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FIRE CONTROL NOTES

A PERIODICAL DEVOTED TO THE TECHNIQUE OF FOREST FIRE CONTROL

FOREST SERVICE • U. S. DEPARTMENT OF AGRICULTURE

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Volume 19 Number 1

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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Forest Service, Washington, D. C.

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CONTENTS

MAKE IT POSITIVE . . . Some Opportunities in Fire Control Training

JACK C. KERN,
Chief, Branch of Training, U. S. Forest Service

The field of fire management has many opportunities for advancement. One of the greatest challenges, as Show[1] pointed out in an earlier issue of this periodical, is the intensive and specialized development of fire control personnel. But their effective management cannot be passive or taken for granted. Good personnel management requires aggressive and positive direction.

People, the priceless resource of any organization, require understanding, guidance, encouragement, and the chance for full expression of thought and action. Most of us need skilled job leadership and a planned schedule of off-the-job experiences to gain perspective and widen our knowledge.

It has been stated that at least 90 percent of a man's training and development is gained by the man himself under capable job leadership. The remaining 10 percent is gained through formalized group sessions and planned study under skilled instructors. In this whole process of learning by doing and of learning by contact with expert instructors and group thinking, there is practically unlimited opportunity for improvement. However, such opportunity has to be created, recognized as a positive aid to individual and team progress, and worked upon vigorously.

Some possibilities for personnel development follow:

1. The opportunity for positive results by simply taking more "time out for people" is essential. Take time to know people as individuals, and to see how their specific responsibilities fit into the organization. Find out what each of them needs and wants in order to do a good job. Our most successful fire leaders are those who recognize that men need individual recognition and job satisfaction. These leaders seek positive ways to help their men help themselves. They assign the full job, following the principle that people grow when given responsibility. A recent study in five large industries shows that supervisors who continually think about the *people* in their organization actually obtain better results than those who think only of job production.

2. Another important way of learning to know people in the fire organization is to analyze individual training needs. Such an analysis can help prepare the man for top performance on his present job and for future assignments. An individual training plan or personal progress record will make this process of growing on the job more systematic and positive. A simple, written plan prepared by the man and his boss together, enables them to set training goals and to understand their separate responsibil-

[1]SHOW, S. B. *Primary Bases and Ideas for Fire Control Planning on California National Forests.* U. S. Forest Serv. Fire Control Notes 16(1): 1-8. 1955.

ities. Both the employee and supervisor can learn through this process. This plan sets down the man's own ideas of what he thinks he needs to become a better fireman or a better fire leader. The boss may add to these needs, based on his ideas or the suggestions of others who have observed the employee's work. A mutually agreed upon schedule can tell what is needed, and when, where, and by whom training can best be accomplished. Some of this training can probably be done most effectively in a group with a skilled instructor. Good study habits are the responsibility of the individual, but the will-to-do and can-do-it attitudes are often set by the boss.

3. The professional services offered by schools and universities give another chance to improve our training in fire-attack methods and fire leadership. The University of Maryland's College of Engineering, for example, conducts Fire Service Extension Institutes for volunteer fire departments. Three courses of 22 weeks each, involving latest attack methods, are given. They include basic, advanced, and special classes. More and more schools are offering professional help with specialized short courses or workshops. Local fire departments have also developed skill courses for local talent. Such courses are an encouraging contribution to America's growing field of adult education.

4. Fire training committees in mutual-aid organizations, such as those established in the Fire Compacts of the Eastern States, can determine the size and nature of the training job ahead. They bring about a more uniform understanding of fire problems, and of fire organization and control actions. Adding a professional educator or a training specialist to these committees, in an advisory capacity, will help to bring up-to-date teaching techniques to bear upon tough problems of instruction.

5. The assignment of fire training leaders to accompany groups of trainees to going fires has real promise. These group leaders can see that the men are assigned to capable trainers, and that they "learn under fire." Later each man's experiences can be evaluated by the leader and a chart made for future training based on individual need.

In summary, most of us have the capacity to do our jobs better, safer, easier, and cheaper. Most of us have the potential to take on increased responsibilities. Taking time out to analyze ways for self-improvement and the improvement of team efforts can pay dividends. There are opportunities for positive results by the fire man and his fire leader looking at this situation together. The preparation of simple, individual training plans can make both individual and fire-team development more positive and thus more effective. Cooperative action from schools, universities, local educators, and mutual-aid training committees can apply the latest instruction techniques. The assignment of trainees to actual fire situations under skilled leadership can be made more systematic. Fire training is a vital element of good supervision and direction. Its end product is efficient fire service.

SAFE PRACTICES UNDER BLOWUP CONDITIONS—A TRAINING OUTLINE FOR THE FIRE CREW BOSS[1]

The purpose of this large fire overhead training outline for the crew boss is to help him know more about blowup conditions and safe practices to use.

Blowup fires and safe practices to follow have always plagued the crew boss. The importance of the problem has again been pointed out by fire accidents during the past several years. There is need for practical, clear, concise instructions to the crew boss on this subject. As a start, the best available information has been listed and recorded in this outline.

A blowup condition is defined as an explosive, violent fire behavior that is difficult to identify before it occurs.

The training outline is organized in three main parts:

I. Instruction steps and key points to stress in fire behavior fundamentals.

II. Instruction steps and key points for indicators of dangerous fire behavior (blowups).

III. Instruction steps and key points for the crew boss to follow for safe practices.

It is extremely important that the instructor use all experiences that can be brought to the attention of the crew boss to point out the key points and principles outlined in this training plan.

It is recommended that a minimum of four hours be given each year to fire crew bosses on the subject of blowup conditions and safe practices.

FIRE BEHAVIOR FUNDAMENTALS

Example of introduction.—Successful fire fighting is based upon the knowledge of why a fire burns and what makes it spread. Fire is simply a rapid chemical combination of fuel, heat, and air. The basic principle of fire suppression is to remove one or more of these elements in the quickest and most effective manner. In order to do this, however, there must be some knowledge of the causes and reasons for fires acting as they do. The primary factors that influence the spread of forest or range fires are fuel, weather, and topography.

[1]For the full text of this training guide see *Safe Practices Under Blowup Conditions for the Fire Crew Boss,* by Forest Service, U. S. Department of Agriculture. 19 pp. 1957. [Processed.]

