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FIRE CONTROL NOTES

A PERIODICAL DEVOTED TO THE TECHNIQUE OF FOREST FIRE CONTROL

FOREST SERVICE • U. S. DEPARTMENT OF AGRICULTURE

FORESTRY cannot restore the American heritage of natural resources if the appalling wastage by fire continues. This publication will serve as a channel through which creative developments in management and techniques may be communicated to and from every worker in the field of forest fire control.

Volume 20 Number 4

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

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RELIABLE STATISTICS AND FIRE RESEARCH[1]

A. A. BROWN
Director, Division of Forest Fire Research, Forest Service

Since organized fire control began some 50 years ago, considerable evolution has taken place. Progress has been made in organization, in training, in fire control planning, and in fire equipment. However, many of our standards and conventional systems, which grew up along the way and were based on the best we knew at the time, have remained constant while the public service job keeps changing in character and significance. Much of the change is elusive and indirect, but it is real. Every change in living, in economics, and in American habits affects the job in some way. Because of this, we need to take a new look at the assumptions on which some of our standards are based. New progress can be made in fire control through the use of reliable fire statistics.

Much of the research in forest fire control follows the established principle that any process must first be understood before it can be controlled. An example is the research we do on the response of fire to its environment—a big field in itself. Such work points the way to better fire-danger rating and better planning, more skill in anticipating the behavior of wildfires, better techniques in managing prescribed fires, and better training of firefighters. In the same way the discovery of new facts ferreted out of reliable records of our day-to-day experience in fire control operations can point the way to improvements in management, training, methods, and techniques.

FIRE PREVENTION

If our fire records are adequate to tell us how, when, and where fires have started and just how many have been starting, we can plan an effective fire prevention program. How fires start is sometimes hard to determine. Always there is a record, but just how accurate is it? Sometimes our eight conventional causes confuse the true cause. If there are a lot of fires from debris burning, the purpose of the burning will make a lot of difference in what can be done to prevent such fires in the future. For example, fires escaping from town dumps, from summer-home incinerators, from burning tobacco beds, from clearing land, and from burning meadows and uncultivated range and woods, each has a different set of remedies. In drawing up a prevention plan, one should always know which cause was the most important and what class of people it represented. Sometimes our records confuse us on these points. Where considerable burning is practiced in a locality, fires included in the record are sometimes only a part of the total, because of a loose definition of which fires are "wild." If

[1]From a paper presented for C-M 2 Program Review, Feb. 16-18, 1959, Washington, D. C.

you know just what the record means, you can make your efforts count more.

When to expect fires often depends on the cause as much as on the fire danger at the time. Some causes concentrate fire starts during weekends and holidays, or out-of-work hours. Some are tied to the season, some to certain hours of the day. Prevalence of fires in one locality as compared to another sometimes means more hazardous fuels. If our records are good enough to show that, they can be used to guide hazard-reduction programs.

The design of a fire prevention program is only as valid as the fire statistics on which it is based.

FIRE BEHAVIOR

As already stated, basic research on combustion is essential to a full understanding of fire behavior. It can give us answers to why and how much in fire behavior relationships. But basic research in combustion would not be very useful without a record of the experience with fire behavior in the field. This can be obtained only by the agency responsible for the firefighting job. Case studies can be carried out here and there by Research. They serve only as more fully documented samples. Most of what has been learned to date about fire occurrence and rate of spread has come from past records. Such records are still invaluable in relating weather conditions to fire, and the differences in fire control success chargeable to fuels.

At one time an effort was made to study the separate and combined effects of relative humidity, wind, temperature, and fuels on fire behavior through the interpretation of 929 reports. We now know that was expecting too much. Nevertheless, the trends that can be established from fire statistics for a period of years are highly significant. For example, Hornby in Montana and North Idaho, and Show and Kotok in California were able to show that there was a distinct difference in the rate of spread of fires in different fuel types with a consequent difference in success of control, and that different crew sizes and different elapsed times give different success scores. Good records of the more disastrous fires are particularly valuable because they permit analysis of atmospheric conditions and weather records that can help to "red flag" similar situations when they occur.

FIRE CONTROL

Fire statistics serve two important purposes in planning and managing fire control organization. The first is for current administrative use; the second is for longer term planning. Good records are needed for both purposes, but the information needed varies somewhat. For example, if current reports show an unusual number of instances of equipment breakdown or slowness of one suppression crew in getting to fires than the rest, or there are too many fires getting away after they are reported controlled, the manager needs to know this promptly in order to minimize personnel failures through administrative action. In the interest of efficient management, it is highly important that essential information be kept to let the manager know how his organization is doing.

For longer term planning, the answers to many questions cannot be had without drawing on statistics covering the experience of many men over a period of years and of a considerable geographic area. First of all, are fire control objectives up to date? Other questions are as follows:

What is the most efficient crew unit?

How, and how much does the firefighting force need to be increased as fire danger increases?

How does one piece of equipment pay off compared to another?

Are fire crews properly placed?

How close do they need to be spaced?

How effective is the detection system?

What should be the balance between the prevention activity and investments in detection, communication and first attack crews?

How much fire damage are we getting?

Some of these questions cannot be answered from fire statistics alone. The fireman also needs cost records.

A whole new research field known as Operations Analysis or Operations Research has been developed in the last 20 years. It holds a great deal of promise of usefulness to fire control operations through mathematical techniques that are capable of comparing one alternative with another and that can be applied to show the optimum combination to produce a desired result. Much of the research done by Battelle is described as Operations Research. However, this kind of research cannot produce answers that are more accurate than the data available. This is the reason for the strong recommendation that action be taken to collect reliable information that is consistent in its meaning.

The research done in fire control planning is a form of Operations Research. Its principal weakness was the rather crude criteria and techniques on which it was based. Operations Research employs highly refined mathematical techniques and machine methods that can rapidly carry through analyses that were once very tedious and time consuming. It can greatly expand the number of answers obtainable from fire statistics. But again, reliable information must first be available.

FIRE DAMAGE AND FIRE COSTS

The purpose of all fire control activities is to prevent or reduce damage to wild-land resources. Yet our information on the values threatened and the damage done by fires is perhaps the weakest part of our record at the present time. This is a big and complex subject.

The "growth impact" concept of damage to growing stock that was adopted in the Timber Resource Review is the biggest improvement we have made in computing fire damage in many years. For the first time the fact that we are not fighting fire just to protect saw logs is clearly recognized.

The cost of protection is a closely related subject. There is reason to classify costs. Firefighting costs are in a very real sense a damage item. Even more important, cost and return comparisons of a wide variety of alternatives in fire control cannot be made unless reliable cost figures are available.

In the National Forest Fire Reports there is a special block for determination of damages for each fire. This was carefully designed a number of years ago, but it has failed to produce a realistic picture of damages for several reasons. The most important is the lack of recent research comprehensive enough to establish a scale of values and of damages for general acceptance. Some of the reasons are inherent in the arbitrary means taken to convert intangible damages to dollars, and in the dependence placed on fieldmen to apply consistent evaluations. Often, too, damage indexes of 20 years ago are still being used. It is quite possible that we can ask only for a few key items of information from the man making out the fire report, then compute damages as a later step in compilation of the record.

SOME LESSONS FROM PAST EXPERIENCE

I have participated actively in the decisions on what to include and what to omit in National Forest Fire Reports for 30 years, and have watched the results. A few things stand out.

1. Reports need to be designed simply, with the fieldman and machine codes in mind.
2. They should be made out immediately after the fire by someone who was there.
3. There is a definite limit to the reliable information one can expect from the fieldman in a fire report.
4. Data needed for a special study may best be handled as a temporary supplement.
5. There needs to be a special reason and an intended use for each item of information.
6. Arithmetic computations should be eliminated as much as possible in the information requested.
7. But when the necessary information has been decided on, strict accountability for accuracy must be enforced, since whatever degree of inaccuracy is accepted becomes the standard.
8. Both training and followup are necessary to a good reporting system.
9. At best the degree of accuracy of the information on a fire report will vary by items. This needs to be taken into account in statistical analyses.
10. Reporting requirements in fire control activities are to date less exacting than in other forestry activity.

Most administrators are astonished at the facts obtainable through statistical analysis—facts that they had not realized, or had not previously recognized as important. By being completely informed through reliable records of fire business and of the functioning of the fire organization, we can make new progress in fire control.

FOREST FIRE RESEARCH[1]

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The broad title "Forest Fire Research" shown on the agenda for the C-M 2 Program Review originally appeared in the form of two questions: What is Fire Research doing about fire damage appraisals, and what is it doing about resource values? A direct answer to these would be very short, so I will comment on considerations of these two fields of interest.

Fire damage still means different things to different people. For the purposes of the Review, the published glossary definition is probably applicable. It defines fire damage thus: "The loss, expressed in money or other units, caused by fire. Includes all indirect losses, such as reduction in future values produced by the forest area, as well as direct losses of cover, improvements, wildlife, etc., killed or consumed by fire."

This is a rather broad definition. It includes the concept of growth impact on forests by fire. But it is not definite about other indirect losses to be included. This is the area particularly where some guidelines are needed. To establish them, however, it seems necessary to back up to the concept of program justification.

One school of thought holds that damage to timber, for example, is represented by the present value of current and future volume lost. That is, loss of stumpage value, or loss to the owner. Another school of thought is that an important function of public protection against forest fire is to prevent economic loss to dependent industries and communities as well. Such loss is usually expressed in terms of loss of values that would have been produced through labor, transportation, and manufacture. This approach appears more realistic than the first one, if a generally acceptable framework for its application can be developed.

Realistic appraisal of watershed damage can be made only when this latter approach is used. Much more frequently than not in this case, the actual injury to people's monetary or other interests occurs at some distance in both place and time from the fire event, and to people who have no ownership or other direct interest in the property on which the fire occurred.

Use of this concept of direct plus indirect damages is not without precedent in justifying public programs. In flood control work, for example, it has been the practice to use both direct and indirect benefits in computing cost-benefit ratios for watershed as well as downstream programs. It is appropriate to put public protection against fire in the same category.

[1]From a paper presented for C-M 2 Program Review, Feb. 16-18, 1959, Washington, D. C.

Perhaps an even more basic consideration with respect to the concept of program justification has to do with the justification formula itself. The theory of least-cost plus damage to find a justifiable level of protection financing is wholly applicable to an economic enterprise in which all terms are expressed in dollars. But in its application to protection against fire we always come up with an expression like:

$$X = (2 + Y)(3) \\ = 6 + 3Y$$

To get a number for X always requires that we assign a number by judgment to Y, which we call the intangibles.

At present there is no known way to appraise some of these intangible damages. It is not certain that research can ever find a practical way to do it. While the Battelle Institute recognized this limitation, it still found it feasible to estimate the value of Y for the country as a whole. When this is attempted locally, however, as a guide to a particular protection-action program, the system is difficult to apply. Hence, it is not a very useful local fire planning tool.

Perhaps one of the most important obstacles to local application of least-cost plus damage in fire planning is the concentration of the great bulk of damage in a small percentage of fires. By varying local protection effort it is possible to modify the probability of occurrence of a conflagration fire, but the element of chance is so great at the local level that current damages against which to balance protection costs may be highly misleading.

Nevertheless, there is need for systematic ways to appraise the losses suffered from fire. As long as no better system is proposed for establishing national needs, it is highly desirable that the basic records necessary for this be systematized.

If this discussion has appeared to go around in a circle, it has been done purposely to indicate the need for another fire damage measure. The real measure of success of a protection organization is its prevention of potential fire damages. Damage that has already occurred is in a true sense the measure of failure. The two are dissimilar only in that the latter is susceptible to physical measurement and evaluation while potential damage must be estimated.

