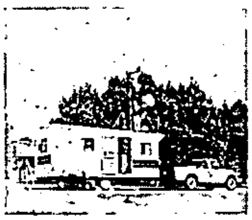
FIRE CONTROL NOTES

A quarterly periodical devoted to forest fire control

CONTENTS



COVER.—A general view of a mobile fire laboratory is shown. **See story on page 7.**

(NOTE—Use of trade names is for information purposes and does not imply endorsement by the U.S. Department of Agriculture.)

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 (Sept. 16, 1963). 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.

PREPARING A TOTAL PREVENTION PROGRAM

Merle S. Lowden

Director, Division of Fire Control[1]

Fire prevention is an essential part of any comprehensive fire control program. Its need and value are generally accepted by firemen. However, prevention work is becoming more varied and complicated. Many approaches must be considered in planning and executing a total prevention program. To obtain optimum effectiveness, all known and applicable approaches must be used. Some approaches that do not always receive enough attention are discussed in this article.

When the public thinks of fire prevention, it usually visualizes posters, TV appeals, and other information items of the Smokey Bear type. Use of these media is an important part of any comprehensive fire prevention effort, and it is the best method of informing the general public and certain groups such as school children. However, many other approaches to fire prevention are needed in a well-designed program.

In this article other prevention work has been classified into several general fields: Risk engineering, hazard engineering, exposure controls, industrial user controls, and law enforcement. Each of these fields is applicable in various degrees—depending on the location and the prevention problem. It is important to first obtain an optimum analysis of fire causes and then to carefully plan actions to meet needs. It is desirable to try to improve definitions, increase our investigations, and obtain better information on who is responsible and what is involved in man-caused fires. Fire prevention research can be particularly helpful in providing administrators with guides for obtaining better records of fire-starting causes. This effort is now receiving particular attention in a cooperative study project in the South. A fire statistical center is planned. Fire records from all fire control agencies in the Southern States are to be gathered and analyzed.

RISK ENGINEERING

Risk engineering includes all ways of eliminating sparks that start forest fires. Basic research is needed on the sizes and types of carbon that cause fires, how they are emitted, what can be done to eliminate them, and similar problems.

The change to diesel engines did not stop engine fires or fires from diesel tractors. An "offensive" diesel tractor under a heavy load emits sparks from an unprotected or poorly protected exhaust stack. Also, all diesel oils, as well as other fuels, are not equally hazardous. Additives can be placed in fuels to decrease the likelihood of carbon particles starting fires. However, economic considerations further complicate the situation. Cheaper fuels generally cause more fires, and engine designs which reduce the problem often cost more.

Much can be done to prevent "engine" fires. Effective spark arresters will prevent emission of fuel sparks that cause fires. The Forest Service has established a method of testing and certifying arresters that meet a certain standard. A new Identification Guide lists tested arresters. New and better arresters have recently been developed for powersaws and similar small engines. While much more must be known about the sparks from engines, aids and methods for working on the problem are available. Equipment should be inspected regularly by competent specialists to be certain required devices are functioning.

New devices for reducing offensive gases that increase air pollution may be a source of future fire problems. These are being studied at the San Dimas Equipment Development Center (Calif.). New cars with these devices may prove a source of serious trouble. These devices, now required in some areas, are fairly certain to receive wider use. When smog control equipment is attached to engine exhaust systems, the temperature usually rises. Some afterburner-type units still undergoing research may produce exhaust gas temperatures high enough to ignite forest fuels. Development of special protective devices such as guards

[1] This article is adapted from a speech presented at the Society of American Foresters Annual Meeting, Seattle, Wash., Sept. 14, 1966.

or exhaust deflectors may be needed. Fortunately, automotive engineers are also trying to solve the smog problem by "cleaning up" motor designs. The trend is to design out smog-producing characteristics and thereby obtain better combustion for the car of the future. This approach is much more practical than adding apparatus to the present exhaust systems; such additions may create corrosion which destroys metal parts in about 10,000 miles, or causes high temperature. Also, it seems there will always be the motorist who drives through dry grass. Such grass may have an ignition temperature dangerously close to the heat of his dragging exhaust system. His tail pipe may be turned down, his muffler defective, and his engine missing.

There are also fires from railroad brake shoes and sparks from pulleys and cables. New electric brakes prevent brake shoe fires, but sparks from cables are particularly troublesome. New types of materials must be sought. Alert vigilance can help at points where cables contact wooden fuels. Increases in cable logging and even the new balloon systems that use cables may be a problem. The need to be alert to new risks is constant.

Community dumps have been a fire risk source for many years. In some localities legislation concerning their location and other safeguards has been helpful. Many fire control units have made special efforts to clean up or "fireproof" dumps. Such efforts have usually eliminated or greatly reduced dump fires. A new, mobile incinerator has had favorable use for campground refuse, but dumps for local refuse are sure to be used for many years. These dumps must not continue to be a cause of wildfires. There is much that can be done to improve the "fire proofability" of most dumps.

HAZARD ENGINEERING

Obviously the objective of prevention is to prevent sources of ignition from contacting burnable material. Hazard engineering can eliminate natural vegetation and other materials that burn. Vegetation can be removed where sparks are most likely to fall—along railroads, on roadsides, in recreation areas, near powerlines, and in similar places. Some phenomenal results have been obtained from close cleanups along certain sections of railroad tracks and highways (fig. 1). Fire crews of the San Bernardino National Forest, Calif., have done much such work along forest roads and highways. They cleared road edges for 10 feet on many miles of highways and roads and reduced roadside fires from 52 to 11 percent of all fires on the Forest.

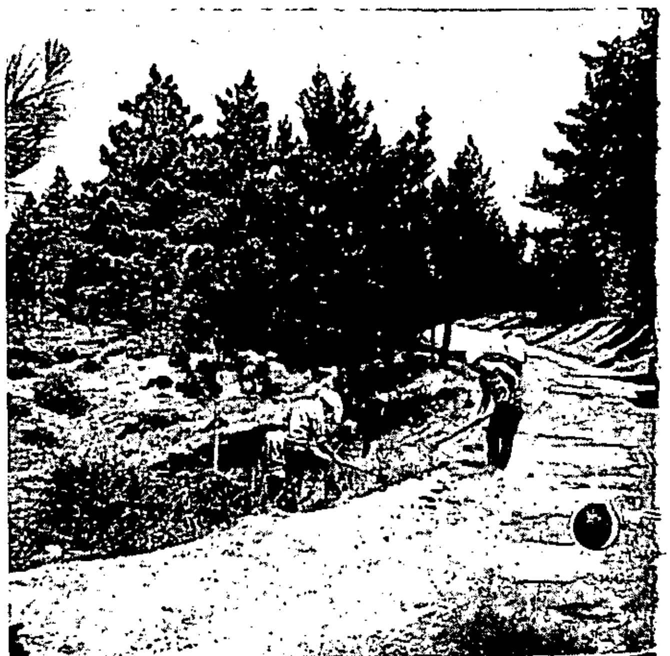
One stretch of railroad had a history of high, but fluctuating, fire incidence. The number of fires was almost directly correlated with good or poor right-of-way cleanup. On a short section of right-of-way, railroad fires averaged 7 to 9 per year. After a cleanup, there was none.