Fuels.—Fuels are commonly divided into two main groups: (1) Flash fuels such as dry grass, dead leaves, tree needles, brush, and small bushy trees; and (2) slow burning fuels such as logs, stumps, deep duff.

Weather.—Weather factors with which you as a fire crew boss will be concerned are wind, moisture, and to a lesser degree, temperature.

Slope or topography.—Slope greatly affects the spread of fire in two major ways: (1) Preheating and (2) draft.

Judgment is the major factor in determining the relative importance of all the elements which determine fire behavior. For example, continuity and arrangement of fuels are sometimes more important than volume. Given a certain volume of fuel, features of arrangement or position will influence spread as well as difficulty of control. If fuels are patchy, broken up by areas of thinner fuel, rocky or barren spots, the spread may be uneven and slow (blackboard illustration recommended). If these same fuels are partly on the ground and partly in the air—standing snags—spread may be by spotting, and with severe winds, this may cause a most difficult fire. *It pays to look carefully at all conditions in sizing up a fire.*

The fire crew boss must take advantage of known methods of sizing up a fire at a given time and predicting what will happen as the fire advances or as changes of weather occur.

INDICATORS OF POSSIBLE UNUSUAL FIRE BEHAVIOR

Occasionally a forest fire burns with an intensity that seems far out of proportion to apparent burning conditions. Each blowup fire raises the question: What can we do to recognize conditions causing extreme fire behavior? How can we predict these conditions in advance? The following on-the-ground indicators should be watched for as they may mark extreme burning conditions that will follow:

A. Fast burning fuels.
  1. Unusually dry fuels.
  2. Large amounts of fine fuel (grass, needles, moss, etc.) particularly where continuous and on steep slopes.
  3. Crown foliage dried by surface fire over large area.
  4. Brush and conifer tree foliage after prolonged drought.
  5. Concentration of snags.

B. Weather factors.
  1. Strong winds blowing.
  2. Unexpected calm. May result in winds shifting.
  3. High clouds moving fast may result in unusual winds on ground.
  4. Unusually high temperatures early in morning.
  5. Dust devils and whirlwinds.

6. Thunderheads above or in close proximity to fire usually lead to dangerous downdraft winds. If thunderhead is upwind of the prevailing wind, the danger is greatest.
7. When slope becomes shaded, look out for downdrafts.
8. If a fire is burning near a mountain or glacier (such as Mt. Hood), greater downslope wind velocities will normally occur.
9. Keep an eye on smoke column. Winds may be blowing from different directions above fire. This could result in spot fires outside.
10. Watch smoke column for an increase in wind speeds aloft. This leads to spotting, and gusty wind conditions may also result.
11. Sudden changes in direction and/or velocity of wind when weather fronts move in.

C. Fire behavior (which could lead to a blowup).

1. Spotting ahead of fire or downslope below line being worked.
2. Intense burning inside fireline.
3. Smoldering fires over a large area.
4. Many simultaneous fires starting.
5. Whirlwinds inside fire causing spots and creating intense, erratic burning.
6. Broadcast crown fires in brush or timber.

SAFE PRACTICES FOR CREW BOSS TO KNOW AND USE

The crew boss has two main responsibilities: (a) To obtain an effective, fair day's work from his crew, and (b) to look after the safety and welfare of his crew 24 hours a day to the best of his ability.

After instructing in how to recognize conditions leading to blowup fires, the training leader guides the group into sharing experiences in what safe practices to know and use to prevent injuries or loss of life during blowup conditions. As he puts across the following instruction steps and key points (which are numbered) he should (a) review with group and stress key points, (b) encourage crew bosses to relate actual experiences they have had on a fire to stress key points, (c) relate experiences he has had to illustrate points, and (d) use case histories of disasters or near misses.

A. *STAY ALERT.* Be prepared for safe emergency action. Keep Your Head.

1. Heads up: Look up, look down, look around.
2. See what you look at.
3. Know where the fire is and how it is behaving at all times. If necessary, use scouts or post lookout with proper communication.
4. Know what danger signs to look for, including fatigue. Use your fire behavior know how.

5. Think before acting. Pause, think, then act.
6. Fire fighting is dangerous. Crew boss has a key job. Men are looking to the crew boss.
7. Keep an up-to-the-minute plan of get-away action in mind.
8. Act with decision and promptly when escape action is needed.
9. Remember—a fireline is not usually safe until it is burned out.
10. The spectacular fire may not be the most dangerous. The quiet-looking fire may be the most hazardous.
11. Get weather forecast in morning.

B. *WORK* and *ACT* as a *TEAM.*

1. Gain confidence of crewmen.
2. Keep crew together. Need to do this for clear, safe actions.
3. Use action words: "Come here," "Follow me," "Keep together." The crew boss is the leader.
4. Don't assume anything. Crew bosses have said, "Let's go" and men have gone different directions.
5. Know where all your men are.
6. Men must follow all verbal orders and stick together when orders are given to move out.
7. Have men keep handtools as they may be of value in providing protection.
8. Assign most experienced, mature men for scouting and for lookout when in especially hazardous situations. Arrange for prompt communication.
9. Manage and control your men.

C. PLAN GET-AWAY, including escape routes.

1. Crew boss must always have in mind a clear-cut plan of action for fire blowups. Know in advance where you will lead your crew. If necessary, prepare and mark escape route in advance.
2. Let your crew members know you are responsible for their safety.
3. In the event of a blowup, pause a moment and size up the situation. Then think clearly, speak decisively, and act in a calm and deliberate manner.
4. Remember danger potential of timber, brush, and grass fire fighting.
5. Keep crew informed.
6. Keep in mind open places such as rock slides, streams, burned-over places, meadows, alder patches, and gravel bars.
7. One of the safest spots is burned-over area. If needed, dig in.

8. When not possible to get into burned area, remember, men can travel faster downhill or along contour.
   Warning—Remember, winds usually blow downslope at night and fires can run rapidly downhill.
9. If necessary to jump through burning edge of fire, have men place hat or coat over face.
10. Caution men: if clothes catch on fire, roll on ground in dirt to put out fire.
11. Do not travel ahead of fires in direction of spread unless you are positive that a safe place ahead can be reached by crew.
12. When not possible to get within burn, pick most open ground available and avoid dense brush, where men can become separated and go astray.
13. After reaching escape spot, check to be sure it is safe from falling trees, snags, rolling logs, or rocks. Try to find a safe vantage point and post lookout.
14. In any brush fire fighting, when working in advance of fire with dozer, build safety strip for retreat.
15. In timber types, sharp ridgetops are good bet to get to if possible.
16. Watch for safer topography, benches in steep country.
17. As last resort, burn out and dig in.
18. When at safe spot, remember suffocation has killed. Have men keep damp clothes over their noses and get next to ground.
19. Where heliports exist, keep their location in mind.