The fire damage tables now in use in parts of the country are estimating devices. They are necessarily based on averages obtained from study of past fires, and are therefore more appropriate for determining potential damage than for appraising the damage from one particular event.

In brief then, it appears two jobs need doing. First, systematize procedures for appraising actual fire damages; second, perfect and extend to other areas the needed aids and devices for estimating potential damage. Fire research has experience in these fields, but it has very little active work that would be directly helpful. Further work would undoubtedly be quite productive along some lines, although there is little reason to be optimistic in looking for a satisfactory, early solution to the problem of adding tangible and intangible damages.

What about evaluation of forest resources? The situation here is in about the same status as it is in fire damage. Actually, less fire research effort has been devoted to this aspect, but it presents many of the same problems as evaluation of damages.

Only very recently we developed with National-Forest Fire Control a tentative interim resource value scheme that may have general application in fire planning. It is more applicable at the protection-unit level than at either State or national levels, although these could conceivably be added to derive meaningful comparisons between units of any size. Further study and development of this approach may make it useful for C-M 2 program purposes.

This preliminary system results in relative value classes rather than in dollar values. Where appropriate, however, dollars form the basis for establishing class limits. Judgment again was used in defining class limits for those resource values we do not know how to assess in dollar units.

In all, six classes of relative value were recognized. Individual resource values might occur on a given area in any class from the lowest to the highest. Others would not ordinarily be expected to reach the top. Value ratings possible for each of the resources are as follows: timber, 5; soil and water, 6; grazing land, 2; wildlife, 1; recreation, 6; improvements, 6; other, 6.

When the resource value rating is applied to any land area, each resource is recorded. The value class of the area is then defined as the highest individual value rating shown; or if the highest rating appears more than once, the rating is raised to the next highest class unless already in class 6. Guidelines for rating individual resource values have been suggested as follows:

	Value rating
A. *Timber*	
Potential timber loss plus regeneration:	
Over $1,000 per acre	5
$500 - $1,000	4
$201 - $500	3
$ 51 - $200	2
$ 0 - $50	1
B. *Soil and water*	
Areas which, if burned, would likely result in soil and water movement and damage to valuable improvements, such as metropolitan areas, agricultural lands, and irrigation and power installations	6
Municipal and other high-value watersheds where analysis shows damaging siltation, pollution, or critical loss of water use will follow fire	5
Lands listed for value-rating 5, but with stable soils	4
Areas not above valuable improvements or agricultural lands, where soil loss reduces productivity of land	3
Areas which, if burned, would result in adverse changes in seasonal streamflow	2
Low water-producing lands with little flood hazard or damage potential	1
Areas on which fire would have no effect on watershed values	0

	Value rating
C. *Grazing*	
Areas where rehabilitation is required following fire	2
Areas where temporary loss of range will reproduce naturally	1
D. *Wildlife*	
Areas where fire will adversely affect the wildlife habitat	1
E. *Recreation*	
Adequate buffer strips should be included when analyzing value class of recreation areas.	
Recreation areas where the use of the site exceeds 25,000 visits per year and fire would destroy the recreation values	6
Areas dedicated to summer-home sites or where recreation use is between 15,000 and 25,000 visits per year	5
Areas where recreation use is less than 15,000 visits per year	4
Areas where other uses are restricted because of recreation values. Examples are lakeshores and areas planned for future recreation development	3
Areas where other uses are restricted because of scenic values, i.e., roadside zones or wilderness areas	2
Other areas receiving recreation use with other uses unrestricted	1
No recreation use or areas where fire has no effect on recreation values	0
F. *Improvements*	
Major improvements or developed areas within or adjacent to the forest that would be lost by forest fire in the protected area, such as industries, settlements, resorts, residences, and observatories.	
Value of potential improvement loss per acre	
Over $2,000	6
$1,001 - $2,000	5
$ 501 - $1,000	4
$ 201 - $500	3
$ 51 - $200	2
$ 1 - $50	1

G. *Other*

Examples of values to be considered under this item are natural areas having historical values, experimental forests, etc. In rating these areas, use the same schedule as shown for improvements. Values are to be based on investment and cost of replacement per acre.

A PLAN FOR APPLIED FOREST FIRE PREVENTION

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In most forest fire control programs it is assumed that an agency is engaged in fire prevention whenever it conducts an educational and advertising campaign directed at the prevention of fires. These programs consist of the widespread use of such media as posters, leaflets, radio, and newspapers. The aim is general and the application broad. Results are scattered and difficult to assess.

This type of effort is widely used in Pennsylvania, but it is supplemented by specific fire prevention efforts directed at known areas of fire concentration. Such areas are located from past records and then studied to determine cause of fires. Based on cause, plans for eliminating the fires are then prepared and executed.

This method has been used in Pennsylvania for 18 years, and it has produced the results cited later in this article. It is a method that is readily adaptable to most administrative or political units for which tabulated fire statistics are available. It is practical enough to be used by any staff fieldworkers in a fire control organization. Its particular merit lies in the fact that it automatically sets its own target and objective for each successive year without requiring involved calculations or analysis.

Pennsylvania's fire prevention program developed from the obvious need for a better effort to reduce the number of fires and from the observed fact that past efforts were too often misdirected. It was recognized that many of the activities and much of the time and effort of our field units were not geared closely enough on the ground to the areas of greatest actual fire occurrence. The total effort was spread thin over the entire area being administered. Too little effort was being placed on those limited parts of areas where a study of past occurrence indicated the greatest need.

In Pennsylvania, and this is true anywhere, it is difficult to apply details to a unit as large as a State, or to any one of its forest districts, or even its counties. Nearly every State has one or both of these subdivisions. In most there is a further subdivision of county into town, township, or parish. These basic units have a size, shape, terrain, and habitation character that are readily grasped. Their roads, streams, topography, and people provide a local basis on which a fire prevention man can establish his personal knowledge and relationship.

Pennsylvania's forest fires are tabulated by the township in which they occur. The high township in each administrative unit automatically becomes the target for attention during the next year. Since a single year's occurrence may not be indicative of actual conditions, chronic fire problems are recognized by taking 5-year averages. This may set up additional township targets.

Thus, designated townships become the center for a concentrated fire prevention effort. A careful study of the fire reports for each township for 1 or 5 or more years may indicate an outstanding cause or causes. It gives an indication of factors such as time, place, elements, and local conditions. Based on this study, a plan of action is devised that is directed at the elimination of each cause of fire in a unit.

Into such a plan, the fire control man can weave all sorts of "gimmicks" and "gadgets." Personal contact, group contacts, house-by-house canvass, posters, telephone roundups, tags, stuffers, post cards, movies, radio, letters, and all the other media for reaching people can be used with near saturation effectiveness. In a limited unit like a township, the study of a single fire can often reveal specific cures that would be useless for larger areas.

The focusing of attention on problem townships has the added advantage of helping field personnel to recognize the development of local fire problems at an early date, and it keeps their attention centered on chronic problem townships.

That this program has been effective in Pennsylvania can be seen from the results obtained in a few of its original 52 problem townships. For the period 1936–40, Hazle Township, the State's worst, averaged 99 reported fires per year. It became the main target for a prevention campaign. As a result of these efforts, its 5-year averages ran as follows: 1941–45, 52 fires; 1946–50, 5 fires; 1951–55, 6 fires. Mt. Carmel Township recorded an average of 63 fires per year during the 1936–40 period. In the three following 5-year periods, this average dropped to 12, then to 5, and finally to 2.

The 52 original townships to receive attention at the State level reported an average of 1,156 fires per year during the period 1936–40. These fires accounted for 35 percent of the State total. For the next 5-year period, their percentage of the State's total fire load dropped to 30 percent, then to 20 percent for the last two 5-year periods.

Until recently, major efforts have been concentrated on the 52 townships. As the number of fires in these problem townships dropped, the townships approached, even fell below, the general level of formerly low-average townships. Meanwhile there were no new townships to show up with a 5-year average of 10 or more fires per year, the level at which they would be classed as "problems."

In view of the achievements of the program and the obvious advantages of the township approach to fire prevention, the Division of Forest Protection broadened the base of the program by setting two new standards for determining problem townships.

1. The 5-year average figure of 10 fires per year was lowered to 5 per year over a 5-year period.

2. The high-fire township in each administrative unit for any given year was designated as a special problem for fire prevention effort for the following year.

This reappraisal and adjustment of goals served to advance the fire prevention effort from an administrative district campaign to a statewide campaign. Under the original campaign, several administrative districts had not been working on specific goals because they had no townships with a 5-year average of 10 or more fires. Under the new twofold target system, every district has at least one problem township—its last year high-occurrence unit. Most districts have in addition at least one "five or more" township to serve as a long-range prevention effort. There is no question that adherence to a planned program of this nature over a period of time will result in a progressive reduction in fire occurrence.

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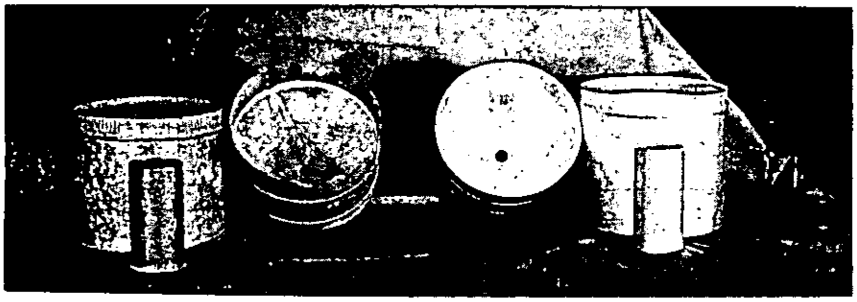
Aluminum Rain Gage and Plastic Measuring Stick For Fire-Weather Stations

Recent advances in metal fabrication and plastics have given us an aluminum rain gage and a plastic (Lamicoid) measuring stick. Advantages of the aluminum over the galvanized iron gage: (1) It is seamless and will not leak even after water freezes in it; (2) it will not corrode or rust. Advantages of the plastic over the gumwood stick: (1) Water will not creep up the stick by capillary action; (2) does not absorb water; (3) is more dimensionally stable; (4) stick and markings are more durable; (5) can be washed.



The gage has been field tested for 3 years at the Priest Lake Experimental Forest (northern Idaho) and is satisfactory in all respects. It was calibrated by the U. S. Weather Bureau and is accurate enough for fire-danger rating purposes. The Weather Bureau has used the plastic measuring stick since 1956. These items will be stocked at Federal Supply Service depots.—DIVISION OF FOREST FIRE RESEARCH, *Intermountain Forest and Range Experiment Station.*

WIND INDICATORS FOR USE WITH HELICOPTERS

Missoula Equipment Development Center, U. S. Forest Service

Forest helicopter pilots use natural helispots that are usually located in back-country areas where there are rarely wind socks or wind indicators of any kind. Knowledge of wind currents, their direction and intensity, enables a pilot to land in small spots with a greater margin of safety.

Participants at the 1959 Smokejumper Workshop recommended that the Forest Service furnish pilots some type of wind indicator for use at helispots where wind socks are not provided. Because of previous experience with wind drift indicators (Fire Control Notes, October 1952) the Missoula Equipment Development Center was assigned the job.

A wind indicator has been developed that can be carried in the helicopter and thrown out over a proposed landing spot to serve as a wind sock after its contact with the ground. The streamer-type indicator gives accurate wind direction and indicates wind intensity by its degree of movement. The streamer consists of a piece of lightweight colored paper (bright orange is best for visibility against most forest backgrounds), taped endwise to a piece of black crepe paper of the same size. About 12 inches of the free end of the black paper are rolled around a 3½-inch length of No. 9 galvanized wire and taped in place to form a weighted end (fig. 1). The streamer is folded and stored under the 'copter's seat cushion. A dozen or two can be carried in this manner with no appreciable increase in weight or bulk.