Firemen have long searched for a retardant to spray over high-risk fuels to keep them from igniting. Tests in California and elsewhere have revealed some retardants that are effective but not durable—the first rain washed them away. An effective and economical retardant will be found, but more effort is needed.

The chip problem along certain railroads has been particularly vexing in recent years. Chips blowing off heaped railroad gondolas pile up on rights-of-way, particularly where wind currents are strong. These chips provide an ideal fuelbed for sparks to ignite. They also are a safety hazard when they block railroad switches and tunnel drains. Concern about this safety hazard, or the persistence of protection agencies, or possibly a combination of both, has resulted in some improvement. Intensive cleanup of chips has been done in a few places. An embargo on high-piled uncovered cars in the Pacific Northwest has produced definite results, and chips are no longer "flying" at will. Cutting the height of chips on cars or putting on either permanent or temporary covers can pr[illegible] well cure this problem.

At the national level, the American Association of Railroads and the Railroad Section of the National Fire Protection Association have promised to help with the railroad fire problems. Several States, including Michigan, Missouri, and Califor-

Figure 1.—Cleanup of hazardous material along roadsides greatly reduces the chances of fires starting. Those that do occur spread slowly and can be quickly controlled.

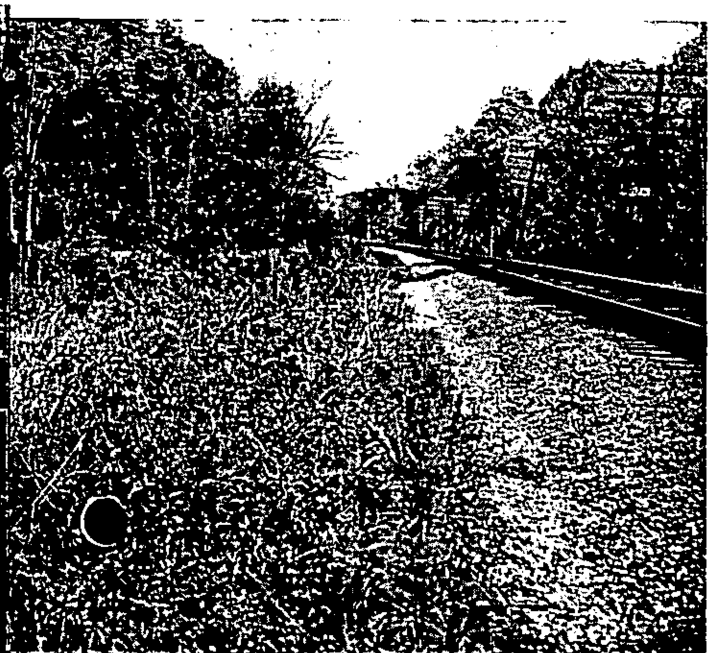


..a, have been working hard with railroads on hazard and risk problems. It is particularly important that local fire managers work with railroad people both to make them aware of problems and to seek joint solutions (fig. 2).

Highway fire prevention cleanup can and does enhance roadside beauty. Foresters are rightly concerned with soil erosion. But to prevent disastrous fires, some small soil losses may have to be accepted temporarily. For example, vegetation may have to be removed along roads until a cover is found which does not ignite. We need to be working with highway commissions and road engineers to design roadsides that are less hazardous as sources of fires. Snags or trees frequently fall across powerlines and produce fires. Removal of dead and risk trees can prevent most of these fires. Research is needed on roadside fire hazards and their alleviation.

The elimination of fuels where fire starts are likely is being done around forest homes and other buildings surrounded by flammable fuels. California's "Fire Safe", a formal program, has this aim. State officials hope to extend law enforcement so the program will be successful. They are convinced it will eliminate many fires, particularly those that ..rt in the most hazardous places and often cause large property losses. We now accept as standard practice cleanup in recreation areas (especially around fireplaces, stoves, and tables). Dust likelihood may prevent a complete cleanup in such places, but we can at least lessen the problem. The search for new fireproof ground covers needs to be continued. We need "fireproof" overlooks, vistas, waysides, and similar places where people congregate.

Figure 2.—Concentrations of light fuels along railroad rights-of-way present a severe hazard and substantially increase the chances for railroad fires to occur.



Some people broadly define prevention and include the action needed to hold fires to small size. This may seem like suppression rather than prevention. It is valuable to build firebreaks and wider fuelbreaks to stop fires or help hold them at critical locations. This is the chief purpose for the cleared lanes on the ridgetops over much of southern California, and such areas are being cleared in other parts of the country. For years "light" burning has been advocated to remove hazards, and it can be effective in prevention. Such burning should be carefully prescribed and competently done. There is no question that fire, if properly used, can prevent many fires and hold others to small acreages. While, this in reality may not be fully pertinent to this general subject, it is in effect, hazard engineering.

Regulation of burning, on government or private land, is a particularly important prevention job. Debris burning is one of the large causes of fires, and these fires often occur at critical times and in especially hazardous places. Both hazard and risk engineering are involved. When a better way is found to dispose of limbs and other slash debris or to make them less hazardous, more fires will be prevented. On some National Forests operators bury debris on road construction projects. This eliminates the hazard and also the risks of escape fires when burning is done. Experiments have been conducted with various chemicals and decomposition agents including fungi to dispose of fuel debris, but I know of no noteworthy results. Current concern for clean air has raised many questions as to the effect of hazard reduction by burning on air pollution. We have some facts, and research is being conducted to find more. It's a big job to explain our work to "Clean Air" administrators so excessive restrictions are not placed on burning. Formulation of mutually satisfactory regulations and methods will continue to require orientation and understanding by all concerned.

EXPOSURE CONTROLS

There are a wide variety of actions under exposure regulation. Limiting the exposure of the forest to fire risks may restrict the activities of individuals and often is unpopular. In the Forest Service, our general objective is to permit maximum use of the National Forests. In some locations it is necessary to restrict the use of fire under extreme conditions of fuel, weather, or exposure. Sometimes an area may be closed to all use. However, at other times people may merely be required to smoke only in certain areas, obtain a campfire permit, or carry fire tools.

Even changing the hunting seasons to keep people out of the woods at certain times is a form of exposure regulation. Like other regulations, it is only used when other means are not adequate. Regulations are usually resisted, but people informed of the reasons for limitations are remarkably willing to comply with them. Mass media can be particularly helpful by advising people of severe fire danger and the reasons for restricting their actions. All regulations should be lifted as soon as possible.

Signs and posters are used as part of exposure regulations. These are used to motivate people to action or inaction when they are exposed to forest fuels. We are just beginning to learn, through research and tests, about effectiveness of various signs. It is certain that people must see, read, and understand a sign before they will act upon it. It should provide a reason, a stimulation, or a reward for doing the right thing. All of these things need consideration in sign planning as a part of your total prevention program.