FOREST FIRE SOUND LOCATOR MISSILE

AUSTIN H. WILKINS
Deputy Forest Commissioner, Maine Forest Service

In Maine, forest fire fighting ground crews have had many exasperating experiences trying to locate lightning strikes in dense woods in remote areas. Often they were close, yet valuable time was lost before the actual tree or small smoldering ground spot was discovered. Many times, when near enough, crew members were able to locate the fire only by a good sense of smell, or spotted the tree while circling through the area. In other instances they were directed by means of plane to ground radio communication, loud speaker from plane, dropped sketch maps, smoke signals, compass bearings, or some other helpful method. Sometimes crews were fortunate enough to travel right to the spot without too much delay, but this did not occur too often[1]. No doubt fire fighters in other States have had similar experiences.

A former Maine Forest Service fire warden, Maurice Clark, had a number of these experiences while working as patrolman in the Katahdin District. For some time he had been thinking on how to perfect a mechanical device that could be released from a plane and that would give off an audible sound of sufficient volume to be heard within a range of 500 yards on the ground and thus narrow down the search area. This idea began to take physical shape after many experiments in his home workshop. Satisfied that his rough homemade model had merit, he then decided that an electronic engineer should be consulted and specialized equipment was necessary to meet desired requirements. He also had to find a concern to manufacture and market the item at a reasonable price.

Electronic Technician William Tiffany of Auburn, Me., provided both financial and technical assistance in developing the device. Thus was born the "Forest Fire Sound Locator Missile" from Maurice Clark's original idea. Patent rights have been approved and production started on a limited scale. The total cost is approximately $265 per unit, complete with parachute.

In general, this missile is an electronic device, with dry batteries and amplifier, encased in a galvanized iron cylinder. It emits a rising and flowing high pitch signal audible up to one mile in densely wooded areas. It is most effective within one-half mile radius and under favorable terrain and woods conditions can be heard beyond a mile.

Specifically, the component parts and features of this unit are as follows (fig. 1): Removable blunt nose section of 16-gage galvanized iron with battery holder for two power pack batteries in a rubber shock mount; a watertight cylinder housing of 18-gage galvanized iron containing an amplifier unit of a sealed transistorized amplifier in an inner shock case; a reentrant sound projector (signal device); a sound dispensary cone of 360°.

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[1]As a safety factor the department has a firm policy of always sending out fire fighters in pairs to look for lightning fires.

FIGURE 1.—Dismantled missile showing component parts of power pack batteries, transistorized amplifier, relation oscillator, and removable nose section.

The mechanism is positively triggered by jack-type switch either manually or by plane release mechanism. The overall weight is approximately 36 pounds, diameter 8½ inches, and height 38 inches, painted either cab yellow or Chinese red. There are two hooks on the outside for attaching the parachute, two hooks for provision of a slide bar to simultaneously release the missile from a specially designed carrying rack and trigger the mechanism, and two clamps to hold the nose section of the missile to the main body of the missile housing. By turning a set screw it is possible to adjust the sound pitch from low to medium to high.

One significant feature is that with oscillation there is little drain on the battery. In both laboratory and field tests the first few manufactured missiles gave a strong oscillating signal for 8 hours without a stop. In another unusual instance, in the spring of 1957, three of these missiles gave an oscillated sound for 21 hours without a stop while being used to coordinate three separate ground search crews that were looking for a lost fisherman. Tests also determined that cold winter storage had no ill effect on the dry batteries.

The missile is waterproof, and will withstand the shock of hitting rocks, ledges, and other hard objects and still emit a strong signal. Experiments are now being made to devise a hard rubber nose for the removable nose section to help break the shock of hitting hard objects.

The missile can be manually thrown from a plane "free fall" or with a parachute. Tests indicate it is best to use the parachute because there is no guarantee on "free fall" (fig. 2). The Maine Forest Service has devised for each of its two float planes a single V-shaped trough 10 feet long of aluminum tubing attached to the pontoon (fig. 3). The trough is of a size to permit carrying one or more missiles. Highly successful test drops have been made with this type of rack. Plans are underway to equip each plane with two racks to go on each pontoon. These racks can be easily attached or detached.

The present missile has an outside plug that has to be pulled or released in some manner to trigger the sound mechanism. When the missile is dropped by parachute the pulled plug stays with the static line in the plane. To the parachute case is attached an extra plug with which the person finding the missile can stop the sound signal. Otherwise, it would be necessary to remove the nose section and disconnect the battery wires.

With no actual lightning fires to make drops on, several experiments were made under typical woods conditions in Maine, New Hampshire, and the Provinces of Ontario and New Brunswick during the 1957 fire season. One test drop was made from the Maine Forest Service Cessna 170 float plane with very satisfactory results. By prearrangement a crew of ten was placed in an area with a ½-mile radius in a dense, second-growth hardwood type near a heavy white pine cutting. The missile, with sound signal working, was dropped from the plane at 2:05 p. m. at an altitude of 300 feet. At 2:25 p. m. the unit was discovered hanging about 5 feet above the ground with the 17-foot orange parachute caught on a branch of a hardwood tree (fig. 4).

FIGURE 2.—*Left,* Multiple chute release from plane of fire tools and locator missile. *Right,* Locator missile and pack of hose in descent.