While in the air above the proposed landing site, the pilot throws out a streamer and continues his flight pattern so as to observe the streamer. The weighted end unwraps the streamer during the first few feet of descent (fig. 2). After the streamer reaches the ground, surface winds blow the colored free end away from the anchored black end. The black section identifies the weighted end which always points into the wind. If wind is absent or negligible, the streamer will fall in a heap. If gusts occur, the streamer will lay out and gyrate according to wind intensity. On sharp ridges during high winds, it may be necessary to throw more than one streamer to hit a proposed landing site. The difficulty encountered in hitting the proposed site is, to some extent, a measure of wind velocity and turbulence.

A few years ago we investigated and tested several types of helispot wind indicators. Incendiary smoke candles were considered too hazardous for use in aircraft and forested areas. Sealed glass jars containing nonflammable liquid smoke (titanium tetrachloride) were thrown from the 'copter to break upon impact and create a smoke column. To ensure positive breakage, heavy steel ball-bearings were enclosed in the jar. The glass jar containers were rather heavy and bulky (about 1 pound each) and did not stow readily within the pilot's reach. The liquid smoke gave

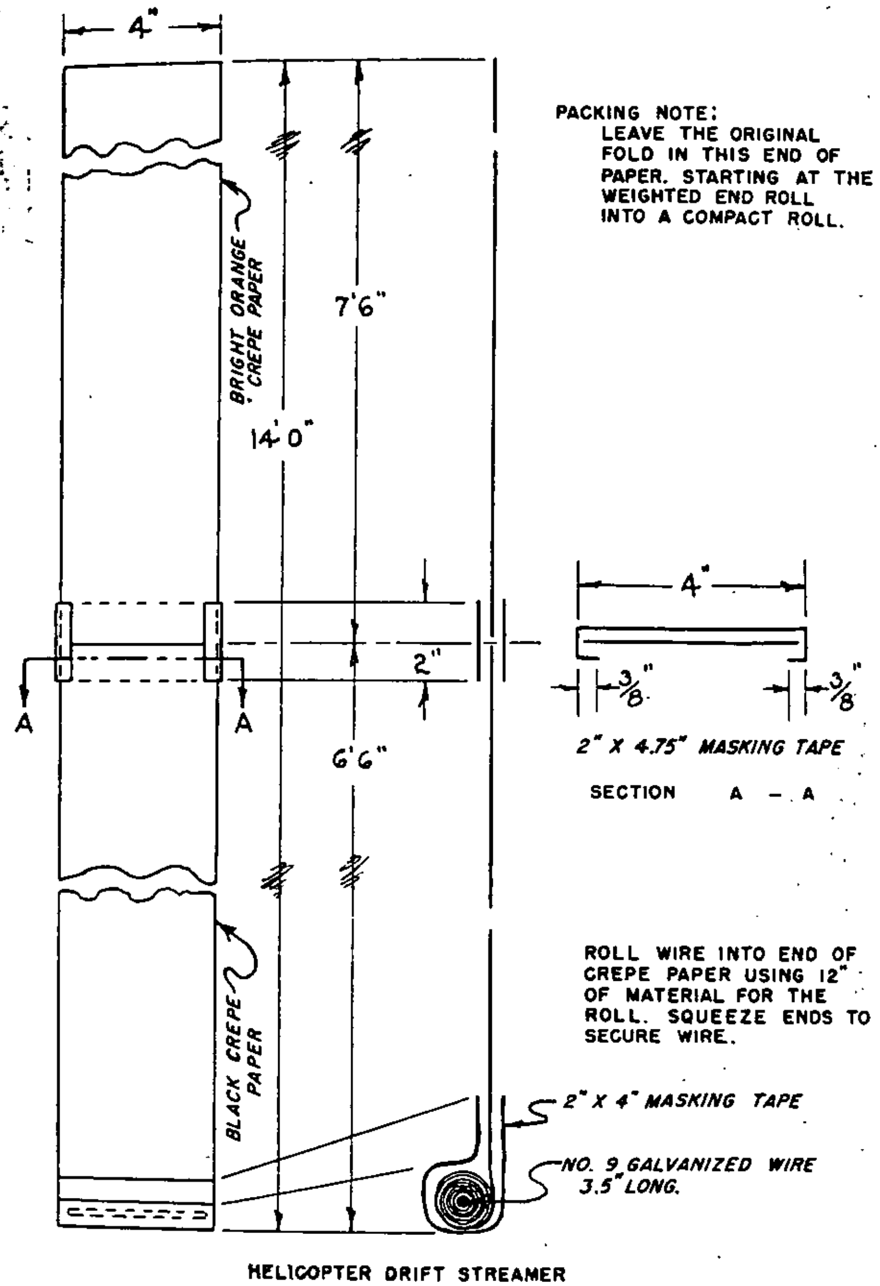


FIGURE 1.—Helicopter drift streamer (drawing ED-185-R1, July 59).

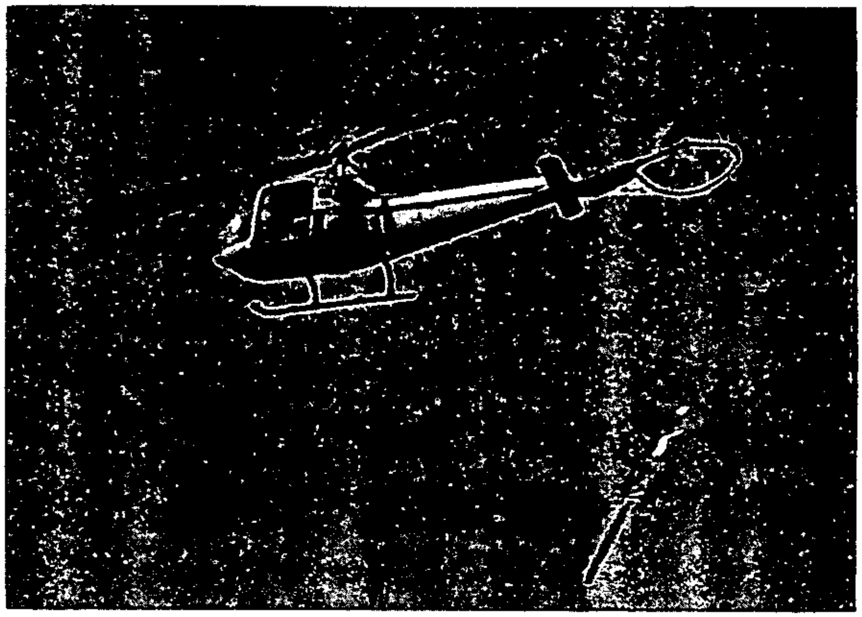


FIGURE 2.—Pilot throws drift streamer out above helispot and circles to observe wind.

excellent indications of wind movement but the method was abandoned because of several problems encountered in handling and packaging the corrosive liquid. Commercial container firms informed us that a satisfactory release container (pressure type, among others) would be extremely difficult to build and then only at prohibitive cost. Recent developments in pressure containers and smoke-producing chemicals will be investigated this year.

The helicopter drift streamer is inexpensive and easy to make. Crepe paper folds 7½ feet long and 20 inches wide can be purchased from most paper suppliers, cut to a 4-inch width, taped and weighted with wire to form a streamer which is easy to observe from low-level flight. Lightweight crepe paper is available in rolls of varied length in widths up to 2½ inches; however, flight tests showed that widths less than 4 inches are difficult to observe during descent.

The streamer shown has a rate of descent of approximately 16 feet per second. Rate of descent, to meet a particular requirement, can be adjusted by changing the amount of wire ballast.

WETTING AGENTS FOR GROUND FIRE MOPUP[1]

Division of Forestry

North Carolina Department of Conservation and Development

Large areas of the forest land in the Coastal Plain of North Carolina have organic soils. During extended droughts, the water table drops and any burning of surface fuels ignites the soil itself. This ground fire is extremely difficult to extinguish because organic soils, particularly peat, do not absorb water readily. No practical method of ground fire mopup is known. These fires often burn to a considerable depth and smolder for several weeks, resulting in a hot fire line until heavy rainfall raises the water level to produce a saturation from below.

To determine the effectiveness of wetting agents added to water in extinguishing ground fire a test was made. Two commercial wetting agents were to be tried and compared, and their effect on pumper equipment determined. The fire fighting procedure followed was a standard one for ground fire mopup. A portable centrifugal pump supplied a nozzleman with water through 1½-inch linen hose. A shovelman dug the hotter spots and puddled the mixture of soil and water.

Two such crews, one applying wet water and the other plain water as a control, used identical portable centrifugal pumps. The men were switched at frequent intervals. The wetting agent was mixed in an open, 1,000-gallon, calibrated steel tank, from which the wet water was pumped directly. The plain water came from an 850-gallon tanker truck.

The selected area, recently burned over as a result of agricultural cleanup, was open brush type, containing ground fire. Aerial fuels were largely consumed by the surface fire. The soil was deep peat, well drained by an adjacent canal. At the beginning of the test the water table was at a depth of 39 inches both inside and outside the burned area. The average depth of ground fire was 18 inches.

To compare the efficiency of the wet water and plain water, two adjacent areas were selected. Each crew was instructed to extinguish all ground fire as they went along. Both crews were stopped after an equal amount had been pumped through each unit. The area of ground fire extinguished was then measured, with the results as follows:

	Water pumped (gallons)	*Pumping time (minutes)*	*Area extinguished (sq. ft.)*
Test No. 1:			
Plain water	2,550	74	1,672
Brand "A"	2,550	[1] 80	3,001
Test No. 2:			
Plain water	750	21	900
Brand "B"	750	[2] 24	1,332

[1]Longer hose.
[2]Pump leaking.

[1]From a progress report on an operational development project in the organic soils forest fire research and development program; F. H. Claridge, State Forester and Project Coordinator; W. B. Flanner, Jr., Project Supervisor.

At the conclusion of the pumping, both areas were equal with regard to the appearance of smoke and steam. The areas treated with wet water were noticeably wetter on the surface, indicating a more thorough saturation. Except for a foam on the surface of the area treated with Brand "B" the areas treated by the two chemicals appeared similar.

Actual chemical concentrations of the wetting agents were unknown since both were distributed under trade names with no analysis of contents, but the mixtures were based on manufacturer's recommendations.

Brand "A" in a concentration of one part to 1,700 parts of water was 79 percent more efficient than plain water in mopping up ground fire, as determined by ground area of fire extinguished. Brand "B" in a concentration of one part to 64 parts of water, was 47 percent more efficient than plain water. The Brand "B" solution at 5 cents a gallon was more than eight times as expensive as Brand "A" which cost 0.6 cent.

At the end of 15 hours, the Brand "A" area had one small spot smoking and this was located where it could have been missed by the nozzleman. Only one small spot of dry ashes was found while digging with a shovel. The rest of the area was moist down to the water level, and the surface was boggy. In contrast, the plain water area had six places still burning and showed dry turf and ashes scattered throughout. In addition to the live fire, heat and steam were in evidence when the soil was turned up with a shovel. Because of rain it was impossible to make a similar observation on the Brand "B" area.

At the conclusion of the pumping, the water level in the burn had risen from 39 to 37 inches. Fifteen hours later the water level was 35 inches. The water table in the unburned area remained constant at 39 inches throughout the test period. The measurement of the water table in the burn was made between the wet and plain water areas.

At the completion of the test, the pumps were taken down and examined for possible damage. Those used had a porcelain seal on the impeller shaft. After one hour of pumping, the pump used for wet water was leaking badly through this seal. By the end of the test period, its efficiency was seriously impaired. However, no physical damage was noted.