INDUSTRIAL USER CONTROLS

Industrial users working in forests are in a somewhat different class, and controls on their actions are usually applied differently. The work they do may be under some type of permit, contract, or special regulation. This permits an advance determination of restrictions to action, and sometimes these can be put in writing. With recent improvements in fire danger rating, these exposure requirements can be more closely related to action fire needs. For instance, we can specify by humidity readings or danger ratings when a logging operator will be permitted to log. Fires start much more readily when relative humidities are below 25 percent. Thus, some special regulation of the exposure is needed. Other restrictions such as demanding watchmen during certain seasons, requiring mufflers or spark arresters, and designating when and where fires may be built all contribute to prevention.

LAW ENFORCEMENT

Another general prevention category is law enforcement and the accompanying trespass or collection action. This should not be slighted in a prevention program. All law enforcement should have as its chief goal the prevention of fires. This is true whether it is applied to enforcement of prefire efforts such as rules and restrictions or in the investigation and apprehension of fire starters. It is important to apply the law equally to all people, but it is also important to keep the prevention objective foremost in mind. We often do not have choices, but where we do, we should stop and appraise. Are we doing this or taking this action in a manner that will obtain maximum prevention, or are we being vindicative, arbitrary, or too authoritative?

It is established Forest Service policy and practice to try to collect both costs of suppression and resource losses from those responsible for starting fires. Many ramifications of responsibility, negligence, and similar items are involved. An aggressive program of trying to collect from fire starters or those responsible has had a marked effect in preventing fires in many places. Since this is a specialized activity, we have found trained, full-time law enforcement officers particularly helpful in areas where there is much of this business; they also provide assistance in areas where personnel don't have much such business.

Closely related to law enforcement are deterrent activities that keep people from violating laws or regulations. These have much the same effect as the policeman on the beat. They range from a "red" fire pickup going up a road to a helicopter overhead with a prevention banner. Certainly, people are more careful if they are being watched. Helicopters and airplane patrols have been effective in reducing incendiary fires. Night patrols with aircraft have worked well in reducing incendiary fires in Missouri. Frequent patrols and "fire-chasing" helicopters in incendiary areas have been helpful.

There is another prevention activity I should mention which cannot be placed within any of the categories I have listed. But it is directly related to all of these categories. This is the human engineering or a person-to-person relationship between a fire officer and a possible fire starter. There are many approaches and methods in human engineering. They range from contact with a known incendiarist to a casual conversation with a forest visitor. Men who spend all or most of their time on this work are especially desired, but we don't have the funds to hire nearly enough of these people. Yet we recognize their great value and hope to hire more.

When I ask field men what they need most to improve their prevention work, they often tell me they need more prevention patrolmen or specialists. This is an age of specialization, and these men can develop many new and improved approaches and techniques. Through training these techniques can be transmitted or improved. In a total prevention

Continued on Page 15

A NEW MOBILE FIRE LABORATORY

S. S. SACKETT and J. H. DECOSTE, *Research Foresters*
Southern Forest Fire Laboratory
Southeastern Forest Experiment Station
Macon, Ga.

A new mobile fire laboratory is being used at the Southern Forest Fire Laboratory to scientifically document both high-intensity (blowup) wildfires and prescribed fires. The unit also can be used for investigating fuels, collecting meteorological data, and other special purposes. The laboratory has already proven valuable in the documentation of a series of prescribed fires and in the monitoring of a wildfire during the disastrous spring 1966 fire season in South Carolina.

The mobile laboratory is used as a base station and is the control and communications center for all documentation activities. Primary weather observations are taken at the mobile unit. Recording meteorological instruments are used for making a continuous record of onsite weather conditions throughout the burning period. Fuel moisture is also determined at the fire site.

DESCRIPTION OF BASIC UNIT

The basic unit is a 20-foot, tandem-axle house trailer drawn by a ¾-ton truck. The truck has a V-8 engine with an all-wheel drive. An observation deck has been installed on the top of the trailer; the deck also provides a base for radio antennas and an anemometer staff. A compact laboratory in the trailer contains considerable scientific and electronic equipment; much of this equipment is specifically designed for fire research. There are also general facilities such as gas, air, and vacuum outlets, an electric balance, and other laboratory hardware. A constant operating temperature for electronic equipment is maintained during the summer by a 7,000-B.t.u. air conditioner and in the winter by an electric heater. Electric power is supplied by a 5,000-watt, gasoline-powered generator. An auxiliary 2,500-watt unit is transported with the trailer for use in case of primary equipment failure. Both generators produce 120-volt, 60-cycle current.

FIRE WEATHER STUDIES

A basic requirement for documenting wildfires or prescribed fires is observation of onsite meteorological conditions that affect fire behavior. Relative humidity, temperature, windspeed, wind direction, and barometric pressure are recorded continuously during the entire documentation period.

Relative humidity and temperature are recorded by hygrothermographs in portable weather shelters. A microbarograph is used to continuously record station pressures.

A system utilizing a Gill microvane and three-cup anemometer as sensors is used for wind observations. The anemometer has a threshold value of 1.25 m.p.h. A dual-channel galvo recorder permanently records wind direction and windspeed on a 0- to 50-m.p.h. or 0- to 100-m.p.h. scale. The sensors can be placed at any height desired. However, they are generally used at the 20-foot height (or its equivalent) in the open and at the 4-foot height within the stand. An aerovane coupled to a dual-channel recorder provides a reserve wind-recording system. The aerovane, which is not as versatile or sensitive as the basic system, is mounted on a mast above the observation platform.

Portable equipment—sling psychrometers, Dwyer wind meters, aspirated psychrometers, Biram anemometers, and compasses—is carried with the trailer for onsite readings.

Current observations on atmospheric conditions aloft are restricted to single pilot-balloon soundings (pibals) for determining windspeeds and wind directions. Two theodolites, a helium tank, balloons, a plotting board, and pibal accessories are stored in the trailer. Future observations on winds aloft may include double theodolite soundings.

Now under investigation is a cold-rocket system designed to carry a radiosonde aloft for monitoring relative humidity and temperature from ground level to 5,000 feet. Data will be radioed back to a recorder in the trailer. Relative humidity and temperature profiles can then be plotted and used to calculate atmospheric stability. This setup should provide much needed information on the relationship of stability and extreme fire behavior.

FUEL MEASUREMENTS

An electric oven is used to dry fuel samples for weight and moisture content determinations. Because at least 24 hours are required to ovendry pine-litter samples at 85° C., this arrangement is used only during a long stay in the field. A Karl Fischer titrimeter to permit immediate moisture content determinations is being installed. These measurements will be especially beneficial for use in prescribed burning. An Ohaus moisture determination balance is also used in the fuel moisture measuring system.

FIRE TEMPERATURE MEASUREMENTS

In documenting prescribed fires, fire temperatures are related to time. The principal value of the data obtained is its relation to research being done on lethal time-temperature ratios for control of undesirable species. The measuring system is composed of four temperature sensing staffs, four strip-chart recorders, a multipoint, automatic reference-junction compensator, a control jack-panel, a 1,400-foot extension cable, and four 150-foot fireproof extension cables. Each temperature sensing staff has four chromelalumel thermocouples. These thermocouples are permanently mounted at four heights—ground level, 1 foot, 4 feet, and 8 feet.

