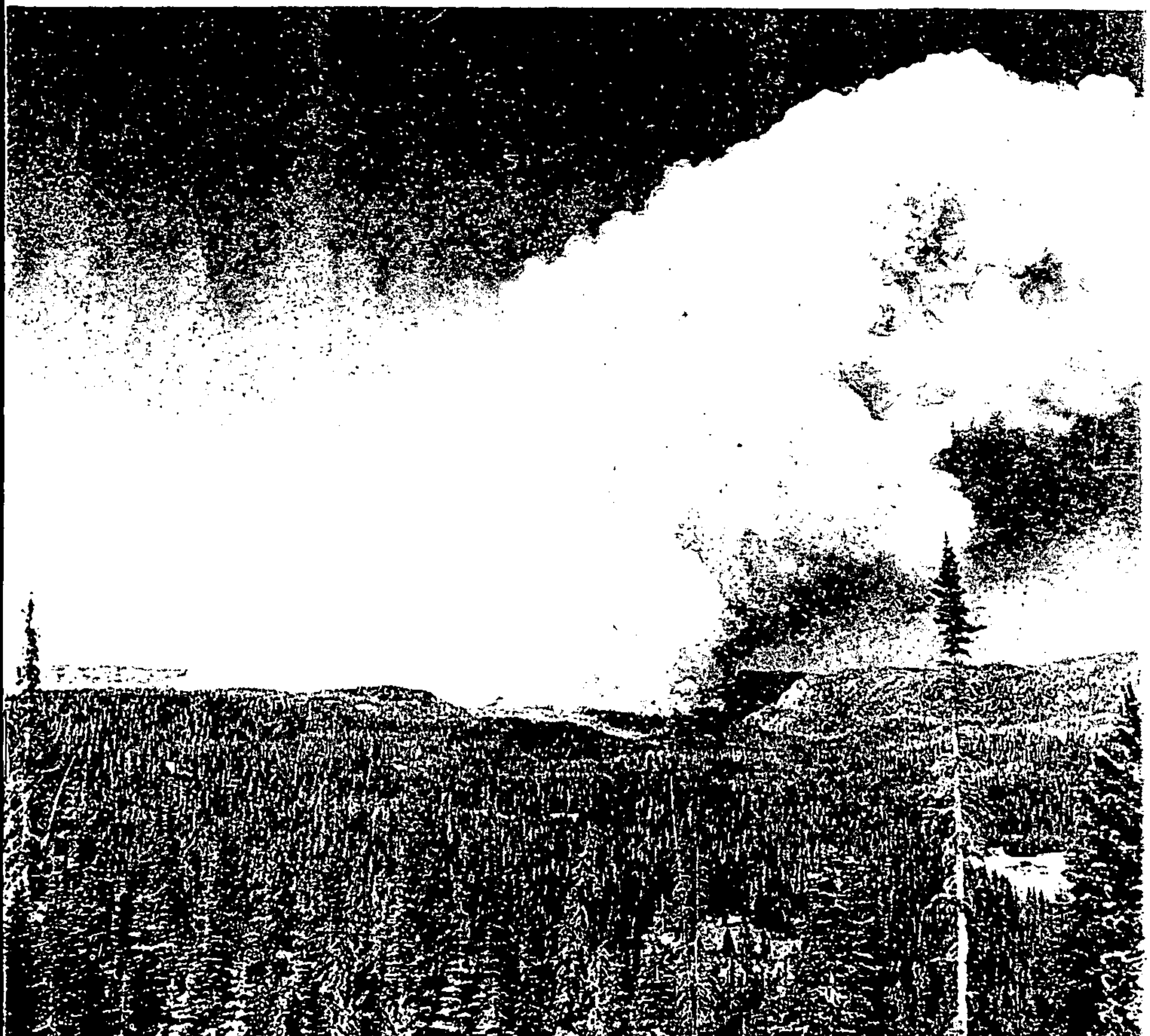
FIRE CONTROL NOTES

U.S. DEPARTMENT OF AGRICULTURE/FOREST SERVICE/SUMMER 1969/VOL. 30, NO. 3



FIRE CONTROL NOTES

A quarterly periodical devoted to forest fire control

CONTENTS

Page

COVER—A fire starts on the rampage. Article on the next page discusses how atmospheric instability can play an important role in such a fire blowup.

(NOTE—The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such does not constitute an official endorsement or approval of any product or service by the U.S. Department of Agriculture to the exclusion of others which may be suitable.)

FIRE CONTROL NOTES is issued by the Forest Service of the United States Department of Agriculture, Washington, D.C. The matter contained herein is published by the direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. Use of funds for printing this publication approved by the Director of the Bureau of the Budget, [illegible].

Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402, 20 cents a copy, or by subscription at the rate of 75 cents per year, domestic, or $1.00, foreign. Postage stamps will not be accepted in payment.

Atmospheric Stability Forecast And Fire Control

ROLLO T. DAVIS [1]

Unstable air masses increase chances of big fires. Relative humidity seems to play a smaller role than thought before. Asmospheric stability forecasts, projecting stability for 36–48 hours, can warn fire control personnel when to expect erratic fire behavior and an increase in blow-up potential.

Figure 1—Convection currents visibly at work on a forest fire.

Have you ever wondered why some forest fires are extremely difficult to control while others, under seemingly like weather and fuel conditions, are relatively easy to curb? Even during dry periods when winds are high and humidities low, some fires show no erratic behavior or blow-up potential and are easily checked. But at other times, under apparently the same conditions, the wildest blow-up develops. Still more puzzling is the fact that some fires are almost impossible to control and become conflagrations even though the soil is wet, humidities are relatively high, and surface winds outside the fire zone are light. Why the difference?

Blow-up characteristics of forest fires have been attributed to low relative humidities and strong surface winds. Papers have been presented about the relationship between relative humidities below 30 percent and large fires. Daniel J. Kreuger, former Georgia Fire Weather Supervisor, made a study of forest fires in Georgia for the years 1950-1959. He reported in the *Georgia Forest Research Paper* #3 that 77 percent of the fires burning 300 acres or more occurred when the relative humidity was 25 percent or less. Ninety-two percent of the large fires occurred when the relative humidity was 30 percent or less. Mr. Kreuger concluded:

1. Fires when promptly and adequately attacked (barring equipment failure), rarely, if ever, become large unless the relative humidity is 30 percent or less at the fire.

2. Potential for large fires increases rapidly as humidities fall below 25 percent. Fire fighters should increase their vigil whenever these low relative humidities exist or are forecast.

Atmospheric Turbulence

The relationship of atmospheric turbulence to erratic fire behavior has also been studied and discussed. As early as 1951, George M. Bryam and Ralph M. Nelson presented a paper titled "The Possible Relation of Air Turbulence to Erratic Fire Behavior in the Southeast." [2] In this paper, they pointed out the possibility of a direct relationship existing between unstable low-level air and extreme fire behavior in the Southeast.

(Continued next page)

[1] Forestry Meterologist, ESSA Weather Bureau, Jackson, Miss.

[2] Fire Control Notes 12(3) 1-8; 1951.