At a later date Brand "A" was used in the suppression of a going ground fire in the Coastal Plain of North Carolina. The area was practically identical to that used in the test, being open brush type with aerial fuels largely consumed by the surface fire. It was well drained by an adjacent ditch and the average depth of the ground fire was 6 to 8 inches. Several days of intensive mopup using conventional methods had failed to extinguish the ground fire.

For mixing purposes the 1,000-gallon calibrated steel tank was again used. Plain water was pumped from a canal into the tank and the wetting agent was then added at a concentration of one part to 3,600 parts of water, about one-half that used in the test. Two portable centrifugal pumps, which were a different make to eliminate the porcelain seals, brought the mixed water from the tank to the fire through 1½-inch linen hose. The third shovelman was not used. Instead, the nozzlemen were instructed to thoroughly wet the surface of the ground as they moved along. At the end of 8 hours, 16,200 gallons had been pumped; a total of 6 acres had been wet down, and the pumps were stopped.

At this time steam could be seen rising from numerous places in the area but no smoke was observed. No smoke or fire could be found during the next 3 days when the entire area was checked each day.

Cost of the wetting agent only for the 6-acre fire was $43.20 or $7.20 an acre (0.27 cent per gallon). This does not include labor but the mixing operation is simple and labor costs are not appreciably higher than those of a similar operation using plain water.

The pumps operated efficiently throughout the operation and no mechanical damage to them was detected upon later examination.

Despite the lack of confirming data, it can be concluded that (1) the use of wet water greatly increases the effectiveness of ground fire mopup with portable pumps; (2) wet water produces lasting results which tend to retard the re-entry of live fire into the treated area; (3) special pumping equipment may be required for the operational use of wet water, but further trial of conventional equipment should solve some of the problems; and (4) the operational use of Brand "A" for ground fire mopup appears to be effective and economical.

A continuation of this type of testing with the same and other wetting agents is planned when ground burning conditions become available again. The actual chemical concentrations of the various wetting agents will be analyzed and both laboratory and field studies made to determine proper concentrations for various field applications. A study into the use of injectors or eductors to proportion the wetting agents into the discharge hose from the pump has been started. This would eliminate any possible harmful effect on the pump, eliminate the use of a mixing tank, and generally simplify the operation.

WEAR REDUCTION IN GEAR PUMPS

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Rotary gear pumps are widely used in fighting forest fires though prone to wear by water containing suspended solid material such as clay or sand. Examples may be cited where pumps have become useless after as little as 10 hours pumping from earthen dams or streams. According to the forestry organizations of Australia one particular unit, a portable Y pumper, was typical. This pumper is a self-contained combination of pump and power unit rated to deliver 50 Imperial gallons per minute at 125 p.s.i.

Filters of satisfactory size seriously restricted the pump suction and were found to lead to cavitation characterized by rapid pump wear and a loss of developed pressure with increasing speed. Centrifugal separators (hydrocyclones) restricted flow less than filters and were found to be very effective when placed in the suction, provided the sludge outlet led to a closed vessel which was emptied periodically. However, these units, though light, appeared too bulky for the usual portable pumps.

Since to clarify the water seemed impracticable, the pumper under test was modified to improve its wear resistance and to facilitate repair. The pumping gears were fitted with replaceable rubber inserts to combine the mechanical strength of the metal gears with the excellent abrasion resistance of rubber (fig. 1).

The slot for the insert is 0.100 inch wide, the hole 0.234 inch in diameter, and the molded insert is approximately 0.015 inch larger in each dimension. Inserts may be fitted into worn pumps without having to face the casing. The inserts are molded longer than required and are slid into position while being stretched lengthwise. Glycerine may be used as a lubricant. The inserts are then roughly trimmed to size and hammered to ensure a close fit in the hole. The excess rubber is ground off on a sanding machine leaving about 0.010-0.015 inch protruding from all faces of the gear. When assembled, the pump is tight because of the oversize inserts which, however, wear in time to give a satisfactory clearance fit. When inserts are finally worn out they may be easily removed with a coarse (16 point per inch) saw and replaced with new ones.

For the first series of experiments to test the modification, a "dirty" water was prepared to simulate that found under most field conditions. The water contained 0.15 percent by weight of a ground rock, the sieve analysis of which was as follows: Greater than 100 Tyler mesh, 1 percent; 100-200 Tyler mesh, 0.5 percent; 200-300 Tyler mesh, 0.5 percent; less than 300 Tyler mesh, 98 percent.

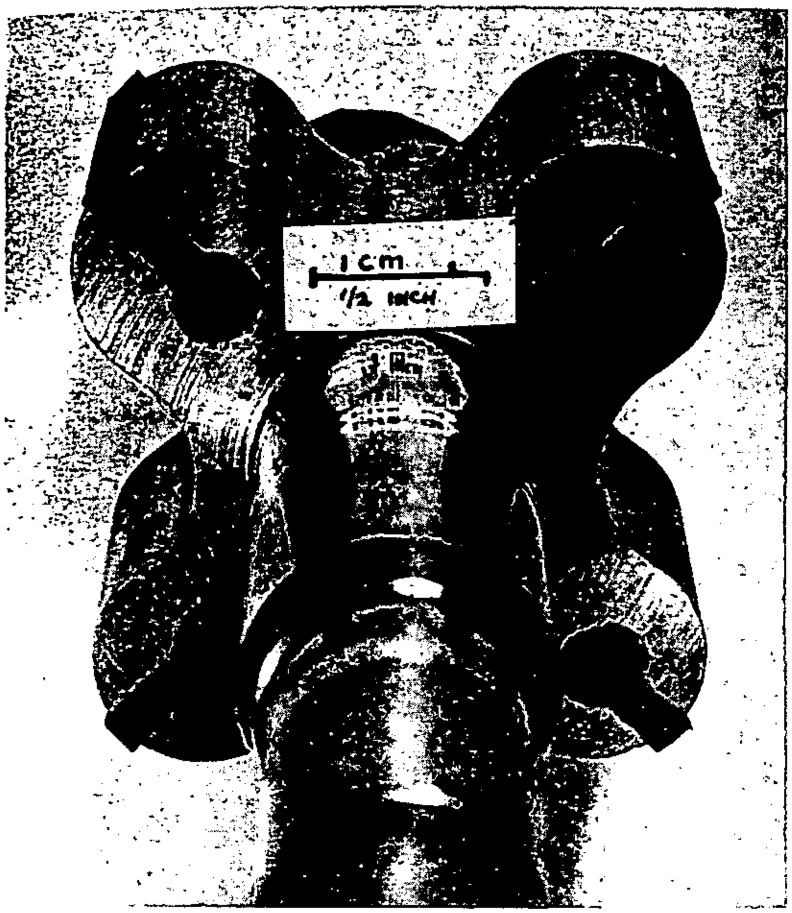

FIGURE 1.—Gear lobes fitted with inserts.

The prepared water was recirculated by the pumper from a 40-gallon container which was flushed out and refilled after every million pump revolutions. Pressure developed against a 3/8-inch nozzle with high and low speed operation dropped rapidly for the bronze gears usually used (fig. 2). After 4 million revolutions the pump was classed as useless not only because of the reduced pressure developed but also because it was slow to prime. The tips and faces of the brass were worn by 0.005-0.010 inch with deep grooving. The aluminum casing was worn by 0.002-0.004 inch and held imbedded pieces of metal and agglomerates of ore.

Natural rubber and neoprene inserts (each of 60-65 Shore hardness) were then fitted into opposite lobes of each gear and the pump retested. Even after pumping three times as long as the unmodified gears, the pump could still not be classed as useless (fig. 2). After this use, the rubber inserts had broken down, possibly in part from grease entering through the pump glands and the oil used in startup; however, the neoprene inserts were in good condition and were probably doing most of the pumping (fig. 3). During the test, the temperature of the water varied between 60° and 140° F. without any apparent effect on the insert wearing properties. The aluminum casing was highly polished and wear was only about one-third of that produced by unmodified gears. No wear was detected on the gears themselves.

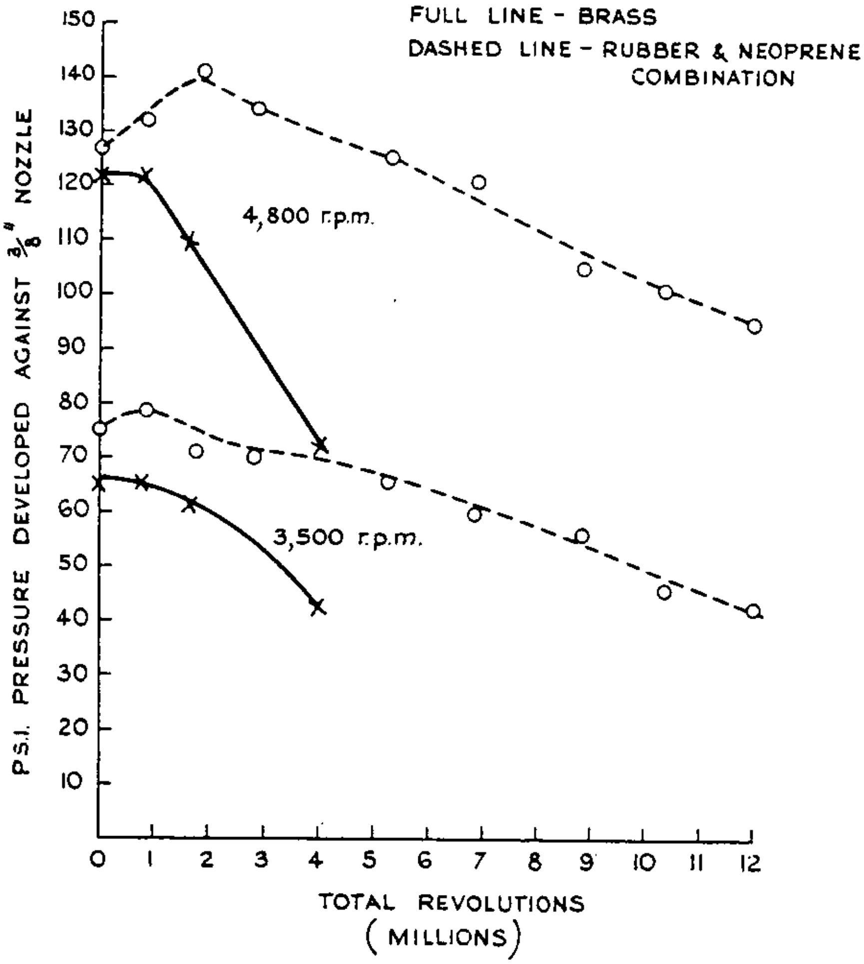

FIGURE 2.—Loss of pressure with use for gears with and without inserts.

For the second series of experiments, coarse particles (0.1 percent of 6-10 mesh) were added to the dirty water used previously to simulate conditions prevailing when water is pumped from the bottom of streams or dams. This suspension broke off the rubber tips and deeply scored the casing to make the pump useless after only one million revolutions.