Fireproof lead assemblies are used within the fire area to connect the temperature sensing staffs to an extension cable that runs back to the trailer.

The reference junction compensator has a constant reference temperature of 150° F. The recorders have an adjustable span between 0 and 50 millivolts. Each recorder measures temperatures at one specific height (fig 1).

At present, only one temperature sensing staff can be connected at one time. The staffs are placed in the fire area so that, as the fire progresses, the main extension cable can be manually shifted to each fireproof lead assembly for each respective staff. However, the system has been designed so that when more extension cables are added, the switching may be done at the control jack-panel rather than manually in the field.

PHOTOGRAPHY

Photography is important in the documentation of fire behavior and fuel conditions. For fire behavior, emphasis is placed on color photography because better contrast is achieved between the smoke column and background.

Different models of 35-mm. cameras are used, but the most effective and versatile type for

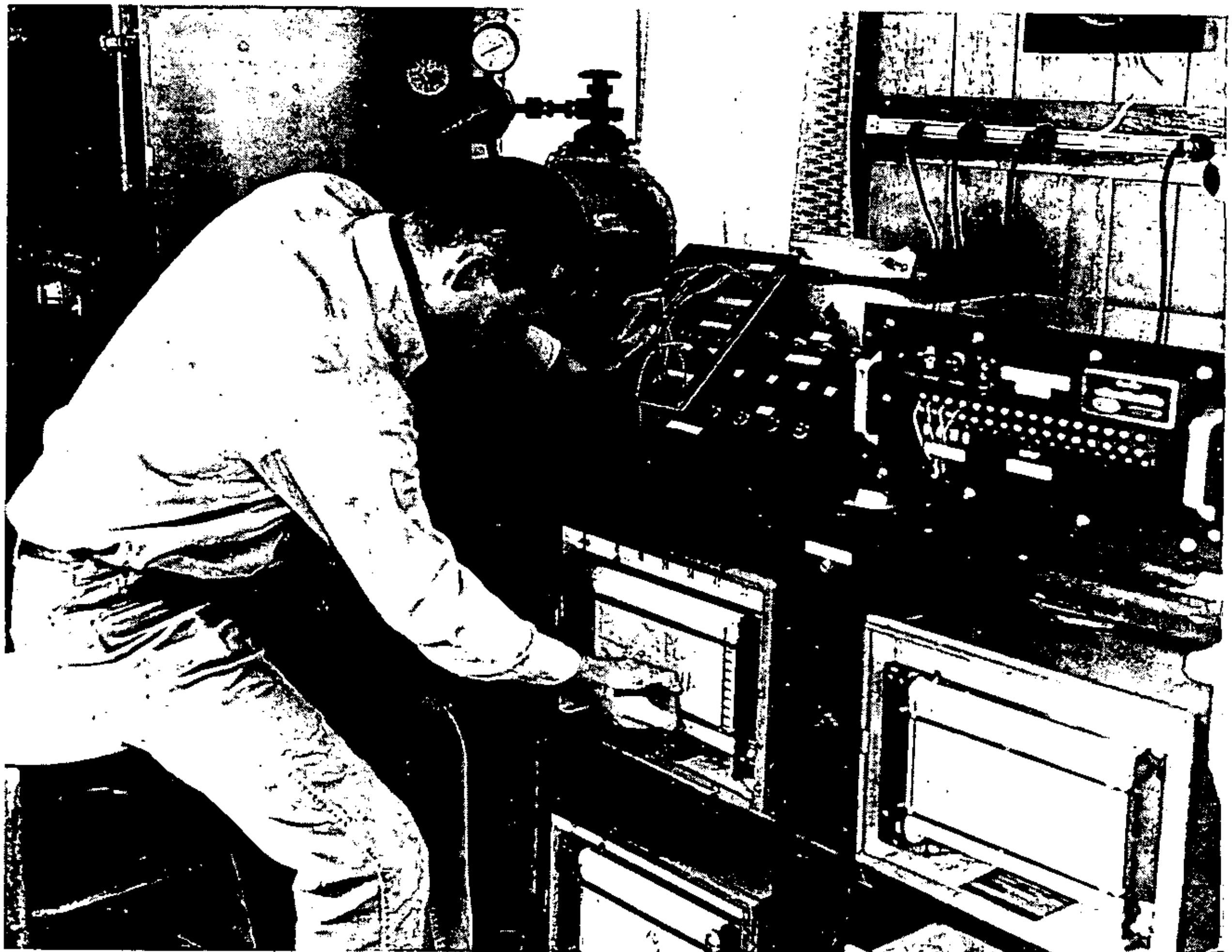


Figure 1.—Data on fire temperature over time will help in determination of lethal ratios for control of undesirable species.

are photography is one in which the lens f-stop and distance settings can be set while the observer is looking through the viewfinder. Black and white photography is done with a 4 by 5 graphic camera.

A 16-mm. movie camera with an electronic time-lapse mechanism is used to record the shape, angle of tilt, motion, and circulation in the smoke or convection column associated with high-intensity wildfires.

COMMUNICATIONS

When high-intensity wildfires are being documented, radio communications must be maintained with the fire control organization. Mobile transceivers that operate on State fire-control frequencies in the Southeast have been installed in the tow truck and in a sedan. To supplement these mobile radios, crystal receivers, which can also monitor the State fire control frequencies, have been installed in the trailer.

To keep current on the weather situation, a surplus Government BC-348-R receiver is used for monitoring the continuous transcribed weather broadcasts from the Federal Aviation Agency's Flight Service Station. These broadcasts, covering a 250-mile radius from the station, give a brief weather synopsis, a forecast of significant area weather, a winds aloft forecast, local radar reports (RATEP), and selected pilot reports (PIREPS).

Intracommunication between team members and the mobile laboratory is also essential in documenting prescribed fires. Communications are maintained by a network of portable transceivers. One transceiver is permanently mounted in the trailer and serves as a base station.

ACCESSORIES

Incidental, yet desirable, items for the operation of the mobile laboratory include the following:

1. Tote-Gote trail scooter (valuable for moving documentation equipment into the field and fuel samples back to the trailer)
2. Collapsible anemometer mast (20 feet)
3. Exterior-mounted machinist's vice.
4. Mechanic's and carpenter's handtools
5. Hand-operated winch (1,000-lb. capacity)
6. Screw-type trailer stabilizer jacks
7. Pioneer tools
8. Electrical repair kit with soldering gun
9. Trouble lights and exterior floodlights
10. Assorted hand-held battery-operated lights
11. Office and drafting accessories
12. Small library of pertinent literature
13. Field first-aid kit with oxygen equipment and stretcher
14. Complete set of fire handtools with gasoline-powered trench flailer

SUMMARY

Prescribed fires and wildfires are complex, and collecting accurate scientific data, especially on high-intensity wildfires, is very difficult. The mobile fire laboratory provides a method for thoroughly documenting such fires.

There have been few documentations; therefore, the data have not been used much. However, as more prescribed fires are recorded, detailed analyses will be necessary to interpret the data and provide meaningful guidelines for conducting more efficient and effective prescribed fires. Also, as more wildfires are documented, fire behavior and the variables affecting it will be better understood.