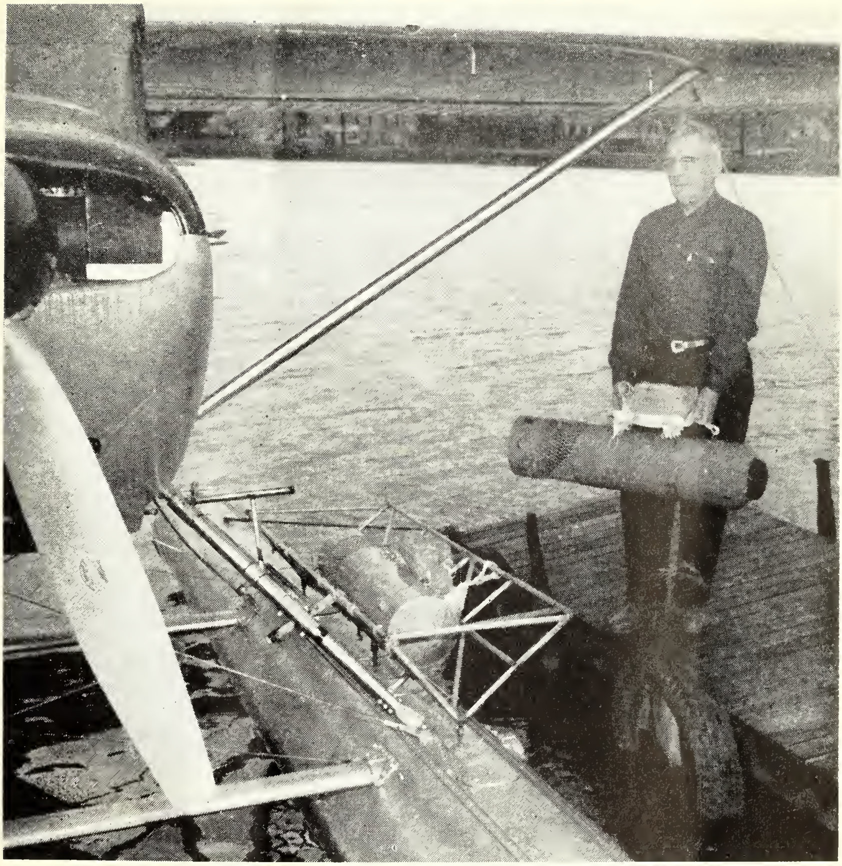

FIGURE 3.—Sound locator missile in position in aluminum carrying rack attached to pontoon for air drops.

The following advantages brought out by experimental drops to date indicate that this sound locator missile has a practical and valuable use in forest fire control work:

1. The audible sound signal is effective at half mile distances and can be heard a mile away under favorable terrain and forest growth conditions.
2. The search area is greatly narrowed down.
3. The device permits quicker discovery of the fire at a saving of valuable time and cost.
4. The device permits early initial suppression action to prevent possible spread of fire.
5. Missile can be recovered and used repeatedly.
6. It is lightweight and can be easily transported.
7. It is compact, with a removable nose section to permit servicing.
8. Strong sound signals will emit continuously for at least 8 hours.
9. It can withstand the shock of hitting hard objects such as rocks, ledges, or trees, and still emit good sound signals.

FIGURE 4.—Parachute and missile found just as they landed in second-growth hardwood.

10. It is waterproof.

11. Missile can be released from the plane either manually or electrically "free fall" or by parachute.

12. Ground crews find the sound signal helpful while the missile is in descent, especially when coming down by parachute.

13. In open forest types the bright red missile and orange parachute can be easily seen, as well as the sound signal being heard.

14. Missile may have practical value for guiding rescue crews to lost persons and other uses not yet determined.

The Maine Forest Service has purchased six of these missiles and distributed two to a division. Several orders have been placed by protective agencies, while others have expressed an interest. Prints and further information may be obtained by writing to Maine Forest Service, State Office Building, Augusta, Me., attention Austin H. Wilkins.

BUILDING FIRELINE WITH A SELF-PROPELLED TRAIL GRADER

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In recent years, a self-propelled, two-man trail grader has been undergoing test in Region 6. This versatile machine is used not only to build new trails and improve old ones but to build fireline as well. Forty of these machines are in use in the region.

As with any new machine, improvements are continually being made. Three models are now in use. The original grader has a single 14-inch driving wheel; the second model has three wheels on one axle for additional traction; the third model has a crawler track 32½ inches long and 5 inches wide (fig. 1).

FIGURE 1.—The crawler-type trail grader. This model is best for fireline construction.

In order to obtain maximum performance of the grader in building fireline, the operators must be well trained. The machine is not a particularly easy one to operate, and there should be frequent reliefs, at least at half-hour intervals. Since the grader is a digging machine only, clearing must be done in advance. For these reasons the grader should be considered a crew machine.

FIRELINE-CONSTRUCTION TESTS

Test runs of single and three-wheel models were organized and reported by District Assistant W. M. Starkovich of the Ellensburg District of the Wenatchee National Forest. Organization of the 13-man crew was as follows: Crew foreman; 1 assistant foreman to locate line; 5 pulaski men to clear and chop; 1 power-saw operator to cut logs and large poles; 2 machine operators for trail grader; 1 man to carry extra gasoline and accessories and assist machine operators; 1 pulaski man to take out roots and decayed logs; 1 shovel man to finish line.

The following rates of line construction were recorded:

Moderate resistance to control type.—Mixed species of large Douglas-fir and western larch with dense stand of white fir understory. Medium amount of down logs with sizes up to 3 feet, and other litter and duff up to 6 inches in depth. Slope, 0 to 35 percent; rate of line construction, 36 chains per hour.

Low resistance to control type.—Pine with understory of pole-size Douglas-fir thickets, sodded pine grass, with light litter on the ground. Duff 2 to 3 inches deep. Slope, 0 to 40 percent; rate of line construction 43 chains per hour.

Large open ponderosa stand with very little litter on ground. Fairly heavy sodded pine grass. Slope, 0 to 45 percent; rate of line construction, 49 chains per hour.

In sidehill operation, the three-wheel machine tends to kick sideways and is difficult to hold in position. The one-wheel machine performs satisfactorily, but there is a noticeable lack of traction and a tendency for the driving wheel to dig in. The traction problem has been solved by using a crawler track instead of wheels. With this improvement, the machine has dug fireline up and down and on contour on a 70-percent slope. Twelve of the Region 6 machines have been converted to the track type.

PERFORMANCE ON FIRES

Opportunity to use the grader on fires has been limited. However, three track-type graders were used on a fire on the Wenatchee Forest in July. The fire started from a railroad on a steep, dry slope at midday. It had all the prospects of a project fire. Actually, credit for control at 60 acres goes to aerial tankers that knocked the fire out of the crowns of reproduction and fireproofed a wide area on the running front, thus giving railroad workers a chance to move in with a handline.