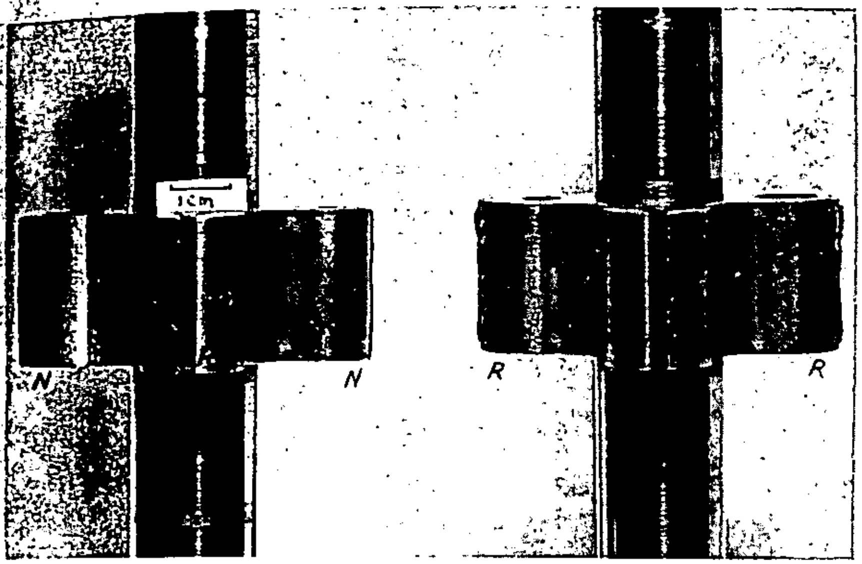

FIGURE 3.—Gears with neoprene (N) and rubber (R) inserts after 12 million revolutions.

To conclude, it could be expected that the life of gear pumps required to handle "dirty" water drawn from the surface of storages can be increased by a factor of at least five if fitted with neoprene inserts. Repair is greatly facilitated by the use of inserts and the pressure developed and the output will, for a considerable time, exceed that for new unmodified gears.

BELT WEATHER KIT

DIVISION OF FOREST FIRE RESEARCH
Intermountain Forest and Range Experiment Station

The belt weather kit is designed primarily to provide a means for measuring wind speed and relative humidity anywhere near a forest fire. It is compact and easily carried on the belt. While it is designed for use on forest fires, the kit can also be used on forest spray projects, aerial reseeding, and other activities where similar weather measurements are needed.

Initial work on a standard "take it with you" weather kit began in the spring of 1957. Instruments and equipment planned for inclusion in this kit were a sling psychrometer, extra wicking, psychrometric slide rule, plastic water bottle, plastic venturi action wind meter, notebook, and pencil. The contents of the kit have remained essentially the same during development but the design of the container has undergone major changes.

The original container was simply a 5- by 8-inch expanding card file envelope. However, the need for a more durable kit that could be carried on a belt led to the design and preparation of more substantial containers. Several prototypes were tested to determine the best material and pocket arrangement (fig. 1). One kit also included a compass.

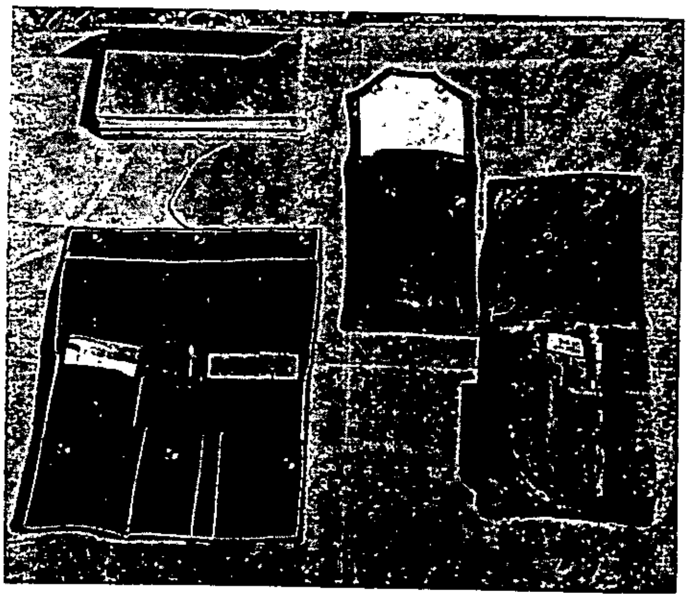

FIGURE 1.—*Upper left,* original paper kit; *center,* green leatherette kit; *lower left,* red canvas kit; *lower right,* final kit.

Twenty-two of the leatherette kits and several of the red canvas design were distributed to interested field people for trial use and appraisal. In summary they recommended adopting the narrower design, eliminating the compass, using red canvas, and making compartments as in the red canvas kit.

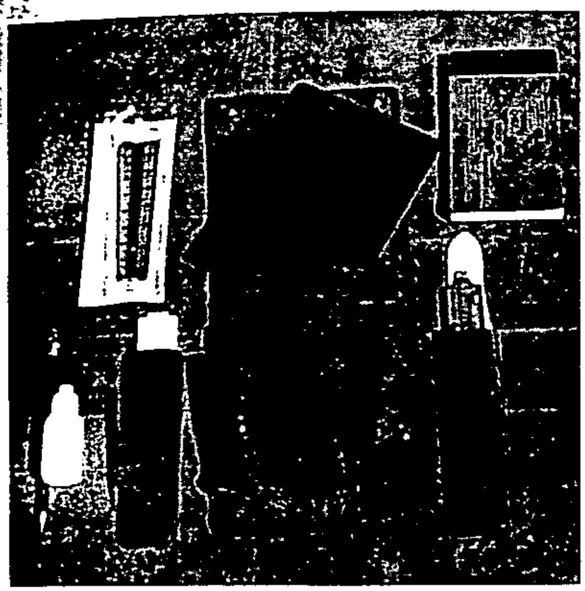

FIGURE 2.—Final model belt weather kit and contents:

1. Combination ⅛-inch hardboard writing board and protective backing.
2. Plastic, pressure-venturi action floating-ball type wind meter.
3. Psychrometric slide rule.
4. A 3⅝- by 6½-inch notebook, plus space for maps, extra notes, etc.
5. One-ounce oval-shaped plastic water bottle.
6. Two pencils.
7. Sling psychrometer.

The final belt weather kit, made of a double layer of 10-ounce red sailcloth, measures 2 by 6½ by 9 inches and contains 7 pockets (fig. 2). Two large belt loops are provided on the back of the kit so it may be easily carried on a belt. Two snap fasteners keep the flap closed to prevent loss of contents while going through brush or bending over. (*Editor's Note:* Forest Service specifications for the kit and contents are being prepared. The kit and contents should be available from GSA this winter.)

A FUSION PYROMETER TO MEASURE SOIL TEMPERATURES DURING WILDLAND FIRES[1]

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and J. R. BENTLEY, *Range Conservationist*
Pacific Southwest Forest and Range Experiment Station[2]

Grass, brush, and forest fires subject the upper inches of soil to intense heat for short intervals. This heat causes significant physical, chemical, and biological changes in the soil, litter, and vegetation. A measure of heat in the upper soil helps to explain plant succession and soil condition associated with fire. Combustion occurring on the entire burned area influences heat transfer at any particular point through conduction, convection, and radiation. Consequently, temperature data from small fires or from the perimeter of large fires fail to represent conditions at specific points within large burns. Measuring fire temperatures within a large burn is normally a difficult and expensive task.

A simple, inexpensive instrument that will provide such measurements was used successfully in 1952 by the authors to measure soil temperatures associated with recognizable postfire soil surface conditions. This pyrometer can be further developed and adapted to different uses to provide better understanding of the heat input variables during burning and the associated effects on soil and vegetation.

Fusion pyrometers depend on the melting point of specific chemical compounds to indicate maximum temperature reached in the surrounding medium. Melting points of pure compounds are very precise, and compounds are available commercially in the range of 113° to 2,000° F. Pyrometric or Seegar cones used in ceramic firing are not discussed here as they respond to temperature and time periods which are normally higher than those in which we are interested. Fusible plugs have been used to measure temperatures in oil wells.

H. C. W. Beadle (1940), in Australia, buried small pill boxes at depths of 1 to 15 inches in the soil beneath wildland fires. Each box contained glass vials of chemicals which melted at different temperatures, giving him the maximum temperature reached at each depth.

Another method tested consists of inserting continuous strips of different fusible compounds vertically into the soil. Melting temperatures of the compounds varied from 150° up to 1,200° F.

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[1]Condensed from "A Simple Pyrometer for Measuring Soil Temperatures During Wildland Fires."

[2]Maintained at Berkeley, Calif., by the Forest Service, U. S. Department of Agriculture, in cooperation with the University of California.

After the fire the depth to which a strip melted indicated the deepest penetration of the particular temperature front associated with the melting point of that chemical. The technique is not a substitute for other methods. But it provides a simple, low-cost, automatic heat-sensing instrument to supplement other devices used in investigation of wildland fires.

The fusible compounds are pure organic chemicals dissolved in a volatile solvent. While in a liquid state the solution is painted or printed on a mica plate in parallel strips about 1/10 inch wide. When the solvent evaporates, strips of crystalline solid remain. The melting points of the chemicals used in the original instrument, in ° F., were 150, 200, 250, 350, 450, 550, 650, 750, 950, and 1,150.

The fusible strip with the highest melting temperature is placed along the left edge of the mica sheet and those with progressively lower melting temperatures towards the right. The plate is then faced with a sheet of asbestos paper 1/32 inch thick. The asbestos serves to protect the chemicals, support the fragile mica, and absorb the chemicals when they melt.

Since the pyrometer plate provides temperature measurements at a particular point, locating the pyrometer stations to sample field conditions is important. A system of stratified sampling was used. Random or systematic sampling might be more useful under certain conditions. Adequate observational records should be taken at the pyrometer locations so that the prefire conditions may be considered in later analyses. Records of the fuel and air conditions at the time of the burn are also important.

Records from the various pyrometer stations can be combined and plotted to provide average or characteristic curves for particular conditions. We found that prefire fuel stratification resulted in a characteristic curve for each class.

The pyrometer can be filed as a permanent record and is a source of basic data from which several types of heat measurements may be taken. The records can supplement those taken by thermocouples or thermometers.

AUTOMATIC PUMP CUTOUT

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Some types of self-contained pumps used for rural fire fighting are cooled and speed regulated by the water they deliver. Consequently, if the delivery pressure falls below a safe minimum as will happen when a hose bursts or the water supply is cut off, the driving motor will overspeed and overheat resulting in mechanical failure. Two types of automatic motor cutouts have been devised to obviate this possibility by shorting out the low tension power of the electrical ignition system and so prevent the sparkplugs from operating.

The first cutout is a micro-switch held onto the pump delivery hose by a flexible metal band (figs. 1 and 2). When the hose is inflated by water under pressure in excess of the safe minimum, it compresses a spring and forces a rubber buffer to open the switch points. Should the pressure drop, the spring flattens the hose allowing the buffer to move away from the switch, which closes and stops the motor.

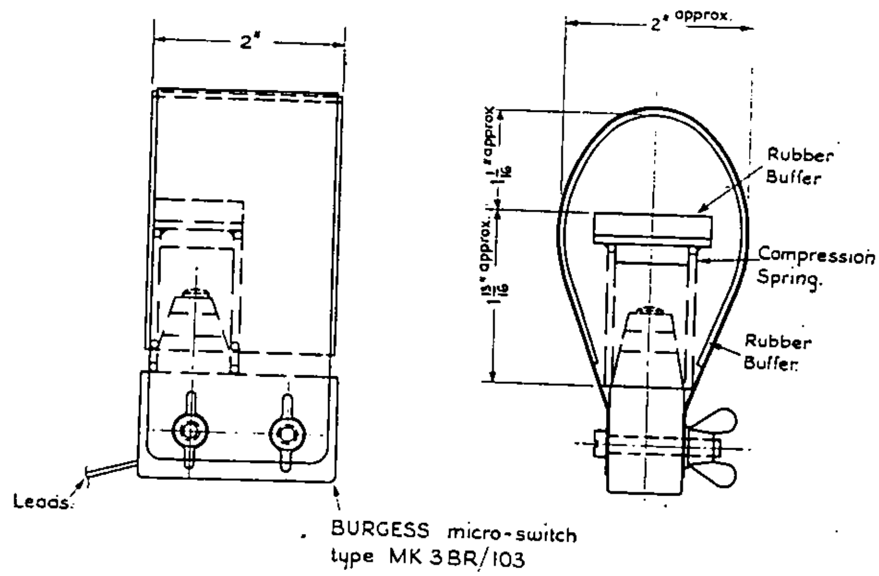

FIGURE 1.—Automatic pump cutout. Further details may be obtained from Chemical Research Laboratories, Division of Physical Chemistry, drawing S-548.