COOPERATORS OBTAIN EXTENSIVE USE OF REGION 6 FIRE SIMULATOR

Howard E. Graham, *Forest Service*
Portland, Oreg.

The Region 6 fire simulator was constantly used from late September 1966 through mid-July 1967. It was in Region 6 for 29 weeks and in Regions 1 and 5 for a total of 11 weeks.

In Region 6, 530 men received valuable training. More than two-thirds of these men were from cooperating agencies. Use in Region 6 was as follows:

Agency	Time used (*Weeks*)	Men trained (*No.*)
Oregon State Forestry Department	19	275
Bureau of Land Management	2	36
Washington Department of Natural Resources	1	24
Washington Forest Protection Assn.	1	20
Forest Service, Region 6	6	175
Total	29	530

It is planned to make the simulator even more accessible to cooperators. The simulator has been used only at the Forest Service Redmond Air Center, Redmond, Oreg.; cooperators will soon be able to assemble and use the simulator at their own facilities. In preparation, Region 6 personnel have trained cooperator personnel as simulator instructors.

INCENDIARY PROJECTILE LAUNCHER TESTED FOR REMOTE SLASH IGNITION

John D. Dell and Franklin R. Ward[1]

Burning logging slash on steep, clearcut units in the Pacific Northwest is hazardous work. Dislodged rocks or rolling logs often endanger firing crews working downslope. There is a need for a method of slash ignition that can be done remotely from accessible spots outside the logging unit.

In the fall of 1966, a pneumatic incendiary projectile launcher was tested for slash ignition in the Douglas-fir region (fig. 1). The test site was an 85-acre clearcut unit on the Umpqua National Forest, Oreg.

An earlier demonstration of the launcher had indicated that it might prove effective for backfiring or for prescribed burning.[2] Originally designed as an airborne launcher for smoke markers in antisubmarine warfare, the device can fire projectiles filled with any gel-like fuel.

In the Oregon tests, a commercial diesel-gel product was used. The launcher was pallet-mounted. Bottled nitrogen provided pneumatic pressure. The purpose of the test was to determine if the launcher's accuracy, range, fire-starting capabilities, maneuverability, safety, and ease of handling were suitable for effective remote slash ignition.

[1] Respectively, Forestry Research Technician and Research Forester, Pacific Southwest Forest and Range Experiment Station, Berkeley, Calif.

[2] Nailen, R. L. New technologies field-tested at California brush fire. Fire Eng. 119(2): 49–50. 1966.

TESTS AND RESULTS

The projectiles used were military surplus items. They were made of wood; they weighed about 24 ounces, and were 3 inches in diameter and 18 inches long (fig 2). A delayed fuse ignited the projectile's fuel store about 10 seconds after impact.

To test the launcher's effectiveness and accuracy, we designated and marked 10 preselected target areas. The launcher was first set up on a road across a canyon 500 yards from the unit to be burned. The launcher, however, could not project the missiles further than 350 yards, although the manufacturer claimed to have fired projectiles as far as 500 yards in some previous tests. Only three rounds were fired from this spot.

We then moved the equipment across the canyon to a position on a landing above the slash unit. All remaining rounds were fired from that position, down and laterally along the slope. Nearly all firing was done with the launcher in a mortar position, lobbing the projectile toward its target. Of the 18 rounds fired, 10 ignited in the general vicinity desired. The remaining eight projectiles either broke upon impact, failed to ignite, or completely missed the designated target areas. Accuracy—even at the closer ranges—was only fair. Of the 10 rounds which ignited slash, eight were within a

Continued on Page 15

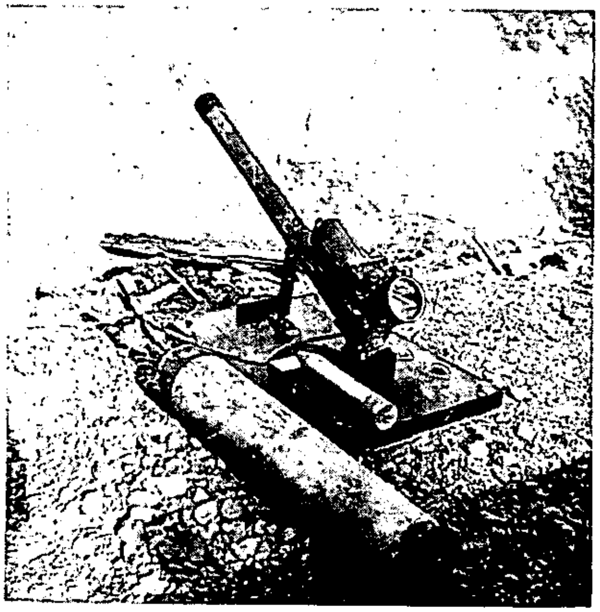


Figure 1.—In the Oregon tests, the incendiary projectile launcher was fired up to 350 yards.

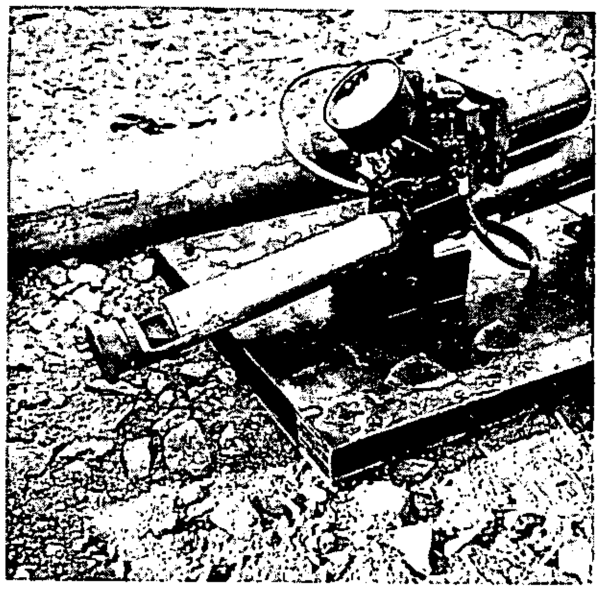


Figure 2.—Exit velocity of projectile is determined by the pressure stored in the pressure chamber, which completely empties after each firing.

SPRINKLER SYSTEM PROTECTS FIRELINE PERIMETER IN SLASH BURNING

WILLIAM J. ORR AND JOHN D. DELL[1]

Broadcast burning of logging slash on Douglas-fir clearcut units nearly always presents some risk. Usually, careful planning reduces most of the risk. Firelines are constructed on unit perimeters, snags are felled, and fire pumps, hoses, tankers, and manpower are positioned for optimum fire control.

A difficult slash burning job may require special control measures. Where water is available, an oscillating sprinkler system shows promise for protecting the fireline perimeter. Such a system can be used to saturate live vegetation and dead fuels at critical points next to firelines. And the water, if properly applied, can reduce or eliminate both spotting and fuel ignition by fire radiation.