The line built by the first two graders on the fire, which arrived before experienced fire overhead, was not properly located to be most effective. The third machine went all the way around the fire with a new line, some of which became the final line. In evaluating use of the machines, Ranger McNeil made it clear that he was not depreciating the machines in any way. The fact that there were 75 railroad workers on the fire with handtools made the machines less of a necessity than would otherwise have been true.

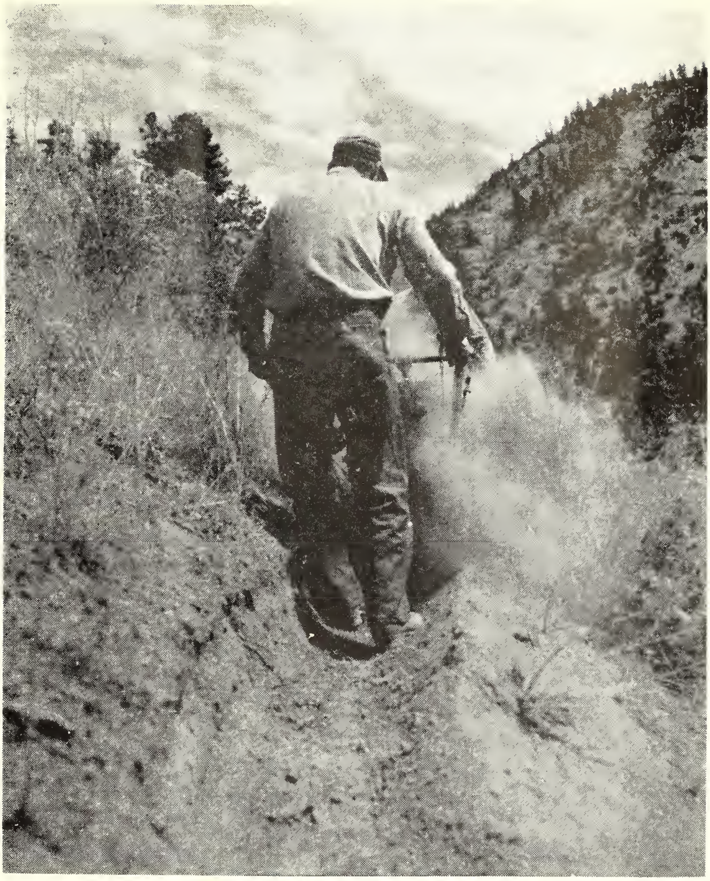

FIGURE 2.—Line constructed by the track-type grader on a side slope.

The grader builds an excellent fireline (fig. 2). Since the cutter disk is reversible, the dirt can be cast to either side. On cross-slope operation the dirt is cast downhill; otherwise, it is cast to the side away from the fire where it helps to insulate the fuel next to the line. The cutter disk will kick out rocks as large as coconuts, and is sturdy enough to withstand contact with larger rocks without damage. Brush-type roots are easily severed.

In summing up, the following points are made:

1. For trail construction, there is a difference of opinion as to the need for the crawler track. For fireline construction, there is no difference of opinion; the track is the answer.

2. This is definitely a crew machine. The size of the crew will vary with the fuel type. In areas where clearing is unnecessary, four men may be sufficient. Training in machine operation is required.

3. The machine can be transported in a pickup. The Wenatchee Forest carries its machine in a horse trailer.

4. The machine does not have a reverse, which is certainly desirable. The manufacturer is presently working on this problem.

5. Fire trenchers, at least in the Western States, should have a means of winching the machines through or across otherwise impassable areas such as sharp canyons and talus slides, or over ground where traction is difficult. A simple spool-type arrangement and 100 feet of nylon line should solve this problem.

6. It is much easier to work the machine down slope than it is up slope, and this fact is worthy of consideration in planning fireline construction.

SPECIFICATIONS FOR THE LATEST MODEL

Engine.—Nine hp., 4 cycles.

Transmission.—Transmission case, idler shaft, wheel shaft, and belt-tension adjustment idlers have sealed ball bearings—keywayed sprockets.

Clutching.—One master clutch from engine to jack shaft, controlled from lever on handle bars. Two secondary clutches that allow forward motion independent of rotation of cutter disk. Low speed (or work speed) allows travel up to 1¼ m. p. h. Secondary clutch lever allows for higher speeds up to 5 m. p. h. "Double clutch" arms and levers permit change of speed without stopping to change belts.

Gear box.—Shift on gear box for clockwise and counterclockwise rotation of cutter disk. Removable disk, 16-, 18-, and 20-inch. Gear box adjustable to operate at four angles in relation to ground surface.

Brake.—Mechanical brake controlled by lever on right rear handle bar.

Front handles.—Adjustable up and down. Fold back for easier transport of machine.

Dimensions:

Height, 37 inches to handle bars, 24 inches to top of bed.

Length, 109 inches overall, front handles extended; 78 inches at top of bed, front handles folded; 50 inches at bottom of bed.

Width, 29 inches at handle bars, 17 inches at bottom of bed, 21 inches at bed top.

Weights, 1-wheel grader, 390 pounds; 3-wheel grader, 420 pounds; grader with track, 480 pounds.

GLARE-REDUCING GLASS FOR LOOKOUT STRUCTURES

DIVISION OF FIRE CONTROL
Region 7, U. S. Forest Service

Lookout personnel in modern towers are exposed to intense glare of light, and frequently to heat. As a result they experience eye discomfort that can be assumed to impair efficiency in searching for and locating smokes. Sunlight fades furniture, interior paint, and exposed maps, thus creating some maintenance problems.

The problem of glare from ordinary clear window glass has been worked on unsuccessfully. At one time towers were equipped with wooden shutters hinged at the top of the window to form a canopy over the window. This was abandoned in many localities because storms would tear them from the hinges and create a severe safety hazard. The use of sunglasses by towermen will help but sunglasses become tiresome and are often laid aside.

In 1955 the Region entered into a cooperative agreement with a firm which manufactures a glare-reducing glass. According to the manufacturer the glass gives an even transmission through the visible range of the spectrum. Colors are rendered without distortion but are greyed or toned in brilliance. The glass transmits but 65 percent of the heat energy in comparison with 86 percent by clear glass. According to the company the glass also transmits a large percent of the near ultraviolet light which is beneficial. This type of glass is used in modern schoolhouse construction.

This glass was installed by the company on the 14 x 14 cab of a 60-foot tower, located on top of the Alleghany Mountains, elevation 4,300 feet, on the George Washington National Forest. The comments made on its effectiveness are based on three fire seasons of use.