Air Stability

Continued from page 3

A review of the weather conditions at the time of the larger fires occurring in Mississippi during 1967 revealed that large, hard-to-control fires did not necessarily occur on the days with the lowest relative humidities. In fact, the largest fires occurred 24 to 48 hours after a day with desert-like humidities. This pattern seemed to be begun by the passage of a cold front. With cold, dry, continental arctic air overspreading the State behind the front, the relative humidities often dropped below 20 percent. One to 3 days later, relative humidities started climbing, but fire severity and size also increased.

Hoping that this unexpected fire pattern might be explained, the daily surface weather maps and the temperatures from the surface to the 5,000 ft. level were critically examined for all days on which fires of more than 300 acres, classed as "E" fires, burned. The examination of the temperature profiles aloft strongly suggested that the atmospheric instability in the lower atmosphere played a significant role in erratic behavior of fires.

To investigate further, information on all 1967 fires of the class "E" and larger was requested from the Fire Control Directors of the States surrounding Mississippi. The requested information was supplied by Louisiana, Arkansas, Tennessee, and Alabama, and a total of 70 fires were investigated. No attempt was made to investigate weather conditions for fires when fire control personnel were unable to attack the fire shortly after it started.

Atmospheric stability in the layer between the surface and the 5,000 ft. level was catagorized for the investigations as follows:

1. *Stable*—Temperatures aloft decreasing with increase in altitude at a rate about 3.5 degrees F or less per 1,000 ft.

2. *Conditionally Unstable*—Temperature decrease with increase in altitude at a rate of 3.5 to 5.4 degrees F. per 1,000 ft. (Conditionally unstable air tends to become unstable if forced to rise. Additional heat supplied at the surface is sufficient to produce the needed rise.)

3. *Unstable*—Temperature decrease with increase in altitude of 5.5 degrees F. per 1,000 ft.

4. *Absolutely unstable*—Temperature decrease with increase in altitude greater than 5.5 degrees F. per 1,000 ft.

Only six of the 70 fires studied occurred when the conditions in the low-levels of the atmosphere were classified as stable. Fifteen, or 21 percent, occurred when the air mass was classified as conditionally unstable, and fifteen others burned during unstable conditions. The greatest number, by a significant percentage, occurred when the air mass was classified as absolutely unstable. Thirty four of the big fires, nearly one-half of the 70 cases studied, burned when the air mass at the fire site was absolutely unstable.

Relative Humidities

Relative humidities in the area of the fires ranged from 18 percent to 80 percent. A large percent of the fires during periods when the atmosphere was absolutely unstable burned when relative humidities at the surface were above the level normally associated with big or erratic fires. Nearly 60 percent of the large fires studied took place when the relative humidity in the area was above 30 percent. Air mass stability, therefore, appears to be as significant, if not more significant, than low-level moisture in the behavior of forest fires once they got started.

It seems reasonable that air mass stability should play a very important role in the behavior of forest fires. Unstable air, from the meteorological viewpoint, is also convectively unstable. Once the air starts to rise, it will be warmer than its surroundings. The air continues to rise until it reaches a level where the temperature of the surrounding air is the same. When unstable air is displaced upward, it is replaced by air moving laterally, creating an indraft of air, which is also unstable. This air rises. With the heat of the fire being the initiating force to start and maintaining convection, a chain reaction is begun. The convective column increases in size, and the indrafts increase in velocity to fan the flames which then increase the heat to intensify convection, and so on (fig. 1). Fire control personnel are well aware of many of the direct and indirect effects of air mass instability on forest fires. Some of the more spectacular effects are rapid crowning, long distance spotting, erratic movement, and blow-up potential.

Conclusions and Recommendations

Most large fires occur when the temperature profiles through the lower levels of the atmosphere exhibit some degree of instability. Fire control foresters who are furnished daily with an atmospheric stability forecast can plan ahead

(Continued on page 15)

Chemical Thinning Reduces Fire Hazard

David H. Morton and Elmer Fine [1]

Chemicals have been used successfully in precommercial thinning operations on the Colville National Forest. Not only does the method reduce thinning costs, it also prevents the creation of a fire-hazardous situation and subsequent fire protection problems (fig. 1).

Figure 1—Crown release effect in chemically treated stand. Full, green crowns reduce fire hazard.

Since 1962, the Colville National Forest in northeastern Washington has carried on an extensive thinning program in young, coniferous pole stands on about 12,800 acres of overstock old burns. Both machine- and hand-thinning methods have been employed—the latter method being used in stands with up to about 2,000 stems per acre. In stands denser than this, where trees are usually smaller, mechanical thinning with dozers and choppers is more suitable and economical.

The fire hazard which may be created by precommercial thinning is a serious problem. For example, the chainsaw method commonly employed in hand-thinning operations often results in heavy slash that remains a threat to the residual stand for a number of years (fig. 2).

Chemical Thinning

To overcome this problem, chemicals were used for hand thinning and have been found to be a tool that will satisfactorily meet not only silvicultural and economical objectives, but also those of fire control by keeping fire hazard conditions static.

The chemical thinning process uses a hypo-hatchet injector and Silvisar 510 tree killer. An automatic injection system within the hatchet releases the silvicide into chops made in the bole of the tree. The success of this method in eliminating excess trees and saving time and money has been phenominal. Ninety-five percent of all treated trees are effectively removed as a competing factor in the stand, and total costs of the operation average $21 per acre compared to nearly twice that much for the chainsaw method.

Reaction to Chemicals

The reaction of treated trees to Silvisar 510 is an interesting study in itself. If treated anytime within the growing season, the kill is quite rapid. In warm weather, dying needles can be detected within three days after application, and within two weeks, the entire foliage of a 50-foot tree may be brown. A high percentage of the kill is in this shorter period of time; further studies have shown that kill of seemingly resistant branches may continue into the next growing season. Treatment of conifers in the dormant seasons does not show until spring or when the vibrant growing processes of the tree begins. Douglas-fir treated in January remains green until the growing season begins, then browns at about the same rate as one treated in April. Western larch, when treated with bare limbs, gains almost full needle growth before the needles react to the silvicide, brown, die, and fall.

Needle fall and deterioration of twigs, limbs, and finally the bole itself, of treated trees are the critical factors in the build-up of a slash hazard in this thinning operation. In chainsaw thining, nothing is left in the upper limits of the crowns to provide a fuel, but the mass accumulation of slash on the ground is extremely hazardous. The added drying from sun and wind keeps these ground fuels in a combustible condition for several years until crowns close over, vegetation regrows, and slash deteriorates.

Hazards Eliminated

Chemical thinning eliminates the slash and drying hazards.

(Continued next page)

[1] Respectively, Forester and Forest Dispatcher, Colville National Forest.

Figure 2—Three-year-old chain-saw thinned area showing considerable fire hazard still remaining from the slash.

Chemical Thinning

Continued from page 5

An accumulation of slash does not build up anywhere in the stand (fig. 3). Immediately after thinning, needles brown and die on all species treated. Some species, western larch, hemlock, and Englemann spruce, shed needles within three weeks after browning. Douglas-fir retains needles slightly longer but not beyond one growing season. Western red cedar, grand fir, and lodgepole pine retain a significant amount of needles through the first year after treatment, but after two winters, few needles remain. At no time do these dry needles seem to represent significant fire hazard. Fine twigs and branches, pencil size, two years after treatment, have shown very little evidence of deterioration. In some instances, rotting of the boles of the treated trees, especially near the ground line, has begun. It appears, however, that the stem of the tree will remain standing for quite some time. The deterioration rate is so slow that there is no significant slash buildup.