A simple, effective, and inexpensive sprinkler system for extra fire protection on slash burns has been developed by fire control personnel of the Sweet Home District, Willamette National Forest, Oreg.[2] District personnel have used the sprinkler system effectively on several difficult prescribed burns. If topography and accessibility are not too adverse, a two- or three-man team can usually set up the system in half a day. Vegetation outside the fireline usually can be adequately saturated in 4 or 5 hours. Sometimes the system is set up the day before a burn and operates overnight.

The use of sprinkler systems for slash burning is not a new concept. Although use has been limited in the Pacific Northwest, several similar sprinkler innovations have been used in recent years on the Gifford Pinchot (Wash.) and Mt. Hood (Oreg.) National Forests.[3] In the Kamloops District, British Columbia, Canada, 30-inch lengths of hard plastic pipe for spray nozzles have been used with some success.[4] Several small holes are drilled into the pipe; each section is bowed into an arc with wire. Regular 1½-inch hose couplings were fastened to pipe ends to permit the attachment of hose line. The system uses a pump or gravity-supplied pressure of 90 to 150 p.s.i.; each sprinkler covers a 50-foot area.

THE SWEET HOME SYSTEM

The Sweet Home sprinkler system consists of regular 50-foot sections of 1½-inch CJRL fire hose that distribute water to a maximum of 20 oscillating Rain Bird sprinklers. The sprinklers can be adjusted to any degree of rotation required. Usually 180° is used so that only the area outside the fireline is wet down. The system can cover up to 1,000 lineal feet of fireline. The number of sprinklers that can be operated effectively depends on the capacity of the pump being used and the elevation that the water must be lifted.

Each sprinkler (fig. 1) is mounted on a 4-foot section of rigid galvanized steel conduit connected to a ½-inch tee. A 12-inch length of conduit, with a short piece of ⅝-inch iron rod driven into one end, is connected to the other end of the tee. The rod serves as a spike for driving the sprinkler mount into the ground.

Water is distributed from the main line to the sprinkler mount through a 5-foot length of ¾-inch plastic garden hose. One end of the garden hose is connected to the ½-inch tee on the sprinkler mount. The other end is connected to a faucet and hose line tee. These outlets are spaced at each couplings along the 1½-inch hose line. The faucets allow adjustment of volume and pressure at each sprinkler head so that the maximum number (20)

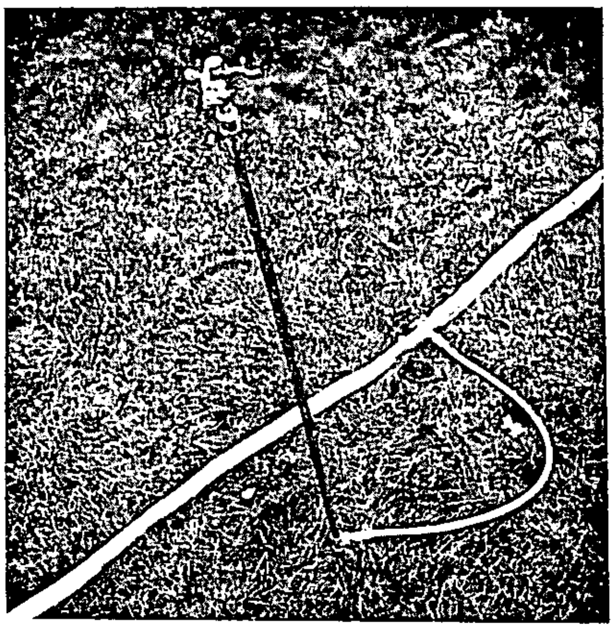


Figure 1.—The main line, sprinkler connection, and sprinkler are shown. The sprinkler is mounted on a 4-foot section of rigid galvanized steel conduit.

[1] Respectively, Fire Control Officer, Sweet Home District, Willamette National Forest, Oreg., and Forestry Research Technician, Pacific Southwest Forest and Range Experiment Station, Berkeley, Calif.

[2] The sprinkler system was developed by William Orr, Cliff Dewey, and George Schram, Sweet Home District, Willamette National Forest, Oreg.

[3] Anonymous. Slash burning job eased by sprinklers. Forest Industries 93(13): 75, illus. December 1966.

[4] Anonymous. Slash-burn sprinklers. British Columbia Lumberman, p. 42, August 1965.

can be operated if desired. The adjustments must be made progressively from the lowest to the highest elevation to provide an even distribution over the line.

An Edwards 120 fire pump, capable of 45 g.p.m. at 150 p.s.i., is used with the system. Any pump with an equivalent capacity would be adequate.

Hoses are laid directly on the fireline, with each sprinkler 5 feet outside the line. Mounts are driven into the ground at right angles to the slopes to provide maximum sprinkler coverage. When operating at 180° rotation, the sprinklers provide a 25-foot-wide wet line. At full rotation, the width is doubled. At corners, the sprinklers are set at 270°.

The sprinklers are also useful in mopup operations to wet down smoldering embers in the burn area. The sprinkling begins from the fireline perimeter, and the system gradually is moved inward.

Sprinkler systems often provide the extra margin of safety necessary in difficult areas where steep topography, aspect, fuel concentrations, or poor boundary locations increase the risk of fire escapes. They also increase the feasibility of burning out of the normal season under more severe conditions. Sprinklers are not applicable to all prescribed burning, but they often are useful tools.

EQUIPMENT

In addition to a fire pump and sufficient fire hose, the system requires the following parts and equipment (source of supply shown after description of item): [5]

- 100 ft. Conduit, rigid galvanized steel, ½ in. (10-ft. sections)—General Services Administration
- 100 ft. Hose, garden, plastic, ¾ in.—GSA
- 10 ft. Rod, iron, ⅝-in. diameter (cut in 6-in. lengths) local machine shop
- 20 Pipe tees, ½ by ½ by ½ in.—GSA
- 20 Pipe couplings, ½ in.—GSA
- 20 Pipe nipples, ½ by 3 in.—GSA
- 20 Hose line tees, aluminum or brass, 1½ in. female by 1½ in. male by ½ in. female—Western Fire Equipment Company
- 20 Faucets, with hose bib, ½ in.—GSA
- 20 Sprinklers, Rain Bird, full circle—local distributor
- 19 Hose couplings, ¾ in. (reusable)—GSA
- 20 Hose clamps, ¾ in.—GSA

ASSEMBLING THE SYSTEM

1. Cut the 10-ft. lengths of ½-in. conduit in half, and cut 12 in. off each unthreaded end.
2. Drive half the 6-in. pieces of ⅝-in. rod into one end of the 12-in. section of conduit (use a press if available).
3. Cut pipe threads on the opposite end and also on the unthreaded end of the 4-ft. piece of conduit.
4. Remove the male fitting from the 100-ft. length of plastic garden hose and cut into 20 equal lengths. Attach female hose coupling to one end of each piece.
5. Slip the other end of the garden hose on the ½-by 3-in. pipe nipples and apply hose clamps.
6. Sharpen the end of the protruding ⅝-in. iron rod to a blunt point and assemble at bottom end of conduit mount.

COSTS

The cost of the 20-unit (1,000-ft.) sprinkler system is about $350, not including the main line hose and pump. When costs for assembling are added, (about 2 man-days), expenditure would probably total about $400.