The color of objects is retained in true relationship although darkened. Glare is reduced to an extent that it is no longer evident. The glass acts as a haze cutter to improve visibility to a marked degree. Heat is reduced materially. The interior of the tower is protected from fading by the effects of bright sunlight. The critical test of any glass reducing light transmission is its effect on discovering night fires. It was determined that visibility was reduced to a minor degree only and that this reduction was not an important factor overall.

On a cloudy day more heat is required to keep the tower at a comfortable temperature than with clear glass as might be expected because of low heat transmission characteristics of the glass. The glass must be cleaned frequently because dust lowers visibility perceptibly, much more than with clear glass. From the exterior this glass looks opaque with practically no "see in" properties.

As a result of the demonstrated advantages of this glass the forest is making a second installation. Its cost is about double that of clear glass, or approximately $150.

A second lookout in the Region is equipped with a rose-tinted glass on the south and west sides. This has proved to be an aid in reducing glare and has haze-cutting properties. Its cost is also about double that of clear glass.

As a result of the tests conducted in the Region with glare-reducing, haze-cutting glass it can be stated that the advantages are material and the disadvantages small. The small investment is justified when compared with the added comfort and efficiency afforded the lookout.

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Outdoor Fire Statistic Sign

The Arcadia Dispatcher's Office of the Angeles National Forest felt a need for some means of informing the public of the current fire situation. To meet this need a routed redwood sign with slots for removable figures was placed where both the general public and the nonfire personnel at the Arcadia Depot would notice it. The sign shows the fire danger for the day, total number of statistical fires to date, and acreage burned. It measures 24 by 50 inches, with 2- and 3-inch letters sprinkled with glass beads for night illumination.

This sign reaches many more people than an inside fire danger clock. Local comment has been very favorable, and some of the district rangers have expressed interest in using a similar sign at their headquarters.—Charles G. Colver, *Assistant Dispatcher, Angeles National Forest.*

HOUSE TRAILERS FOR DETECTION OF FOREST FIRES

E. C. DeGraaf
Formerly Assistant Forest Supervisor, Olympic National Forest

In the Pacific Northwest an important forest fire control problem, not solved by the conventional lookout system, is the need for additional intensive detection over areas and drainages recently logged. Everyone is familiar with the fixed lookout stations used by the U. S. Forest Service and other forest protective agencies. Location, coverage, and intervening distance standards for these fixed lookouts were largely adapted to the protection of undeveloped areas. Detection standards were used that provided for coverage of large unbroken blocks of standing timber. The hazards and risks common to this condition were recognized, and protection was planned accordingly.

The situation in parts of the Northwest has changed appreciably. Logging roads are now opening up many timbered areas. Logging operations are expanding in all directions, and many unbroken timbered areas have now become a checkerboard of cutovers and logging slash. Logging no longer is limited to lower elevations, since heavy construction equipment, powerful logging trucks, and cable-type logging have pushed operations to whatever elevations contain stands of merchantable timber. This expansion in logging operations has provided access to many ridges and low mountain tops that offer excellent intensive detection coverage of the slash and timbered areas. If the slash on the logged units is burned successfully, it still represents a major change in fuel type and a somewhat hazardous area for a few years until the next crop is well established.

This change in hazard, from inaccessible areas of unbroken timber to accessible areas of highly flammable fuel types, calls for supplementing the fire detection program.

A ready answer to the problem is the use of a lightweight house trailer for mobile detection quarters. The house trailer should be relatively small with an abundance of windows. It should be light enough to be readily pulled up steep pitches by a 3/4-ton or 1-ton vehicle to the desired location. It should be short enough to negotiate sharp road curves. A firefinder does not have to be installed in the trailer; it can easily be installed on a fixed table or stump on the selected site to permit an unobstructed view of the surrounding country. It would need to be properly oriented and its position spotted on the platting map of the dispatcher. A waterproof plastic or canvas hood is all that is needed to cover the firefinder when it is not in use. A radio in the trailer provides necessary communications.

On the Olympic National Forest in northwestern Washington, logging operations and resulting conditions brought on the need for intensive detection of the cutover areas. The use of house trailers to provide mobile detection facilities was decided on and locations selected. Two trailers were placed strategically in the Forks Burn of the Soleduck District. This burn of 35,000 acres occurred in 1951 and has since been completely salvage logged. This resulted in a major slash area of mixed ownerships where further slash burning was not advisable. The nature of the terrain and the need for intensive detection are evident in figure 1, which shows some of the area blind to fixed lookout stations.

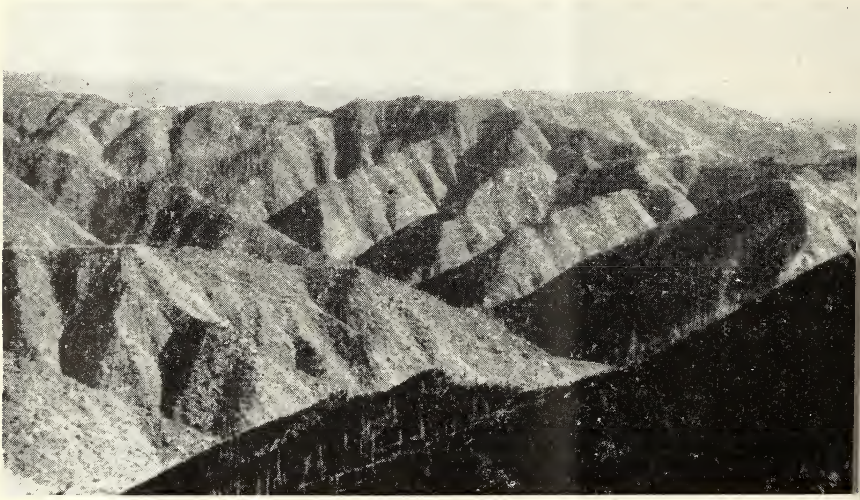

FIGURE 1.—Area seen from house trailer used for intensive detection or Burma Point in the Forks Burn. This broken terrain is not covered by direct visibility from fixed lookouts.

In the spring of 1956, a fire that could not be seen by the fixed lookouts was detected from one of the house trailer points in the Forks Burn.