Other Advantages

There are several other advantages to chemical thinning. The killed trees protect the crop trees from sun scald and weather damage. The skeletons of killed trees significantly reduce sun and wind as drying agents. Light meter readings taken in chemically thinned stands show a 30 percent decrease in exposure compared to the stands where excess trees are felled. Although the chemical thinning does increase drying slightly more than in the wild stands, it is far below those conditions created by the chainsaw method.

Standing dead stems, resulting from trees killed in the chemical thinning process, do not represent a significant fire hazard after needle fall. The dead trees in the thinning operations are below or within the canopy of live, green trees. Very few trees are killed whose tops protrude to a position where sparks could be carried for any distance, and, anyway, the adjacent, green tops would deflect and catch sparks before much distance could be covered. Spotting, associated with snags or dead trees in wildfire, would not occur to any significant degree.

The likelihood of fire reaching the tops of the dead trees is low. In thinned stands, natural pruning removes most fine fuels from the lower quarter of the boles of the trees. Without an accumulation of material under the trees to heat up, a wildfire, in most cases, would not be any different than in unthinned stands.

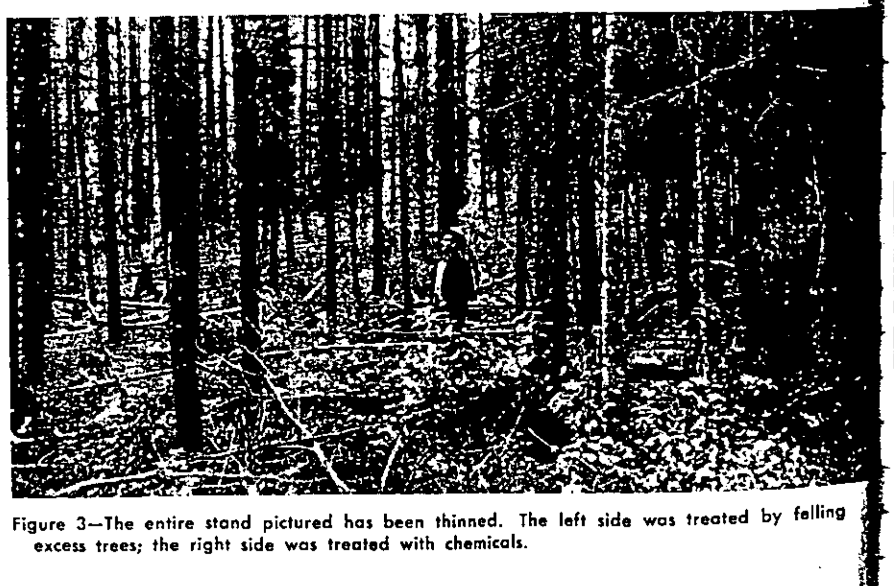


Figure 3—The entire stand pictured has been thinned. The left side was treated by felling excess trees; the right side was treated with chemicals.

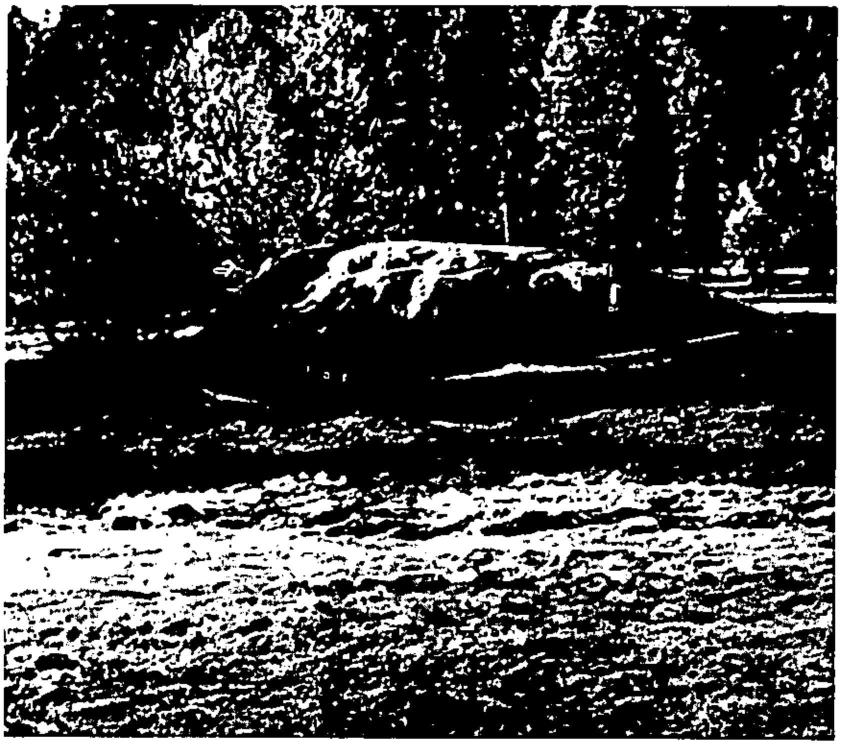


Figure 1—View of sawdust pile after fire was finally extinguished.

Back to Nature

Returning the chemical thinned area to a natural condition, as far as fire control is concerned, is not an important issue. In chainsaw thinned areas, it is very important that the canopy close to increase shade and wind deflection and for slash accumulations to deteriorate. However, in the chemical thinned stands, these factors are insignificant. As standing, dead trees slowly deteriorate and fall, the crowns of leaves will also be increasing. An abrupt change will not occur because the natural spread and growth of live crowns cover the space left by dead trees. Normal spacing objective in thinning operations has been 13 by 13 feet. Crown diameters have generally averaged 6 feet, leaving a space of nearly 7 feet to be filled by growing crowns. Crop tree crowns will probably begin touching within 15 years. At the same time, deterioration and falling of the killed trees should be nearly complete.

An added advantage of chemical thining over chainsaw methods is the lesser impact on the aesthetics of the treated area. Without the accumulation of material on the ground, it is less likely to be apparent to a casual observer that anything has been done to the stand.

Fire Prevention

Although there has not been a wildfire in any of the thinned areas, it is clearly evident that extra suppression effort will be required should one occur in the ax, chainsaw, or dozer-thinned stands. Accordingly, special fire planning and fire control measures have been

(Continued on page 15)

A New Way To Snuff Out Burning Sawdust

HARRY NICKLESS [1]

During the late elk season of 1965, a hunter put out a cigarette in an old sawdust pile. The pile was 10-20 ft. high and covered an area 75 by 100 ft. Surrounding this area was an area of decomposed sawdust 150 by 200 ft. (fig. 1). The pile came to life and burned from time to time during the fall. Winter snows soon followed, and the sawdust pile was covered with 4 to 6 ft. of snow.

Under Snow—Fire!

In March 1966, as the Fire Danger was approaching Moderate, the sawdust pile started burning again. The burning parts of the sawdust were worked over with a fireplow and later with a D-6 Cat. The old sawdust, which was wet, was turned over and mixed with the burning material in an attempt to put out the fire.