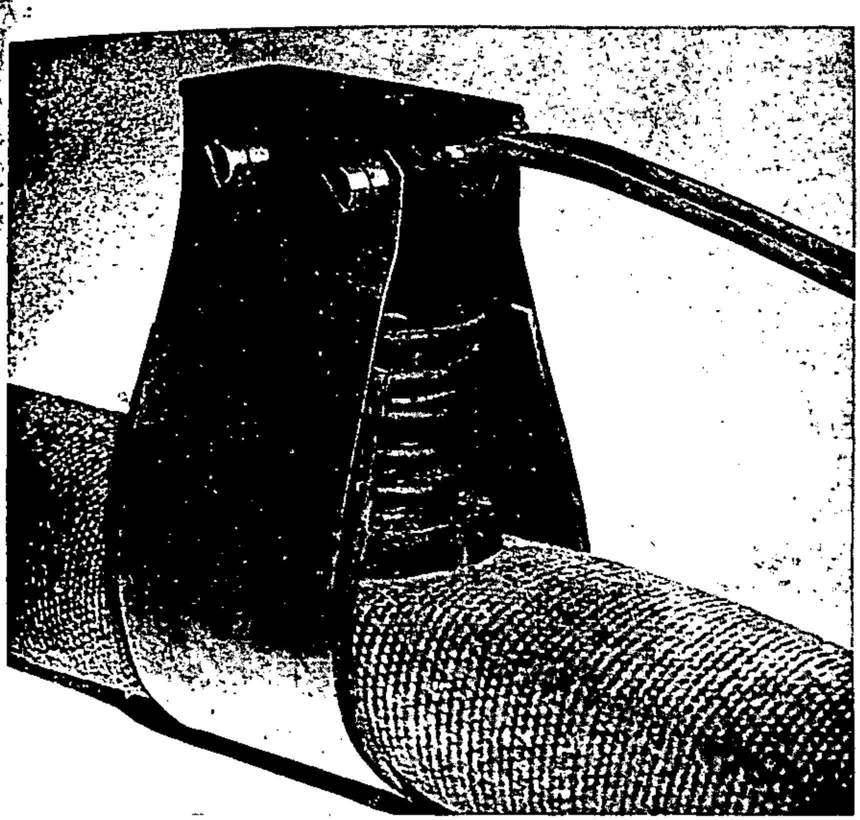

FIGURE 2.—Automatic pump cutout in place.

The second cutout is an oil pressure tell-tale switch, as used frequently on automobiles, mounted onto the output of the pump. A special part (No. 1504807) for an Australian car has been found satisfactory since it is compact and robust and its operating pressure is adjustable.

With both types, it is necessary to install a switch to disconnect the leads between the cutout and ignition system so that the motor may be started. In the case of multicylinder motors, the ignition system may usually be modified to be operated by a single cutout device, but if the wiring is inaccessible then a separate one must be installed for each cylinder.

REMOTE INDICATING AIRCRAFT COMPASS HELPS FIND SMALL FIRES

CLARENCE S. SINCLAIR
District Ranger, Lincoln National Forest

During the 1958 and 1959 fire seasons, contract pilot Ralph Brown and Jim McEuen, Forest Service aerial observer, Ruidoso District, Lincoln National Forest, have been pioneering the use of a new device that will help ground crews locate small fires in the back country.

This device is called a "remote indicating compass." It is available at aircraft supply stores and can be installed in light planes. It is not affected by local magnetic fields, and declination can be set off. It will not drift and require frequent resetting as is the case with gyro compasses. Initial cost is about $70 or less depending on the make of the compass. Readings can be made to an accuracy of one degree.

The pilot usually lines up the fire with a well-known and readily identifiable landmark (landmark should be one shown on map), which may be a lookout tower, triangulation point, road intersection, farm house, etc. He then flies a steady course directly over the fire and toward the landmark and takes a reading from the compass. The observer then gives the reading to the ground crews. Usually it is best to convert this backsight to a foresight by adding or subtracting 180° before relaying it to ground crews. This eliminates confusion and enables them to plot the fire on their maps by the use of a protractor. Ground crew effectiveness is greatly enhanced in finding small fires if they make full use of hand compasses, protractors, and maps in working with the aircraft. We have found the system is valuable to the extent that we are marking our triangulation points with painted structures to increase their visibility.

The remote indicating compass is valuable for several reasons.

1. Many smokes while small are invisible to a fixed lookout if they are a considerable distance away even when not in blind areas.
2. There are always some blind areas behind ridges that the lookouts cannot see but because of the increased altitude of the aircraft these same lookouts can still be used as reference points.
3. It is not necessary to use lookouts as reference points; almost any prominent feature that can be located on existing maps, pinpointed, and identified can be used.
4. Augmenting a single lookout bearing with another reading from a known point can fix a fire location by the cross reading method.

There are some disadvantages present in the system but they are not highly critical except in rare cases.

1. In extremely rough air and cross winds it is difficult to get a very accurate reading.
2. In very steep, rough terrain it is somewhat difficult for the pilot to line up smokes with landmarks accurately because of the difference in elevation of the various points. The device works best in more or less flat or rolling terrain.
3. It takes a trained pilot to hold a straight, accurate course.
4. Considerable skill is required to install the compass and get it oriented properly.
5. It is said that rough landings might damage the compass badly. Contract pilot Ralph Brown has kept one in use over a year and has had no difficulty with it.

Although it was originally designed solely as a navigational aid for cross country flying, by and large the remote indicating compass has proved a very useful tool in fire control work.

☆ ☆ ☆

Portable Powered Tool Sharpener

This sharpener, developed primarily for 200-man fire camps, uses a lightweight low-cost four-cycle air-cooled gasoline engine with a built-in generator to provide light for night work. A grinding disk is mounted horizontally on a vertical shaft.

The tool sharpener is reliable and easy to start and operate, and has a throttle control to regulate the grinding speed. The grinder alone weighs 70 pounds. The complete unit, box and accessories, packaged for air-drop, weighs 125 pounds. It is small, slightly less than a 2-foot cube, and rugged enough for delivery by parachute, helicopter, truck, mule, or man-pack.

A time study with average dull tools showed the new model to be superior to other fire-camp grinders used in Region 1. Tools can be sharpened faster since they can be held at any angle. Tools need not be clamped in place for grinding as is the case with other portable grinders. Wing nuts and bolts are used to secure the grinder to the box which serves as a work bench. A tool gage board is included to aid in determining the grinding and reconditioning limits for badly worn or heavily nicked blades.

Field tests have shown this grinder to be reliable and economical. It fulfills a long-standing need for a grinder to be used in back-country stations or fire camps. (More detailed information is available in *Tool Sharpeners for Fire Camps*, Technical Equipment Report No. F-8, Forest Service, U. S. Department of Agriculture.)—MISSOULA EQUIPMENT DEVELOPMENT CENTER.

USE OF FIRE BEHAVIOR SPECIALISTS CAN PAY OFF

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Pacific Southwest Forest and Range Experiment Station[1]

As a result of the Inaja fire disaster of November 1956, the Forest Service launched an intensive study to determine action needed to reduce the chances of similar disasters in the future. One of the primary recommendations of this study, since incorporated in the fire fighting section of the Forest Service 1958 safety code, was that "Where blowup potential exists, consideration shall be given to using a fire behavior specialist to identify especially hazardous conditions." Such a specialist position was first used in southern California in 1958. This paper presents observations and conclusions based on the experiences of this first "shakedown" year.

The job description used in the California Region for fire behavior specialists states "The job of the fire behavior specialist is to supplement the plans chief in identifying unusual fire hazards and risks that may exist because of weather, fuel, topography, or a combination of any, to the point that the fire suppression forces are aware of the situation or conditions." To do this job the fire behavior specialist—

1. Must be familiar with fire behavior in a variety of fuel types, terrain, and weather situations.
2. Needs a working knowledge of meteorology and microclimate that will enable him to determine local weather patterns from general weather forecasts and local weather observations.
3. Must be able to select the key points for making weather observations that will help define local weather patterns, and must be able to identify those small but critical changes in weather elements that forewarn of changes in these patterns.
4. Must understand the interrelationships between fuels, fire, and weather so that he can prepare detailed fire behavior forecasts for specific line locations.

For a small fire the fire behavior specialist can often fulfill this job alone. When a fire-weather forecaster is assigned to the fire, he and the fire behavior specialist work as a team collecting essential data and preparing joint weather and behavior forecasts. On a large, fast-moving fire, the fire behavior team faces the same obstacles—manpower, transportation, and communication—as do the fire control forces. On blowup fires, where fire behavior predictions are most urgently needed, fire behavior is affected to a much larger extent by action of the fire itself than is true under normal circumstances, and there is more contrast in behavior on different segments of the fire. Consequently, if fire behavior predictions are to be accurate and useful, several trained

[1]Maintained at Berkeley, Calif., by the Forest Service, U. S. Department of Agriculture, in cooperation with the University of California.

observers are necessary to obtain spot readings at critical points around the fire area. If the forecasts are to be current enough to aid the control action, these spot readings must be promptly relayed to the behavior specialist. Working with the fire-weather forecaster, the behavior specialist can then prepare detailed behavior forecasts and be in a position to warn control forces of impending changes.

A TYPICAL BEHAVIOR FORECAST

The following behavior forecast, taken from forecasts prepared for the 66,000-acre Stewart fire on the Cleveland National Forest in 1958, is typical of the kind of information a behavior team can supply a fire boss:

Fire Behavior Forecast, Stewart Fire, Dayshift

GENERAL FORECAST:

The fire can be expected to pick up and move earlier than yesterday. The Santa Ana conditions are breaking down further, and a west wind influence should be felt on the whole fire area around noon. Winds will be light, gusty, and variable in the morning, becoming southwest to west and somewhat stronger in the afternoon. Upslope winds can be expected on south and east-facing slopes by 0900 and upcanyon winds in south and east-facing drainages by 1000. Humidities will remain low, 8 to 12 percent in all fire areas.

SPECIFIC FORECASTS:

Margarita Peak-San Mateo Canyon fire area: Westerly winds will be stronger than yesterday, and should start earlier; probably before noon. The west influence will be felt clear to the head of Devil's Canyon at Tenaja Camp.

Los Pinos fire area: Upslope winds will be noticeable on all south-facing slopes by 0900 to 1000. Winds will be light east across the ridges this morning, but will switch to southwest around noon or shortly after, particularly at the lower ridges. Winds across the ridges *may* switch back to easterly after 1600, but don't count on it.

Backfiring job, Ortego hiway to Los Pinos Camp: The section of line from the southeast corner of section 18 to BM 3058 runs on the lee side of a ridge and relatively near the crest. Firing crews should expect wind eddies and erratic fire behavior in this section. Crews should check wind direction carefully in advance of the firing operation on this stretch of line.

Bell Canyon-Hot Springs area: Fire should begin to move up out of Hot Springs sometime between 0900 and 1100. The runs are not likely to stop short of ridge crests as they did yesterday. All crews working the line between the Jamison burn and BM 3907 should be particularly alert to this possibility and have escape routes well in mind.

Backfiring job, Pigeon Spring to Richard's Camp: The odds of completing this job successfully will get progressively poorer throughout the day. Upslope winds will develop early on the stretch from the southeast corner of section 29 to Richard's Camp. Erratic behavior and conflicting winds and eddies can be expected on this stretch, particularly in the beginning portion where the road first breaks down off the potrero.