A house trailer in 1956 cost $2,178 delivered to the Shelton Ranger District. Transporting it into position on the Canyon River drainage cost an additional $25. By comparison, the cost of a standard 14 x 14 ground lookout house constructed in place is from $4,000 up ($2,400 f. o. b. Portland). Compactness of the trailer and size of the conventional windows can be seen in figure 2.

After two fire seasons the merit of house trailers for detection in high-hazard areas has been established for conditions on the Olympic National Forest. To date, four house trailers have been purchased for this purpose. Two additional sites where this type of detection unit will be of value in logged-over areas are already selected for the 1957 season.

On the basis of experience on the Olympic National Forest the use of a house trailer, with modified design if possible, offer

FIGURE 2.—House trailer on Burma Point in the Forks Burn. Opportunity is evident for increasing the size and number of windows for better vision.

an excellent means of supplementing fixed detection over logged areas with highly hazardous fuel types. This could become an effective and relatively low-cost method of insuring economical and flexible detection in one phase of fire control work in the Northwest.

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Fire Hazard Data Available At Brooklyn Public Library

"To save even one life or prevent one injury to a civilian or fireman" was the aim of Fire Lt. Martin Chayette, a fireman in Brooklyn since 1945. Lt. Chayette was recovering from injuries received in battling a fire when the idea of collecting literature on fire hazards occurred to him.

Although he knew that the field of fire prevention and protection was vast, he also knew that there was no place where this information had been assembled. With this as a goal, he sought to establish a center where firemen, architects, businessmen, laymen, and students could find source material for further study. Deciding to create this source, he sent out more than 1,500 letters requesting available literature from fire underwriters, fire departments, insurance companies, and equipment manufacturers.

Pamphlets, bulletins, magazines, and books have been collected. Lt. Chayette has assembled more than 4,000 publications on fire hazards covering the field from acetylene and air conditioning to wiring and woodwork. The collection fills a dozen shelves and eight filing cabinets in the Science and Industry Division of the Brooklyn Public Library.

Lt. Chayette speaks with high praise of the cooperation given him by the Brooklyn Public Library. Plans for the future are progressing. The library allotted $500 of its current budget to expand the collection. Eventually, it is hoped that the material on fire protection and prevention will be operated as a section of the library.—From an article in the New York World-Telegram and Sun, April 23, 1957.

FIRE TRAILER FOR A TREE FARM

Judson Parsons

Mountcrest Tree Farm, Siskiyou Summit, Oregon

For our 1,800-acre tree farm in southern Oregon we constructed a small trailer (fig. 1) which can be pulled by a jeep, over our many roads, to any area on the tree farm.

Figure 1.—Trailer and equipment. The trailer, drum, and box are painted red with white "FIRE" signs on the sides and ends.

On the rear half of the trailer is mounted a 55-gallon drum with two valves connected to the lower bunghole. Next to the drum is a hand-operated pump with 10 feet of suction hose. Water is pumped into the drum through the bunghole on the upper side. The pump will fill the drum from a small pond in 2½ minutes.

On the front of the trailer is a box in which fire tools are stored. The box is kept sealed, but not locked. The tools include two back-pack cans each containing 5 gallons of water, two shovels, two fire hoes, one ax, one bucket, and 75 feet of ½-inch garden hose with a trombone type pump similar to those on the back-pack cans.

The water in the drum can be used to refill the back-pack cans or with the garden hose and pump to pump water directly to the fire when the trailer can be brought within 75 feet of the fire.

We believe that this trailer and its equipment could control a small fire, or be used to advantage in helping to control a large fire. Also, the trailer, with its red color and white letters, is a constant reminder to those on the tree farm of the everpresent fire danger.

MOPUP KITS FOR REGION 6

A. B. Everts
Equipment Engineer, Division of Fire Control, Region 6, U. S. Forest Service

Even though water is a great aid in quick and efficient mop-up, great quantities may not have to be used; small amounts properly applied will do the job. The technique of "proper application" is to put water where it will do the most good. Region 6, as a third step in its efforts to secure more efficient use of water in fire control, particularly in mopup, has assembled a standard mopup kit.

The first step was to standardize on tank-truck and portable-pumper accessories.[1] The second step was to supplement pumping equipment with various items such as 1000-gallon folding canvas tanks, relay tanks, gravity intakes, and the pyramidal tanks whose use can make "nurse" tankers out of any flat bed vehicle. These items, along with small slipon tankers and portable pumps, provide the means of getting water to fires.[2] The third step was the assembling in one kit box those accessories needed for applying water efficiently over a wide area (fig. 1).

FIGURE 1.—Region 6 standard mopup kit.

[1]A. B. Everts. *Versatility in Water Application.* U. S. Forest Serv. Fire Control Notes 15 (2): 30-34, illus. 1954.

[2]A. B. Everts. *Canvas Water Show.* U. S. Forest Serv. Fire Control Notes 17 (2): 12-15, illus. 1956.

The contents of a mopup kit are as follows:

	Number
Applicators, 4-foot aluminum	6
Packsacks	2
Spray tips, 15 g. p. m.	2
Straight stream tips, ¼-inch	2
Garden hose Y's	4
Hose tees (1½-inch with 1-inch takeoffs with caps)	6
Reducers (1½ to 1-inch)	2
Spanner wrenches	2
Nozzle pouches (red canvas for easy visibility), each containing a 3 g. p. m. spray tip (¾-inch garden hose threads), a reducer (1 to ¾-inch garden), and a sleeve-type shutoff (with an assortment of 1½-, 1-, and ¾-inch washers	6

This equipment permits the use of six lateral takeoffs from a 1½-inch main line, using either 1-inch CJRL hose or garden hose or both. If the water source is from tankers where the conservation of water is a factor, the sleeve-type shutoff is used on the applicator; otherwise, it is not used.

Nozzlemen should work in pairs, one man digging, stirring, and rolling out burning material, and the other applying the water (fig. 2). The applicator permits the ramming of the spray tip into the smoldering material. For conservative use of water the 3 g. p. m. spray tip is sufficient. It is the favorite tip in the region.

FIGURE 2.—Four-foot aluminum applicator with 15 g. p. m. spray tip.

A foreman should be in overall charge of each mopup sector. It is his job to determine where the takeoffs are to be placed in 1½-inch main lines and how far out lateral lines are to extend, to check on the thoroughness of the mopup crews, and to see that all the items are returned to the kit box when the job is done.

The cost of the entire kit, including box, is approximately $200.