During April, the Fire Danger was Moderate. The sawdust pile continued to show signs of fire every time there was a slight breeze. A portable pump was placed in a nearby creek, and two men spent 2 days flooding the burning sawdust pile and working out the burning pockets by hand. But since smoke continued to show,

[1] Fire Control Assistant, Apache National Forest.

(Continued next page)

People Programs For Fire Prevention

RUDY ANDERSON [1]

Fire prevention programs which stress the involvement of people have proven to be a worthwhile approach in the Black Hills National Forest.

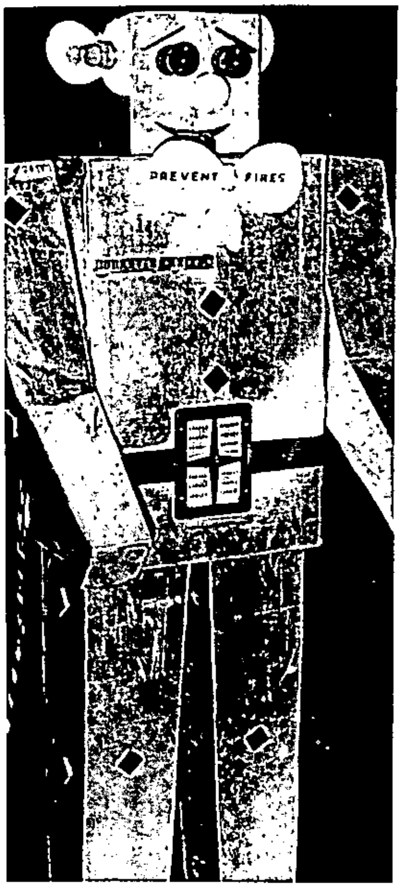


Figure 1—Johnny B. Careful helps to dramatize fire prevention presentations.

The Black Hills Forest has a high potential for man-caused fire, since most all areas are accessible by road. Private land within the forest compounds the problem with industries, ranches, year-long residences and summer homes scattered throughout. Recreation and tourism raise chances of man-caused fires. Over two million people traveled the highways and backroads during the summer of 1968. More are expected each year.

To counteract increasing fire hazards, a fire prevention technician for the forest was appointed in 1963. The position was to strengthen the fire prevention program by exploring new aproaches and methods of personal contact.

School Programs

School children have been most important to the prevention program. All schools in the Black Hills area, grades one through six, are contacted yearly, and two age-graded programs are given.

Programs receiving the most favorable response had student participation. A fire story was told with cardboard cutouts applied by the students to a large, magnetic board which depicted a green forest, showing a slow change in the scene as a wildfire advanced. A fire demonstration dramatically showed the children the hazards of pressurized containers, gasoline fumes, electrical wiring, and hot grease.

After three years of varied approaches, a written program evaluation test was given to the students and teachers. They retained a surprisingly large percentage of information. In addition, each student was requested to take the test home and go over it with his parents. A sample count of 445 students showed 84 percent of the students took the test home.

For the school program in 1968, a life-size robot, named Johnny B. Careful, was constructed from cardboard boxes and equipped with flashing lights and a sound system (fig. 1).

[1] Fire Prevention Technician, Black Hills National Forest.

Snuff Sawdust

Continued from page 7

one or two men had to be sent daily to the sawdust pile on patrol and mopup.

By May, the Fire Danger was High and approaching Extreme. From time to time, small crews from the Job Corps Camp were dispatched to the burning sawdust pile to put out the burning pockets. Two-man District crews made regular patrol and mopup of the sawdust pile. Among other methods, they put all burning embers in a garbage can and filled the can with water. Still the sawdust pile continued to burn.

The Answer

Finally, a successful tactic was tried. Four 57-lb. bags of dry Phos-chek were mixed into the hotspots. The Phos-chek was raked into the top 4-6 inches of sawdust. After this treatment, no further burning was noted. No doubt any of the long-term retardants would probably have done the job. This method may also be useful in controlling ground fires. △

Johnny B. Careful required two men, one man behind the scene to operate the lights and robot voice and the other man to conduct the program with the student body. The script consisted of questions answered by the ranger, the robot and the student body.

A factor to consider in school programing is involvement of other cooperative fire agencies. These agencies are usually willing to participate in school programs, and students are impressed to see several agencies work together.

Displays

Education by displays is another important area of people participation and involvement. Two mobile display units, a rear view slide projection system (fig. 2) and a miniature sawmill (fig. 3) have helped take the fire prevention message to the people.

The sawmill is a working model. Small logs are sawed into boards and the boards stamped: "Prevent Forest Fires—Black Hills National Forest." These are distributed to the audience. The unit always draws a large audience wherever it is on display. The value of this display unit is its hand outs.

The mobile slide projection system is versatile. It is completely self-sustaining with a viewer-operated push button to start the slides and sound systems. Two display panels on each side of the viewing screen are removable. By inserting a different slide tray and tape cartridge and by changing the four display panels, the theme can be changed quickly from fire to timber to recreation to whatever is wanted. The various display panels are stored in the rear of the unit.

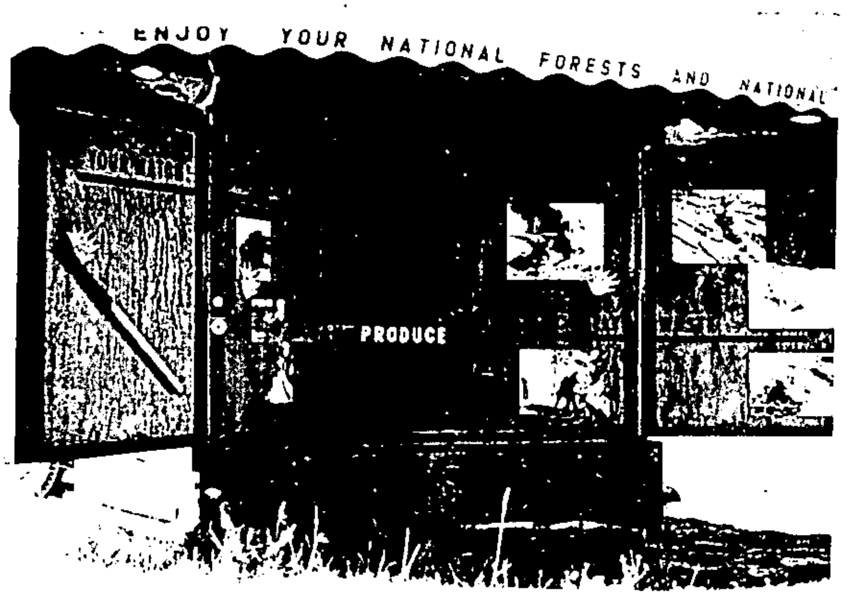


Figure 2—This unit is quickly set up, and the display material can be easily varied.

News Media

A prevention program is no better than its news media support. Again, involvement is the key to success. When a fire becomes Class C or larger, the area news media are immediately informed. A public information officer is assigned to the fire area, and he works directly with the news media people, giving fire information and directions for taking photos. If reporters are not on the scene, the public information officer supplies them with information by phone. The newspapers will give space to forest fires when they are given the facts about them.