SAFETY:

Hot runs are possible in any direction particularly this morning. Watch for the wind shift to west around noon. This fire still has all the potential as a killer. Strict adherence to all 10 standard firefighting orders is advised.

Signature ....

Date ....

Actual fire and wind behavior followed very closely that predicted for each specific area.

REQUIREMENTS FOR SUCCESSFUL OPERATION

This first year's operation has indicated a number of things that are necessary if the fire behavior specialist position is to pay off in fire control.

1. Adequate communication is essential between observers on the line, the fire-weather forecaster, and the fire behavior specialist. In most cases, this means radio communication. If possible, the radio net used by the behavior team should be on a different frequency than that of the control forces, but whatever the frequency, adequate communication between the behavior specialist and fire control forces is a must.

2. The behavior specialist must not become involved directly in control activities. He cannot do an acceptable job if he must perform in a dual role—he cannot be a behavior specialist and line inspector, behavior specialist and scout, etc.

3. The fire behavior forecast must be based on the fire-weather forecast. The behavior specialist is not a weather forecaster; he interprets the weather forecast in terms of effect on fire behavior.

4. The behavior forecast must be in writing, signed and dated. It should appear on the same sheet as the weather forecast and should be delivered by hand to the plans chief. Arrangements should be made in advance with the plans chief or fire boss to cover the times that forecasts are expected and how distribution is to be made to other divisions or agencies on the fire. Forecasts are usually expected in time for briefing crews before each shift.

5. The fire behavior specialist usually requires the assistance of qualified observers. The number of observers that are needed will vary greatly. For complex fires or for difficult firing-out operations, more men will be needed than for large fires burning under uniform conditions of fuel, topography, and weather.

CONCLUSION

When adequately manned with experienced personnel, the fire behavior specialist positions can aid greatly in more rapid, efficient control of going fires with greater safety to men and equipment. To perform his job adequately, the fire behavior specialist must have adequate tools—trained observers, weather equipment, communication, and transportation.

A major difficulty in filling the position is to find men who are qualified. Because this job requires extensive background training in meteorology, thermodynamics, and associated sciences, the short period of training now given to fire control personnel falls short of the training needed for this highly technical and responsible position. To meet the growing demand for fire behavior experts in fire control and fire use activities, a comprehensive training program is required.

SLASH DISPOSAL PROGRAM ON THE HAPPY CAMP RANGER DISTRICT

T. H. SIMPSON
District Ranger, Klamath National Forest

There are two important reasons for maintaining an intensive slash control program on the Happy Camp District: One is to reduce fuels to tolerable limits so that fire losses in our residual stands can be kept to acceptable acreages; the other is to enable successful regeneration of the cutover lands. We make no distinction as to which reason is the most important because either a succession of large fires or a failure to get prompt regeneration would result in a reduction in the productive capacity of the working circle and in a reduced rate of cut.

VOLUME, ORGANIZATION, AND COST OF WORK

The principal cut is in Douglas-fir, with about 20 percent of our commercial volume in other species. There is an average 40-percent cull factor in the Douglas-fir stands of the district ranging from 10 to as high as 90 percent in specific localities. Most of this defect remains on the ground in the form of large logs. Other slash is formed from hardwoods and normal debris.

An estimated area of 1,000 acres of timberland is cut over during a normal season, producing about 50 million feet of logs for industry. By machine piling about 350 acres a year, a fair job of slash abatement can be done. This will meet the needs of fire control if the job is strategically located on the ground. An additional 400 to 450 acres is machine piled for the purpose of developing a good seedbed on the better soils. Additional work is done by hand along roadsides and on slopes too steep for mechanical piling. Broadcast burning and burning of concentrations on steep slopes is also done where machine piling is not feasible. There are about 250 acres in this category.

Last year the slash work was put under the supervision of the district timber organization. It had formerly been under the supervision of fire control. The main reason for the change was to gain certain advantages needed to meet the silvical requirements of the timber types we are dealing with. Money is being collected for this additional work, and no ground is lost in meeting the needs of fire control. The work is supervised by a former fire control assistant who is now a project sales officer in the timber organization.

The machine piling is handled by three tractor crews of two men each. The tractor operator is the crew foreman, and the second man is a choker setter. Once these crews are experienced, the need for close supervision is over. The tractors are currently TD-18's with angle dozers and winches.

One hand-piling crew is kept working through the season. There is usually a foreman and two or three men in this crew. They are equipped with a four-wheel-drive pickup with tank and pump equipment. This crew is an integral part of the fire organization, and it keeps in touch by radio.

A five-man KV crew also works part time in the slash area on piling jobs. They also have fire tools and maintain radio contact during the day.

In the fall, all of the available personnel are organized into burning crews. Timing of the burning operation is critical and must be started as soon as safe conditions exist in order to get the job completed.

This work is costing about $48 per acre for machine piling. Burning costs range from $1.65 to $3.38 per acre. Collection for the work is done on a per thousand basis, and the cost varies from $1.00 to $1.50 per thousand depending on a number of variables within each area.

PLANNING

The planning of the slash program is a very necessary function if the objectives are to be attained at reasonable cost. Our plan was as follows:

1. Reduce the fire hazard to tolerable limits.
   a. Machine pile and burn the bulk of heavy slash within the limits of safety of operation on slopes (fig. 1). The marking system generally leaves cut blocks running up and down slopes. The logging operation tends to bunch some of the material on steeper slopes toward the bottom and to the center during skidding. In order to burn large logs, it is necessary that they be bunched so that they are in contact. This is done by skidding individual logs to a point where they can be pushed into piles by the bulldozer. A chain saw is used to buck logs too large to handle.
   b. Spot burn concentrations of slash that can't be reached by machine. The success of this operation depends on the proper kind of weather conditions; it can be quite successful.
   c. Clean up slash along main roads.
   d. Hand pile slash at key locations.
      (1) Along major ridges.
      (2) In saddles (fig. 2).
      (3) Between certain cut blocks to provide a continuous fireline through strategic locations in the stand.
   e. Machine pile in strategic locations. See number (3) above.
   f. Open key roads in sale areas to provide fast access by suppression crews. This is particularly important in untreated areas. (The work is paid for with extra protection money and is done by slash machine crews.)

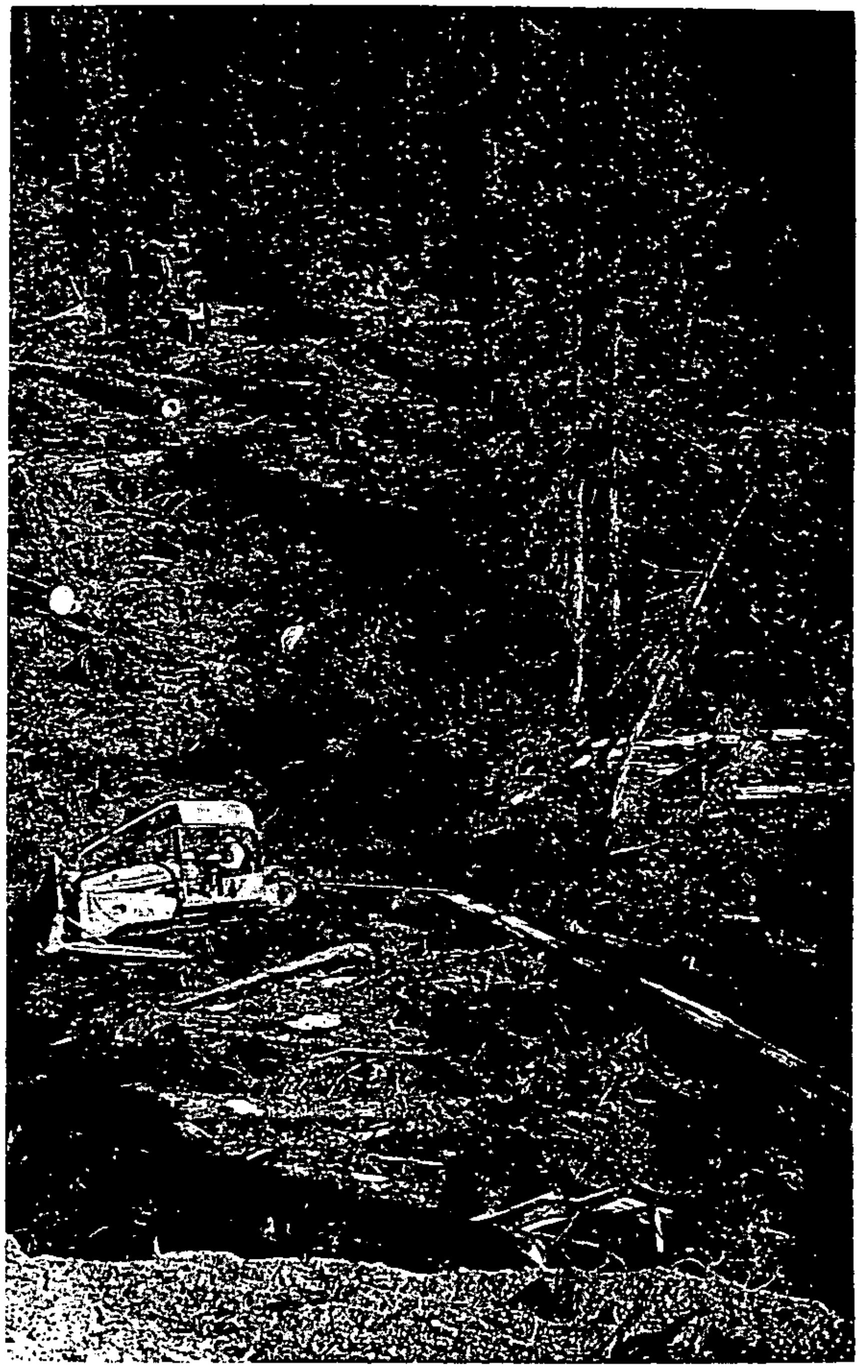


FIGURE 1.—Bulk of slash is in the form of cull logs that have to be pulled into clear area for piling and burning.

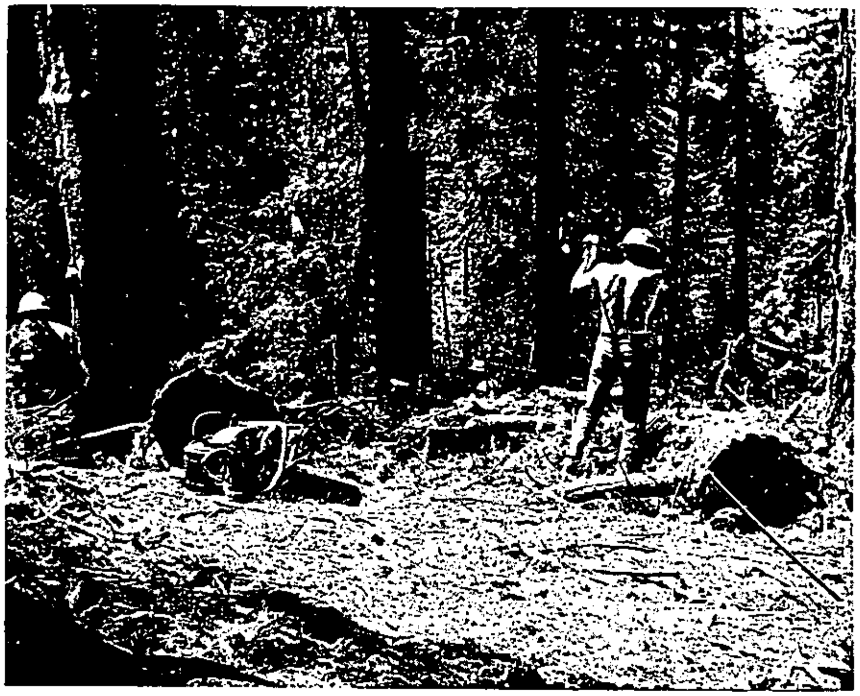


FIGURE 2.—Hand piling slash in critical saddle on Mill Creek Sale area. This crew works in key areas that are uneconomical for machine operation.