[5] Many commercial sprinklers are available. The Sweet Home system uses a Rain Bird model No. 25 PJ, which has an output of about 5 g.p.m. at 50 p.s.i.

POLAROID LITTER MAY BE USEFUL EVIDENCE

CLEO J. ANDERSON, *Forester*

Prescott National Forest

A search for evidence after suppression of a man-caused fire on the Carson National Forest uncovered much common picnic litter and a half-dozen throw-away negative tear sheets from a Polaroid camera. The tear sheets gave us some hope of identifying the offenders.

However, our hopes were diminished when we contacted a photographer to see if an image could be produced from the discarded tear sheets. He called the Polaroid factory and was told it could not be done.

The local FBI agent was then contacted. While he could not assure us, he was very cooperative and said he would see what was possible. The FBI was able to produce a picture from the blank-looking piece of black paper. This knowledge will be useful to other investigators who find discarded Polaroid tear sheets at the scene of a trespass.

FIRE RETARDANT VISCOSITY MEASURED BY MODIFIED MARSH FUNNEL

CHARLES W. GEORGE AND CHARLES E. HARDY, *Reseach Foresters*

Northern Forest Fire Laboratory
Missoula, Mont.[1]

Use of chemical retardants in forest fire suppression is now a firmly established procedure. To obtain the most effective application, the optimum viscosity for each retardant is needed. In turn, optimum viscosity of each fire retardant depends on the project for which it will be used.

Retardants applied from ground equipment must be viscous enough to build up a thick layer on the fuel, but must remain easy to pump. Those applied from air tankers must be more viscous in order to cling together during the drop and to reach and adhere to the fuel properly.

The viscosity of fire retardants is extremely difficult to estimate visually, and most viscometers capable of rendering reliable measurements are expensive and cannot be used in rough field situations.

To provide the measurements of viscosity needed in the field, a Marsh funnel can be modified (fig. 1) for use with all commonly used fire retardants. This funnel has a 6-inch-diameter top, and is 12 inches long. The 10-mesh screen that covers half of the top should not be used as it may change the structure of the retardant. If lumps or impurities are present, pour through screen, but delay viscosity determinations for at least 5 minutes.

Viscosity is measured by agitating the fluid, pouring it into the funnel as high as the screen, and recording the seconds necessary for 1 quart to pass through the funnel (fig. 2). Several fire-retardant materials have a much higher viscosity than that of the drilling muds for which the funnel was designed; thus, the orifice, or tip, is not large enough to accommodate these retardants. However, if the original tip is removed and replaced by a larger one, satisfactory determinations of viscosity can be made. Use of the large tip can be limited to the thicker materials, and the original one can be reinserted for measuring the thinner, less viscous materials.

[1] The Laboratory is administered by the Intermountain Forest and Range Experiment Station, Ogden, Utah.

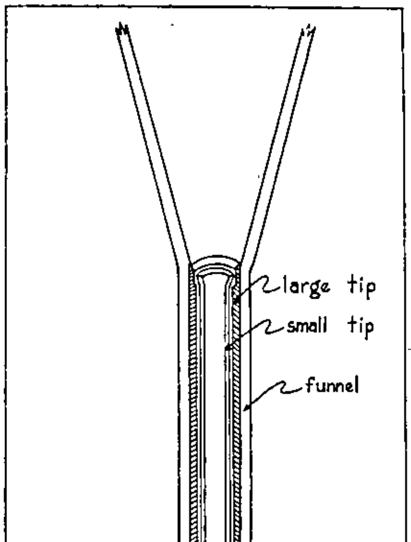


Figure 1.—Cutaway section of the modified Marsh funnel with small tip in place

Figure 2.—Measuring viscosity with modified Marsh funnel

METHOD OF DETERMINING VISCOSITY

There is no single correlation between calibration of the Marsh funnel and that of rotational viscometers (e.g., Brookfield) for all retardants. The two types of instruments respond differently to such characteristics as rate of gelation, gel strength, thixotropy, and density. Consequently, the Marsh funnel must be calibrated for each fire-retardant material. The following method established the relation between viscosity measured in centipoises and in "March funnel seconds":

1. Samples of each retardant were mixed at several viscosity levels. The retardant was not touched for 15 to 18 hours after mixing.

2. A Brookfield model LVF viscometer, at 60 r.p.m. and using spindle 4 (spindle 2 for Phos-Chek 259), rendered viscosity measurements in centipoise units. The readings were taken after the spindle had turned for 1 minute in the sample.[2]

3. From the same samples we filled the Marsh funnel to the screen and measured the seconds required for 1 quart to run out the bottom into a graduated beaker. Measurements were made using both the large and small tips. Table 1 shows the relation

[2] Gelgard thinned rapidly when subjected to the revolving spindle; therefore, turning was needed for 15 seconds before reading.

TABLE 1.—*Relation of Marsh funnel time to viscosity as measured by the Brookfield model LVF viscometer at 60 r.p.m.*

[CENTIPOISES]

Time for 1 quart to flow through funnel[1]		Fire retardant								
		Gelgard M		Gelgard F		Phos-Chek		Bentonite, large tip	Fire-Trol 100	
Min.	*Sec.*	Large tip	Small tip	Large tip	Small tip	202, large tip	259, small tip		Large tip	Small tip
0	15	....	....	....	...	....	...	500	930	....
0	30	....	20	....	20	....	5	1,875	2,140	....
1	00	550	170	625	153	1,000	136	2,450	2,800	1,460
1	30	700	280	780	275	1,380	274	2,675	2,940	1,810
2	00	820	370	883	378	1,640	413	2,815	....	1,960
2	30	908	442	962	471	1,855	...	2,925	....	....
3	00	980	508	1,038	550	2,010	...	3,005	....	....
4	00	1,098	616	1,180	672	2,315	...	....	....	....
5	00	1,188	...	1,316	...	2,560	...	....	....	....
6	00	1,264	...	1,444	...	2,760	...	....	....	....
7	00	1,327	...	....	...	2,950	...	....	....	....
8	00	1,387	...	....	...	....	...	....	....	....

[1] Funnel must be *full* to screen before testing begins.

between viscosities measured by the Brookfield viscometer and the Marsh funnel seconds equivalents.

INSTRUCTIONS FOR MODIFICATION AND USE

A packet to help field personnel modify and use a Marsh funnel to measure viscosity is available from the Northern Forest Fire Laboratory, Forest Service, USDA, Missoula, Mont. 59801. The packet contains instructions for modification, a drawing of the modification, information on places where already modified Marsh funnels can be purchased, instructions for using table 1, and an expansion of table 1 that covers each 5 seconds through 3 minutes and each 10 seconds beyond 3 minutes.

INFORMATION FOR CONTRIBUTORS

Please submit contributions through appropriate channels to Director, Division of Fire Control, Forest Service, U.S. Department of Agriculture, Washington, D.C. 20250. Articles should be typed in duplicate, double spaced. The author's name, position, and organization should appear directly below the title.