Personal contact with the news editor has proved to be the most successful contact when specific prevention programs need promotion. The news editor gets information orally or in written outline form, and he presents it to the public. Many times this personal contact has made the difference between an item getting good coverage or not.

The daily fire index reading is currently one of the major programs in the Black Hills Forest area. The leading newspaper in the area publishes daily the fire index on the front page during the fire season. The same index is presented with the local weather report on the major television station in the area. When very high and extreme fire conditions exist, specific emphasis is placed on the index.

(Continued on page 15)

Figure 3—A working model of a sawmill always draws large crowds.

Fire Follow-up Critiques Fight Future Fires

1ST LT. JOHN H. MAUPIN [1]

Fire follow-up critiques have proven to be beneficial to the fire control effort at Hunter Liggett Military Reservation.

Hunter Liggett consists of 176,000 acres of rugged, grass and brush covered terrain in central California, bounded on the north and west by the Los Padres National Forest. Due to artillery firing and associated military training, fire incidence is high.

After each fire, a fire follow-up critique is held. Short meetings are also held for drills and rolls on suspected smokes. To keep details fresh, discussions are held as soon as practical after the fire is put out.

Who Attends

The fire boss is at all meetings and acts as moderator, leading firefighters and other fire department personnel in a recount of the operation. The dispatcher also attends, since he often has an excellent overall picture of the fire.

If only a few people were involved in the fire, each one is called upon to give his interpretation of what happened. After larger fires, when many more people are involved, the fire boss calls on a cross-section of firefighters. The fire boss is careful to call on new men since many misconceptions are discovered by hearing their viewpoints. Also, the inexperienced men may bring up important items that the experienced men have forgotten or taken for granted.

The Critique

The fire boss opens each session with a brief outline of fire weather and fuel conditions that existed at the time of the fire. Recounts are sequential, and they cover events from the time the fire call was received until the crew returned to the station. Sometimes a blackboard and colored chalk or an overhead projector are helpful in diagramming the life of the fire.

Small fire follow-ups are specific, and such details as response time, hose lays, snag felling, cause and prevention of the spread of the fire, tools used, and line construction are discussed. Large fires demand a much more general discussion, covering topics such as fire weather, line location, and utilization of support facilities or reinforcements. Also, safety hazards and the employment of special procedures, such as backfiring, and equipment, such as bulldozers or air drops, are discussed.

After everyone has given his version of the fire, the fire boss clarifies issues in question and brings up any pertinent topics that he thinks have been omitted.

(Continued on page 14)

[1] Post Fire Marshall, Hunter Liggett Military Reservation.

Marsh Funnel Table Revised

CHARLES W. GEORGE AND CHARLES E. HARDY [1]

Revised table gives flow rates for all currently used fire retardants.

About 3 years ago, the Marsh Funnel was modified so that the viscosity of all forest fire retardants then used could be determined in the field. The data were obtained by comparing viscosity from the Brookfield Viscometer with the flow-through time for the Marsh Funnel; thus "Marsh Funnel time" serves as an inexpensive criterion of actual viscosity.[2 3]

Revised Table

The revised table includes only products currently used. Newest of these is Phos-Chek 202 X/A (see page 16).

The Marsh Funnel Packet is still available. It contains the table, the instructions for converting a Marsh Funnel, and a list of commercial sources. Separate tables and the Packet can be ordered from Northern Forest Fire Laboratory, U.S. Forest Service, Drawer 7, Missoula, Montana 59801.

(Continued on page 15)

[1] Intermountain Forest and Range Experiment Station, Northern Forest Fire Laboratory.

[2] George, Charles W., and Charles E. Hardy. Fire retardant viscosity measured by modified Marsh Funnel. U.S. Forest Serv. Res. Note INT-41, 4 pp., illus. 1966.

[3] George, Charles W., and Charles E. Hardy. Fire retardant viscosity measured by modified Marsh Funnel. Fire Control Notes 28(4): 13–14, illus. 1967.

Root Feeder Suppresses Fires

RICHARD J. BARNEY [1]

A root feeding needle, fitted to a fire hose, deeply saturates heavy accumulations of fuel and partially decomposed organic matter better than conventional nozzles, stream or fog type. Also, less water is used by the needle.

Heavy accumulations of fuels and partially decomposed organic matter, such as peat, mosses, and humus, are abundant throughout the interior of Alaska. Road construction and land clearing activities often create large concentrations of mixed fuel and organic soil. During periods of high fire danger, characterized by high buildup indexes, these fuels can burn to considerable depth. Extinguishing fires during these periods is often difficult and usually requires large volumes of water. Normal application procedures do not always get water down into the fuel where it is needed. Rather than soak, conventional nozzles, both stream and fog type, have a tendency to throw firebrands and to waste water because of runoff. A nozzle which places water in the center of these organic fuels could reduce the total amount of water necessary and improve the efficiency of the suppression technique.

[1] Fire Control Scientist Pacific Northwest Forest and Range Experiment Station; headquarters for the Station is at Portland, Oregon. The author is located at the Institute of Northern Forestry, College, Alaska.

The Feeding Needle

The idea of using a tree surgeon's feeding needle seemed worth trying. The feeding needle (fig. 1) is normally constructed with ¾-inch spray hose fittings; it was modified to use a 1½-inch national fire hose female thread adaptor. The needle is equipped with a shutoff valve and is approximately 40 inches in length. The pointed tip has side holes which direct water in four directions (fig. 1).

In use, the needle is easily inserted into the fuel to the desired depth. Sometimes, slightly opening the valve assists the insertion process. Once the needle is inserted, the valve can be fully opened. The period of time the needle is left in each location depends on the specific fuel. The needle is then moved from place to place until the control or mopup job is completed.

Field Evaluation

The needle was given to the Fairbanks District, Bureau of Land Management, Division of Fire Control for two fire seasons. General reaction to the needle performance was enthusiastic. Various personnel and crews reported that the needle was a real help in controlling and mopping up the deep burning fires.

Flow Rates

A flow-rate check was made because crews involved in field testing thought the needle put out more underground fire with less water than their standard adjustable nozzles. This field observation seemed reasonable

(Continued next page)