2. Organize the work with efficiency and cost in mind.
   a. Efficient organization of crews. Our machine crews are generally two-man crews—a tractor operator and a choker setter; sometimes a third man is necessary if there is much bucking to be done. The equipment operator is also the foreman. There is one five-man crew organized as a fire suppression unit; this crew is engaged in hand piling of slash during the summer season. Additional work is done by key firemen after the fire season until bad weather.
   b. Program work in logical sequence. It is important to plan work for equipment so that at least 2 weeks work is ahead. Moving tractors from place to place is expensive. Lost time of operators is also expensive.
   c. A good program of equipment maintenance. Breakdowns are very costly both in terms of parts and in lost time.
   d. Maintain a crew job list for periods when crew cannot work on slash because of weather, breakdowns, etc.

PROGRESS OF PROGRAM

The rate of cut on the district rose from about 5 million feet annually to over 50 million feet in a period of 5 years. The method of marking has changed from tree selection to group selection in the same period. Slash disposal after tree-selection marking and logging was very expensive and resulted in excessive damage to the residual stand. It was also determined that although about 90 percent of the mortality in the stand was stopped there was no perceptible increase in the growth rate of the residual stand, and regeneration was not occurring except in landings and road cuts.

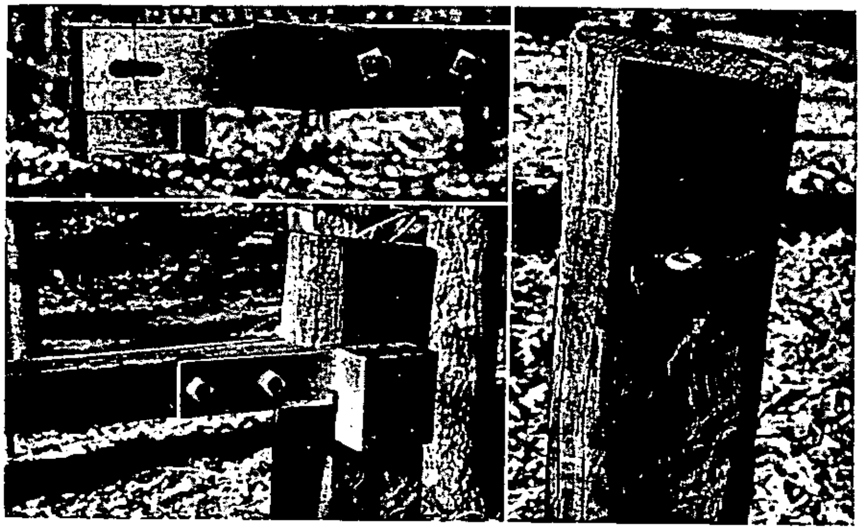
The concept of unit-area control, which was first adapted to the mixed conifer stands by William Hallin, opened the way for development of a similar system in the Douglas-fir on Klamath Forest. The Klamath unit-area control system of marking was such a radical departure from anything used before that it was difficult for foresters trained under the old systems to do the job. After about a year of training and modification of the system, a good job was being done. This system calls for a much higher technical competency than before, and each forester knows that he is practicing forestry that requires an application of everything he has learned.

The slash disposal program had to be adapted to fit the new methods and went through much the same evolution that forestry practices did. It has taken about 3 years to develop the slash disposal program to the size needed to keep pace with the rate of logging. At the present time there are three machine crews and one hand piling crew engaged in the work.

It will be necessary to engage contract tractors at times when market conditions stimulate the rate of cutting, or when seedbed preparation must be increased to take advantage of a good seed year. Present work is on current slash. Our backlog has been completed.

Device for Protecting Gate Padlocks

Do you have trouble with folks shooting or otherwise destroying the padlocks on road gates, buildings, or other units? We were until one of our men developed the metal cover shown in the accompanying photograph. The lock protector is made of heavy gage metal welded to a heavy piece of strapping.



The metal used is heavy enough to withstand battering by hammers or rocks, as well as to deflect shotgun or rifle pellets. The threads of the bolts that fasten the lock protector to the gate rail are battered to prevent removal of the nuts. The eye bolt is a lag that is screwed into the gate post. We have not experienced the problem of folks chopping or sawing the gate rail, but if we do, we plan to bolt a piece of strap metal the entire length of the rail.—GEORGE W. DEAN, *State Forester, Commonwealth of Virginia.*

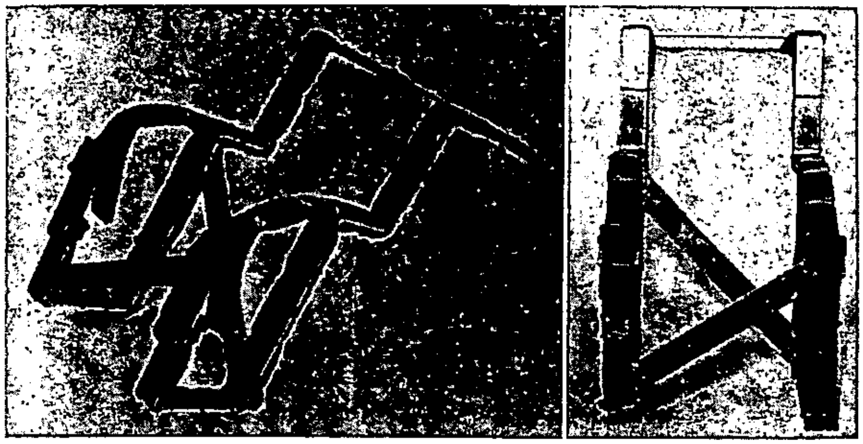
☆ ☆ ☆

A Bracket for Helicopter Minipack Radios

Our helicopter minipack radio was originally carried on the seat between the pilot and the passenger. This arrangement was inconvenient, and it subjected the radio to damage each time it had to be removed to accommodate an extra passenger. To correct this condition, a radio bracket has been developed.

The instrument panel was the most feasible place to mount a bracket. Bolts already in the top and back of the panel provided a way of fastening a bracket without modifying the helicopter. Because the panels of the Bell 47B and B2 helicopters are the same, the bracket can be used on either model and thus changed from one ship to another. A rear panel mounting is in easy reach of both pilot and passengers and does not obstruct their vision. This mounting also allows the aerial cord to be run through a panel in the floor, thus alleviating the danger of someone tripping over it.

The bracket now in use is made of lightweight strap steel. It is suggested that aluminum alloy be used in the future, because of the high tensile strength and light weight. Felt padding is used between the panel and the bracket and between the bracket and the radio to reduce vibration damage.



A quarter-inch "Bungee" cord 2 feet long holds the bottom of the radio snugly to the panel. This further reduces vibration. Two leather straps hold the radio in the bracket. These can be loosened and the radio removed when repairs or new batteries are needed.—Roy V. Thompson, *Angeles National Forest.*

☆ ☆ ☆

Aluminum Knockdown Weather Instrument Shelter

The need for a simple and portable weather instrument shelter, for use with administrative and research projects of only temporary duration, led to the development of this aluminum knockdown shelter. It is well ventilated so that the instruments will indicate true measurements of air conditions but are still adequately protected from rain, snow, and direct sunlight.

The main objectives in the design and development of the shelter were adequate portable instrument housing and durability. It had to be soundly engineered to withstand climate extremes, and the instrument environment within had to be representative of the surrounding atmosphere so that the measurements taken were accurate and meaningful. The shelter had to be compact and light in weight for hand carrying to remote areas, or for the transport of several units in a single vehicle. The design also called for rapid and simple assembly and disassembly with a minimum of tools.

The first model was prepared from do-it-yourself aluminum window framing material. The many pieces of this pilot model defeated the prerequisites of portability and simplicity. Various types of louvers, side panels, and portable construction designs have since been investigated. Out of this research evolved the present shelter, which satisfactorily passed field testing in 1957 and 1958.

Aluminum has the property of transferring heat from the sunny side of the shelter to the shady side, where it is quickly dissipated. This heat conduction capacity of aluminum tends to bring the surface heat of the shelter to equilibrium with the surrounding atmosphere. Besides providing this desirable feature, the light weight makes the final product readily portable. The aluminum is treated with zinc chromate to avert corrosion and then painted with white enamel.

When assembled, the working area of the shelter forms a 2-foot cube, which is placed at the standard height (4 feet) above the ground. It houses such items as maximum-minimum thermometers, psychrometer tubes, barographs, and recording hygrothermographs. Louvers are pressed in the sides and door, and afford protection against rain, snow, and direct sunlight, but they do not restrict the ventilation needed for proper measurement of air conditions. Aluminum tubing is used for the legs with four aluminum cross braces for rigidity. The shelter folds into a packet 5 inches in depth and weighs about 35 pounds. It can be set up or dismantled in a few minutes. The shelter has an attached handle for hand carrying.

The mobility of the shelter makes it readily adaptable to a wide variety of operational and research projects requiring weather information. The shelter has been exposed to drastic weather fluctuations—a temperature spread of —40° F. to 100° F. and winds recorded to 45 m.p.h.—and has performed satisfactorily in every situation. To date the shelter has been utilized in conjunction with a winter study of deer and elk, prescribed burning, silvicultural projects, and a meteorological research program.—INTERMOUNTAIN FOREST AND RANGE EXPERIMENT STATION.

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Salutations for Fire Prevention Signs

One of the basic problems in fire prevention signing is how to maintain a logical sequence of messages in a manner that will attract the attention of the greatest number of forest users. The Sacramento District has added a feature to its standard "T" hanger prevention sign in the form of a salutation plate that is used for direct appeal to specific groups. The plates are scrap plyboard cut to size and stenciled with titles such as "Mr. Hunter," "Mr. Fisherman," and "Mr. Logger." As seasonal changes in forest use occur, the plate and fire message are changed accordingly.

The standard 16- by 44-inch sign is hung from the crossarm by two eye screws and two hook screws. The salutation plate, made with two ⅛-inch holes, is slipped onto two finishing nails driven into the crossarm. Both signs can be quickly changed by the fire prevention officer. The message and salutation plates are made up and maintained by fire suppression crews.—PAUL K. DRYDEN, *Fire Control Assistant, Shasta-Trinity National Forest.*

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INFORMATION FOR CONTRIBUTORS

It is requested that all contributions be submitted in duplicate, typed double space, and with no paragraphs breaking over to the next page.

The title of the article should be typed in capitals at the top of the first page, and immediately underneath it should appear the author's name, position, and unit.

Any introductory or explanatory information should not be included in the body of the article, but should be stated in the letter of transmittal.

Illustrations, whether drawings or photographs, should have clear detail and tell a story. Only glossy prints are acceptable. Legends for illustrations should be typed in the manuscript immediately following the paragraph in which the illustration is first mentioned, the legend being separated from the text by lines both above and below. Illustrations should be labeled "figures" and numbered consecutively. All diagrams should be drawn with the type page proportions in mind, and lettered so as to permit reduction. In mailing, illustrations should be placed between cardboards held together with rubber bands. *Paper clips should never be used.*

When Forest Service photographs are submitted, the negative number should be indicated with the legend to aid in later identification of the illustrations. When pictures do not carry Forest Service numbers, the source of the picture should be given, so that the negative may be located if it is desired.

India ink line drawings will reproduce properly, but no prints (black-line prints or blueprints) will give clear reproductions. Please therefore submit well-drawn tracings instead of prints.

A SPARK CAN BE A DEADLY THING

Remember:

ONLY YOU CAN PREVENT FOREST FIRES!