Articles covering any phase of forest, brush, or range fire control work are desired. Authors are encouraged to include illustrations with their copy. These should have clear detail and tell a story. Only glossy prints or India ink line drawings can be used. Diagrams should be drawn with the page proportions in mind, and lettered so as to permit any necessary reduction. Typed captions should be attached to the illustrations, or included in the text following the paragraph in which they are first mentioned.

Prevention Program—*Continued from Page 6*

program it is particularly important to provide such training. Where men cannot devote full time to this work, other men should put as much time as possible on it. Our prevention men do a lot of complementary jobs closely related to their primary contact job. They inventory hazards and try to get them eliminated, inspect permits and uses, put up signs and posters, make group contacts, enforce rules and laws, etc. Some States are doing an outstanding job with personal contacts. Mississippi has developed a "contactors" handbook and is doing an intensive training job in such work. Results have been particularly good.

To provide better prevention some special prevention test areas deserve attention. These are management units that have had many man-caused fires. On these relatively small areas we try to do a fully adequate prevention job. We improve the financing to do what is considered needed. This is an attempt to see if fire prevention work really pays. New innovations or ideas are tried on these areas.

Results of fire prevention research are immediately applied and tested. Several such results are operational throughout the country, and we want more as quickly as we can finance them. Results to date have been good. Hopefully, ideas developed or proven successful can be extended to other areas.

Fire prevention research is really just getting well underway. However, there are many ways to improve current techniques or approaches to the phases of prevention I have listed. Much research concerning people's attitudes and reasons for starting fires is necessary. We need to go behind apparent causes and perhaps find deeper and real causes. I have long advocated each fire be thoroughly analyzed as to cause and possible prevention, just as automobile accidents and personal injuries are. This idea is still good. Also, equipment can be designed so it is less likely to start fires. There are many opportunities for building fire prevention into forest management without great cost or problems if proper consideration is given.

I could list other jobs and items that are closely connected to prevention and need to be included in a total program. By making friends and influencing people to act wisely in the forest, we are helping fire prevention. If we remove a risk or alleviate a hazard, it should help. All these efforts mean fewer fires, less firefighting, and the saving of more resources. Prevention is sure to pay if well planned and properly directed.

Projectile Launcher—*Continued from page 10*

10-yard target area; the other two ignited slash but were farther away from the desired ignition spot.

These firings were made only to determine the launcher's practicability as a technique for slash burning. No attempt was made to determine costs of the launcher or its accessories.

CONCLUSIONS

The launcher, in its present form, does not seem operational for slash burning. It seems fairly adequate for maneuverability and safe and easy handling. Its range, 300 to 400 yards, is suitable for most slash ignition use. The greatest limitation of the launcher is its lack of accuracy—a necessary requirement for effective slash ignition where fuels are concentrated but not always continuous.

Primarily, the launcher needs a rangefinder to improve accuracy. A slightly smaller bore should improve accuracy and help the projectile achieve greater velocity. A modified projectile with built-in fins would probably prevent "tumbling" in midair and further improve accuracy. Also, weight could be reduced and maneuverability improved by replacing the present pallet mounting with an adjustable tripod. And some weight might be reduced at the breach. Petroleum gels are usually quite effective as fire starters when carefully placed in a good fuel bed, but they sometimes failed to produce satisfactory ignition with the projectiles used in this test. A fuel store consisting of a napalm-type material, when detonated, might produce better fire dispersal. Although the launcher failed to meet all the objectives set forth, this test helped indicate the engineering modifications needed to make the device operational.

EDITOR'S NOTE: *A formal project to develop a projectile launcher system for igniting slash fires was started at the Missoula Equipment Development Center in 1966. A prototype system has been developed under a subsequent contract, and is being tested during the current season. Results of this project will be available at a later date.*

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

OFFICIAL BUSINESS

U. S. DEPARTMENT OF AGRICULTURE
POSTAGE AND FEES PAID

HELITANKER PREVENTION SIGN PROVES VALUABLE

E. F. McNamara, *Chief, Division of Forest Protection*
Pennsylvania Department of Forests and Waters

Since Pennsylvania first used helitankers (in 1960), they have proven to be effective fire prevention tools. The State's entire airtanker program is based on placement of aircraft in areas of high fire occurrence. When helicopters are under contract, there is a marked reduction of fires in areas with a high rate of incendiary fires.

We have long wanted to install a high-visibility sign on the helitanker to identify it as a forest fire control unit. Such a sign would increase the fire prevention effectiveness of aircraft. However, we had to decide what type of sign was needed and how it should be secured to the helitanker.

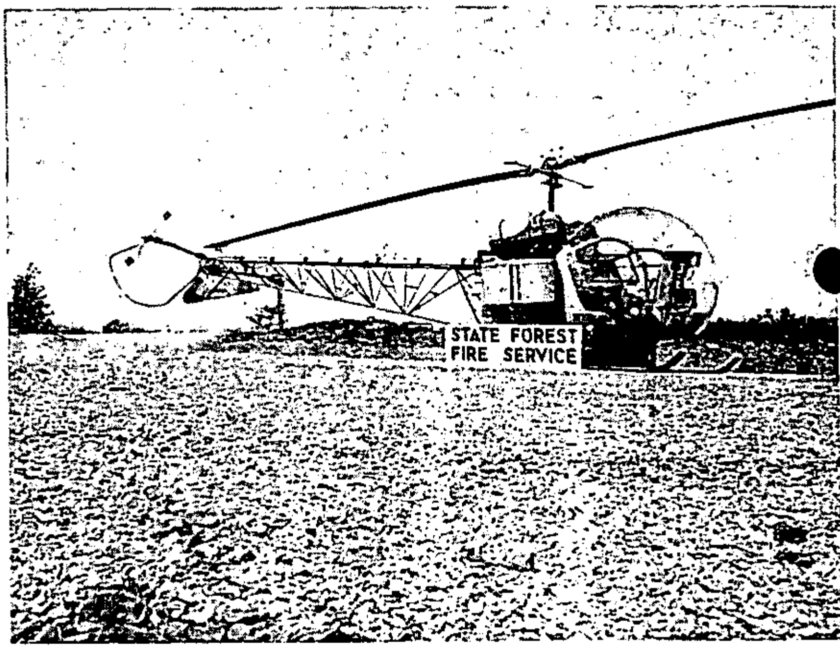


Figure 1.—This helicopter is used in Pennsylvania's fire prevention campaign.

During the 1966 fall fire season we experimented with two signs of 70 by 22 inches painted on ⅛" tempered hardboard. These signs were first painted with fluorescent international orange paint and then lettered with 7-inch black letters. The signs were secured by brackets to the skid cross members on both sides of the helicopter. The installation was approved by the FAA inspector. Both the reaction from the public and the reduction in fires in the test area convinced us that the signs were very effective in reminding people to be careful with fire in or near a forest.

During the 1967 spring season each of five Bell helitankers under contract to the Division of Forest Protection were equipped with two signs (fig. 1). Again all installations were approved by the FAA.

Constant vibration damaged the structure of the hardboard in the original pair of signs. Therefore, the 1967 signs were made of three different materials: ¼" plywood, corrugated vinyl plastic, and aluminum. The three materials will be thoroughly inspected after the 1967 contract period to determine which is the most suitable.