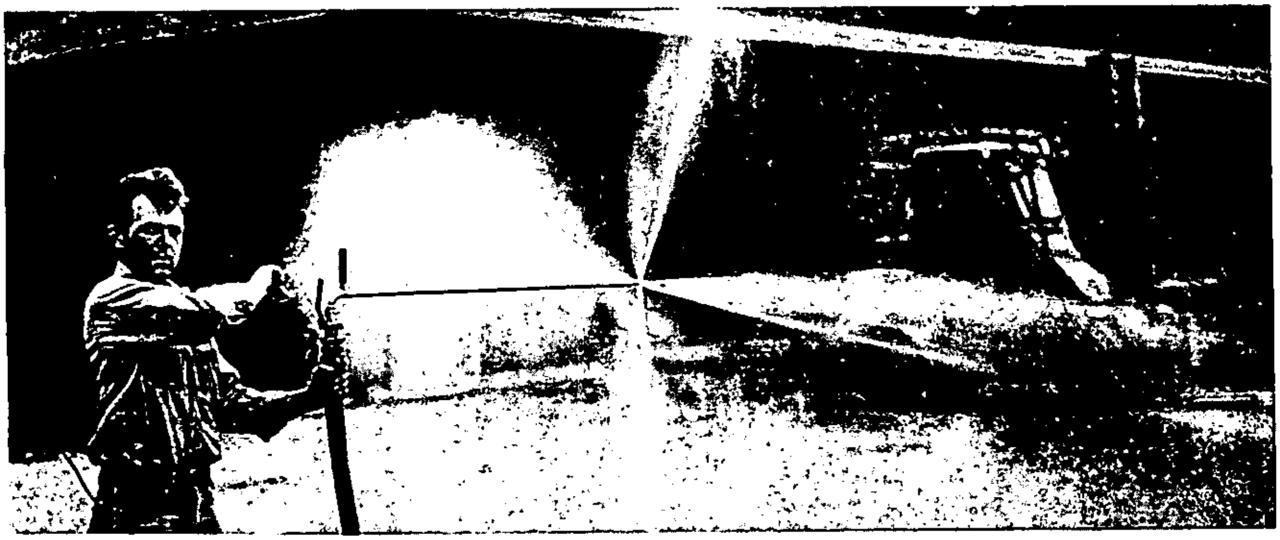


Figure 1.—Feeding needle and spray pattern.

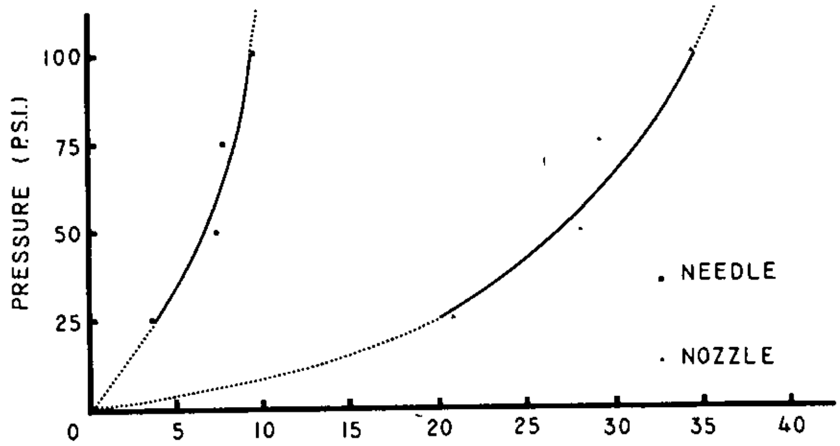


Figure 2.—Needle and nozzle flow rates at various pressures.

Root Feeder

Continued from page 11

since the needle openings were smaller than those of the nozzle. However, an experiment was run to determine how much difference actually existed between units in waterflow per unit of time. This information would also give a tanker operator some idea of how long his supply of water might last using either type of nozzle for control or mopup.

In the flow-rate check, a Western Fire Equipment Co. Nozzle, No. 4A711, set approximately midway between full spray and full stream pattern, was used for comparison since it is more or less a standard nozzle for tankers and portable pumps in interior Alaska. The selected nozzle setting represented a pattern which is used in much of the local suppression work. The Bureau of Land Management's 1,200-gallon tanker truck, equipped with a front-mounted Barton-American centrifugal fire pump, type UA50, was used as the water source. A 32-gallon garbage can was calibrated and used to catch the water. Runs were timed and flow rates calculated for four pressure levels determined by the pump gauge. Pump pressures of 25, 50, 70, and 100 pounds per square inch were selected because they cover the range most used by various crews on both tankers and portable pump units. The 1½-inch hose was selected since it is the standard size hose of the Bureau of Land Management in Alaska.

Figure 2 illustrates the results of the flow test. Obviously, the feeding needle uses considerably less water per minute. At the 25 p.s.i. level, the ratio is about 5 to 1; whereas at 100 p.s.i, the ratio is approximately 4 to 1 with the standard nozzle flow rate compared with the needle flow rate.

Other Tests

In addition to the flow-rate check, some subjective tests were made by actually wetting typical fuels. These tests substantiated the usefulness of getting water into the center of fuels with the needle. In several cases, with the conventional nozzle and essentially similar amounts of water, the wetting went down only a few inches before additional water ran off. The needle, however, completely saturated the vicinity where it was placed, making the area muddy. One explanation for these apparent differences is that the organic fuels used in the tests have a very high surface-to-volume ratio and act as a sponge. Therefore, a considerable amount of water is necessary to saturate the area near the surface before additional amounts will penetrate downward. The needle provides a means to get water at the desired level without having to saturate the levels above.

Discussion and Summary

It appears that the needle can be an effective tool in combating fires in deep, organic fuels. This tool not only uses considerably less water per unit of time but also places it at the depth desired. Modifications could possibly improve the performance; however, the needle seems to perform in a satisfactory manner as originally designed.

Although the manufacture recommends operating the needle at 250–350 p.s.i. using ¾-inch or ½-inch pressure hose for tree feeding, we obtained good performance at lower pressures using 1½-inch hose. Higher pressures seemed to increase water blowback from underground along the needle shaft thus reducing the effectiveness of getting water into the fuels at depth. As in all nozzle work, caution should be taken by operators to avoid stream explosions caused by hitting hot pockets underground. Drawing the needle out of the ground slowly improves the saturation throughout the fuel complex encountered. With a little practice, the operator can use the needle quite effectively. △

Airtanker Tested For Drop Pattern

BRIAN S. HODGSON [1]

Water-drop tests of the new Canadair CL–215 airtanker indicate it has an effective pattern length of some 240 feet when a 0.5 second delay sequence drop is made.

The CL-215 Airtanker

The Canadair CL–215 airtanker has recently completed its water-drop performance trials. The CL–215 is an amphibious, twin-engine, water-bomber aircraft. It can pick up 12,000 pounds of water in 15 seconds, scoop-filling at 70 miles per hour from lakes as small as one mile long. The water bombing system has two tanks, each with a capacity of 6,000 pounds and each consisting of a removable portion above the floor and a lower fixed portion integral with the hull structure. The two drop doors, 63″ long and 32″ wide, form part of the bottom of each tank. The pilot or co-pilot can trigger the water drop by pressing a button on his control wheel; he can empty the tanks together, individually, or in sequence.

Test Measurement

The technique for standardized, impartial measurement used for the CL–215 is the one developed for water-bombing aircraft throughout Canada by the Flight Research Section of the National Research Council of Canada in conjunction with the Forest Fire Research Institute in Ottawa. The test program has served as a background for future work to be done on tree canopy interception and also to test a mathematical model developed for the prediction of the ground distribution of water released from an airtanker.

One part of the test program called for calibrating drops of water to determine the ground distribution pattern. The results for the CL–215 in this phase of testing are the bases of this article.

In anticipation of a larger pattern than with other aircraft tested, the ground distribution grid plot was extended to an area of about 680 by 200 feet for the CL–215. The 15 by 7.5 foot grid spacing of the cup holders was retained except for the last two rows where it was increased to 15 by 15 feet. The collecting unit was a 10-ounce paper cup with provision for a tightly fitted lid, the cup being held in a crimped metal can nailed to an 18-inch wooden stake and wire-locked securely.

For each test run, a total of 1,163 cup-can units were used, each stake identified by a letter and number corresponding to its position in the grid. Prior to placing in a holder, the cup was numbered with the corresponding coordinate value. After each test drop, any cups containing water were capped, collected, and weighed.

(Continued next page)

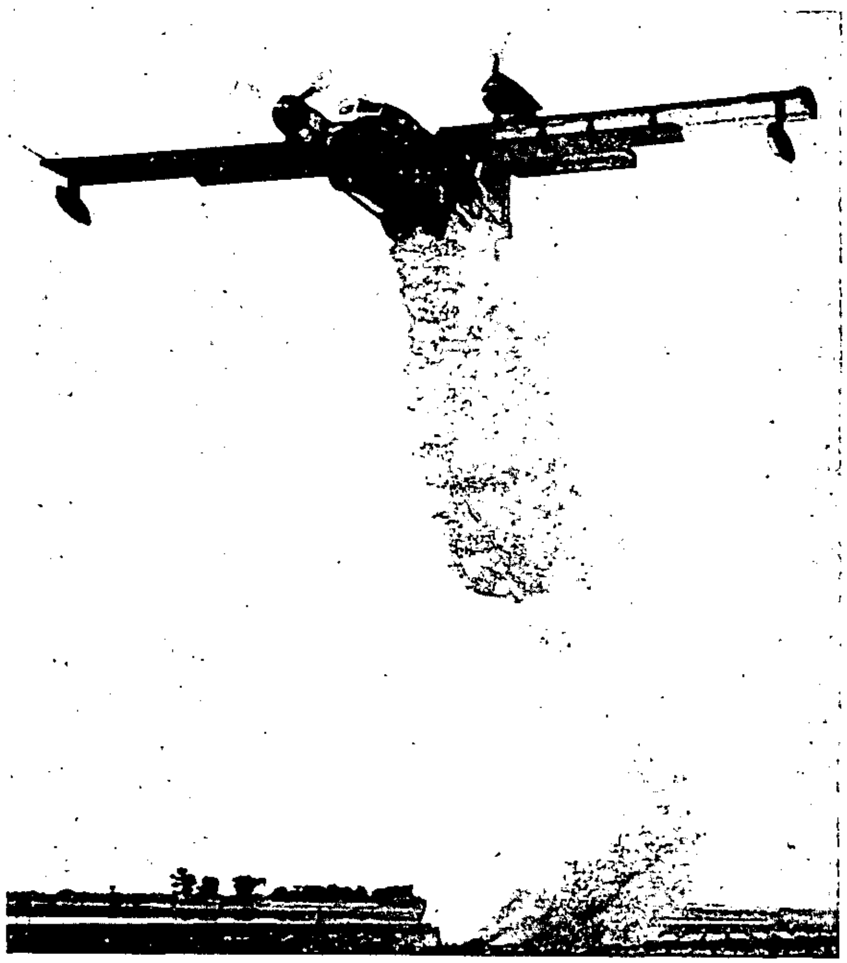
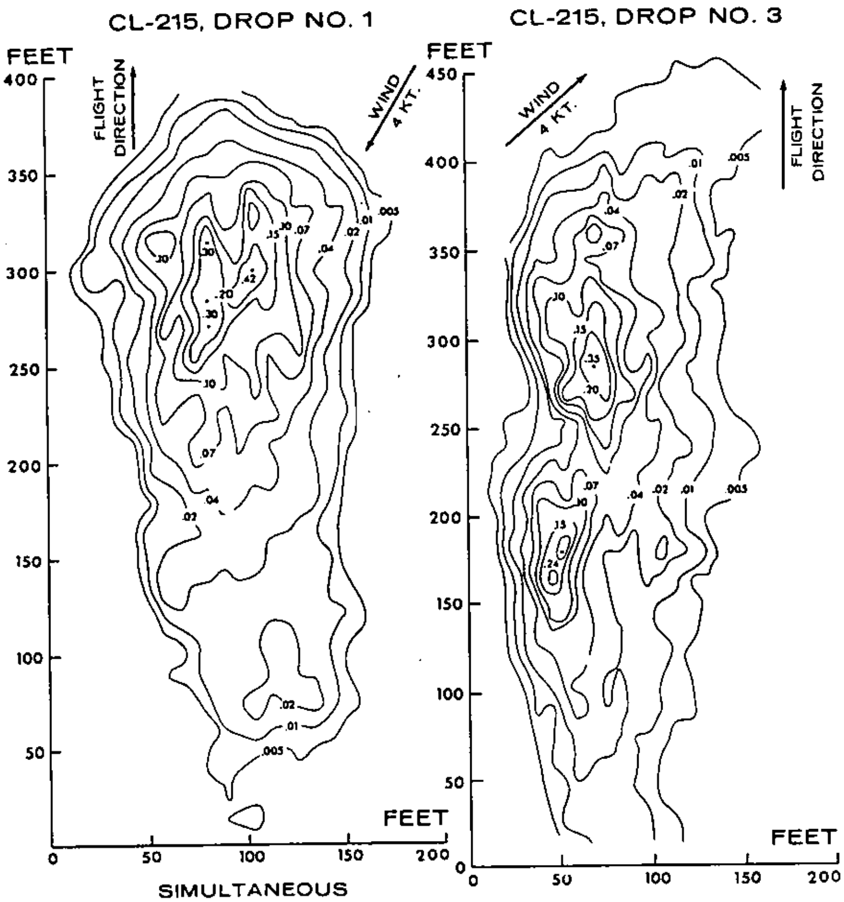


Figure 1—A view of the CL-215 dropping water, with 1 second delay between door openings. Canadair photo.

[1] Fire Research Officer, Department of Fisheries and Forestry, Canada.



SIMULTANEOUS
2-TANK RELEASE
JULY 11, 1968 11:36 EDT

TEMPERATURE	72°
REL. HUMIDITY	61%
ALTITUDE	118'
AIRSPEED	104 KT.
GROUND SPEED	100 KT.
RECOVERY	80%
ON SITE WIND	4 KT.
GALLONS DROPPED	1200 IMP. GAL.

"0.5 SEC." IN-TRAIN RELEASE
OCT. 22, 1968 09:45 EDT

TEMPERATURE	46°
REL. HUMIDITY	85%
ALTITUDE	97'
AIRSPEED	94 KT.
GROUND SPEED	97 KT.
RECOVERY	74%
ON SITE WIND	4 KT.
GALLONS DROPPED	600+600 IMP. GAL.

Figure 2—Contour patterns for salvo and sequence drops. Graphs from Flight Research Section, National Research Council of Canada.

Airtanker

Continued from page 13

Evaluation of Tests

The Flight Research Section wrote a computer program to analyze these results to give the coordinates necessary to plot the distribution contour lines in inches of water rather than gallons per 100 square feet. (0.01″=0.52 Imperial gallons of 0.62 U.S. gal./100 sq. ft.)

Drop pattern variations were made with ½- and 1-second interval delays between door openings, producing a longer water pattern than if the two doors had opened simultaneously (fig. 1).

The contour diagrams shown are those for a simultaneous salvo drop and a sequence drop with a 0.5 second delay between door openings. (fig. 2)

If we consider the 0.07 inch contour (4.4 U.S. gal./100 sq. ft.) as that required to retard a fire, then for the salvo drop the effective pattern length is about 165 feet and for the sequence drop with 0.5 second delay is 240 feet. The PBY Canso, another airtanker tested, had an effective pattern length of 150 feet with an 80 pound load.[2]

Results

The preliminary tests indicate some work will have to be done on the drop system to reduce the peak contours that occur in the distribution pattern. The water contained in these peaks is wasted because it represents water quantities higher than those required for fire suppression. Effects on the pattern of a change in the opening rate of the drop doors, the extent to which the doors open, or the interval between the opening of successive doors, needs more investigation. ⚠

[2] Hodgson, B.S. A procedure to evaluate ground distribution patterns for water dropping aircraft. Inform. Rep. Forest Fire Res. Inst., Ottawa, No. FF-X-9, 1967.

Fire Follow-up

Continued from page 10

Results

As a result of fire follow-ups, fire response time has been shortened, and new refinements in firefighting techniques have been developed. Fire safety is strengthened, and fire control efficiency has increased. Fire follow-ups effectively reinforce the methods of fire control to new men and serve as refresher for the old hands. These sessions also provide an opportunity for new men to take advantage of the knowledge of the more experienced men. Not least of all, effective fire follow-ups yield benefits in acreage saved and accidents prevented. ⚠

Marsh Funnel

Continued from page 10

Instructions for Using the Marsh Funnel

1. Place the appropriate tip in the Marsh Funnel.
2. Cover the hole with a finger and pour a freshly agitated sample into the clean, dry upright funnel until the fluid level *exactly* reaches the bottom of the screen.
3. Measure the time in minutes and seconds for *1 quart* of retardant to flow through the funnel (the funnel hold approximately 2 quarts).
4. Look up measured time on lefthand side of table. Read proper column to the right to find viscosity in centipoise.

NOTE—A. The viscosity reading depends on time because agitation and temperature of retardant will vary. The viscosity found in the table will be for the retardant at the existing settling time and temperature.

B. For the samples tested, the Marsh Funnel method gave viscosities within 5 percent of the Brookfield method.

C. Numbers included within the boxes indicate the normal usage range. △

Air Stability

Continued from page 4

and use their manpower and equipment better.

Upper air temperature data are readily available at all ESSA Weather Bureau Offices where Forestry Meteorologists are stationed. These data enable the forestry meteorologist to determine the degree of atmospheric instability. Using other meteorological information available, such as the computerized lifted index prognostic charts, the Forestry Meterologist can project the stability into the future and come up with a forecast of the atmospheric stability for the following 36 to 48 hours. Considering the value of such forecasts to the forestry industry, the atmospheric stability forecast should be a routine product of all weather offices, and fire control personnel should be trained to use it. △

People Programs

Continued from page 9

Smokey Bear

Smokey Bear now has his day in South Dakota. Each spring, the Governor of the State proclaims a Smokey Bear Day to emphasize the approaching fire season and call attention to Cooperative Forest Fire Prevention. On this day, a mass distribution of CFFP material is made throughout the State by Federal, State, and cooperating fire agencies.

The program has been very successful—and with added benefits. First, the material *is* being distributed, and all key areas *are* covered. Second, in coordinating areas of distribution, other agencies and organizations not previously interested in fire prevention participate. The most valued benefit is news coverage. Spot announcements are periodically aired over the radio three days prior to the CFFP distribution. Television covers Smokey Bear Day, and news articles appear in all weekly and daily papers just before the distribution.

Fire Prevention Week

In the fall of 1968, an air show was organized strictly for fire prevention publicity. All cooperating agencies, the State Forestry Department, National Park Service, State Park Department, the Rural Electrification Agency, volunteer fire departments, and law enforcement agencies, in coordination with the Forest Service, put on a demonstration of fire equipment and related activities. The show was a success because people not familiar with firefighting saw the massive organization needed for a major fire. An aerial tanker retardant drop was demonstrated. The helicopter and helitack operation was explained and demonstrated. Pumps, tools, safety equipment, fire trucks, and communication equipment were all on display and were all demonstrated. A fire story was told, and as it was told, people saw how many tax dollars were spent because of other people's carelessness.

Summary

New approaches in fire prevention are necessary but are not the total answer. Involvement of people is necessary but again is probably not the total answer. The Fire Prevention Program in the Black Hills seems to be successful because new approaches in fire prevention and people involvement have been combined. People are the problem and it takes people to solve it. △

Chemical Thinning

Continued from page 7

required for these areas. In contrast, no similar special precautions have been necessary for the chemically thinned stands.

As a result of these studies, even though their duration has been short, an acceptable method of hand thinning has been established. Chemical hand thinning follows good sivicultural practices and certainly does not increase the fire hazard in thinned areas. △

U.S. DEPARTMENT OF AGRICULTURE
WASHINGTON, D.C. 20250

OFFICIAL BUSINESS

POSTAGE & FEES PAID
United States Department of Agriculture

See article, page 10.

MARSH FUNNEL TIME—FIRE RETARDANT VISCOSITY RELATIONS [1]

Time for 1 quart to flow through a funnel [2]		Fire retardant material						
		Gelgard M		Phos-chek			Fire-Trol 100	
				202	202 X/A	259		
		Large tip [3]	Small tip [3]	Large tip	Large tip	Small tip	Large tip	Small tip
Min.	Sec.	Centipoise						
0	15						930	
0	20				557		[Air] 1530	
0	25				767		1900	
0	30				966	5	2140	
0	35				1155	20	2330	
0	40			540	1334	[Ground] 43	2480	920
0	45			680	[Air] 1502	66	2590	1110
0	50			[Air] 800	1659	89	2680	1250
0	55	[Ground] 520		900	1806	112	2750	1370
1	00	550		1000	1942	136	2800	1460
1	05	580		1080	2067	159	2840	[Air] 1540
1	10	610	210	1150	2183	182	2880	1610
1	15	640	230	1210	2287	205	2900	1670
1	20	660	250	1265	2381	228	2920	1720
1	25	680	265	1320	2465	251	2930	1770
1	30	700	280	1380	2538	274	2940	1810
1	35	720	300	1420		297	2950	1840
1	40	740	315	1470		320	2960	1870
1	45	760	330	1520		343		1900
1	50	780	342	1560		367		1920
1	55	800	355	1600		390		1940
2	00	[Air] 820	370	1640		413		1960
2	15	865	[Ground] 410	1755				
2	30	908	442	1855				
2	45	945	477	1935				
3	00	980	508	2010				
3	15	1014	537					
3	30	1045	564					
3	45	1072	591					
4	00	1098	616					
4	15	1123						
4	30	1147						
4	45	1171						
5	00	1188						

1/ Viscosities by Brookfield Model LVF, at 60 r. p.m., spindle 4 (except spindle 2 for Phos-Chek 259)
2/ Funnel must be FULL to screen before testing begins.
3/ Large tip diameter should be 0.269 ±.002 inch; small tip inside diameter should be 0.187 ±.002.

☆ U. S. GOVERNMENT PRINTING OFFICE: 1969—342-574/.