RECORDS AND EXPERIENCE OF DISCOVERING FIRES FROM AIRCRAFT

WILLIAM G. MORRIS
Forester, Fire Research, Pacific Northwest Forest and Range Experiment Station

During the period 1950-56 about 250 fires on four national forests of Oregon and Washington were discovered by searchers in airplanes; 93 percent were only small spots when discovered.

To learn some of the circumstances of fire discovery from aircraft, the four national forests that were the most frequent users of aerial patrol were selected for study. The personnel kept special records concerning fires discovered and fires missed by aerial patrol, method of using the eyes while looking for fires, and conditions that might affect efficiency of an aerial observer. Of the 247 reports on fires first discovered by aerial observers, Wallowa-Whitman National Forest submitted 134, Okanogan 89, Mt. Baker 13, and Siskiyou 11.

Distribution of these fires according to size when discovered was as follows: (1) Spots too small to warrant an estimate in terms of a fraction of an acre—93 percent; (2) larger than the foregoing but not more than one-quarter acre—4 percent; (3) more than one-quarter acre—3 percent.

Lightning caused 96 percent of the fires and the remainder were man caused.

Discovery time—elapsed time from origin to discovery—was 3 days or more for 9 percent of the fires, and, as commonly happens with sleeper lightning fires, a few were discovered after 3 weeks. For those discovered in less than 3 days, the average time was 15 hours. Fires that were larger than one-quarter acre when discovered had, on the average, longer discovery times than the smaller fires. A fairly long average discovery time by aerial observers can be expected on these national forests. As shown above, most fires were caused by lightning. Since a large proportion of lightning occurs late in the afternoon or after dark, clouds and darkness usually prevent aerial search before the following morning.

Distance from observer to fire at time of discovery was recorded for 105 fires, and the average was 1.3 miles.

Most aerial discoveries—85 percent—were made during the first flight near the fire after ignition, while 10 percent were made during the second flight and 5 percent during later flights.

The forests reported 34 fires missed by aircraft searchers and later discovered by other kinds of detection. Average distance at which the flight passed the fire was 2.3 miles, and only

3 fires were in areas invisible to the aerial observers. These fires were very small at the time they were missed by aerial observers. Two-thirds were still only small spots when later discovered. Lightning fires often smolder several days[1] or even weeks before producing enough heat and smoke to be visible above the forest canopy. Many of the missed fires may have been this type.

In several years, reports were submitted giving the proportion of reportable and miscellaneous smokes first seen by quick scanning compared to slow and careful looking. By far the greater proportion were first seen while quickly scanning. As shown by supplementary memoranda by observers, some were found only after repeated circling and painstaking scrutiny of the general location where the observer knew a smoke had been previously seen. These were the thin small smokes that reflect little light and would probably be missed by quick scanning. Some observers stated they usually used a quick scanning method, but others usually used a slow and careful looking method. Some gave the visible area a preliminary quick scanning to detect clearly visible smokes and followed this with slower, systematic searching as time permitted. This method probably makes the best use of available time in completely covering the visible area and searching for poorly visible smokes.

In two years the observers were asked to determine whether length of flying time, rough air, or airplane noise and vibration affected their alertness in seeing the frequent nonreportable small white smokes, such as those from certain chimneys, mills, and permitted bonfires. They were equally divided in opinion as to whether long flying time decreased their detection efficiency. Most thought neither rough air nor noise and vibration were important factors.

The foregoing records of experience in aerial detection of fires on four widely separated national forests of Oregon and Washington should be useful when considering use of this detection system, estimating its reliability, and training aerial observers.

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[1]MORRIS, WILLIAM G. *Lightning Fire Discovery Time on National Forests in Oregon and Washington.* Fire Control Notes 9 (4): 1-5. 1948.

SIUSLAW FIELD HOSE WASHER

ARVID C. ELLSON, *Forester*, and ALBERT B. SHROY,
District Assistant, Siuslaw National Forest

The Siuslaw National Forest has a large and complex slash disposal problem. After a unit has been burned, mopup starts immediately. Water is used extensively. The hose used becomes caked with mud and ashes. The Siuslaw washer was devised for washing hose on the job as it is gathered in from the line.

The washer, made in a local shop at a cost of $13.65, consists of a stem and ring of 1-inch water or boiler pipe, two guide rings to keep hose centered, and a C-clamp for mounting the washer in any convenient place (fig. 1). Eighteen 1/16-inch holes are drilled in the pipe ring. Water is pumped into the washer under pressures of from 100 to 200 pounds.

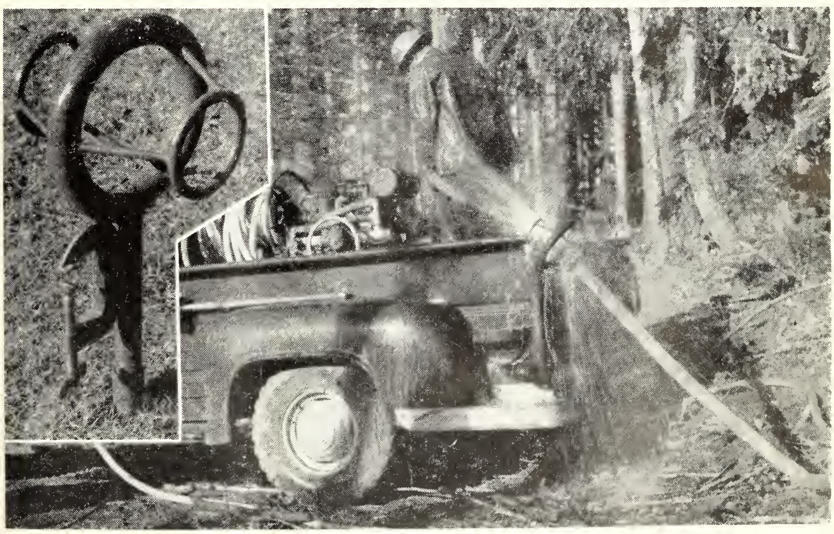

FIGURE 1.—Siuslaw field hose washer; in use clamped to tailgate of pickup.

At 100 pounds pressure the water use is approximately 21 g. p. m. At 200 pounds it is 30.7 g. p. m. These deliveries are well within the capabilities of the pumps used in Region 6.

SCOOTERS FOR TRAIL TRAVEL[1]

Compiled by Equipment Development Section
Region 1, U. S. Forest Service

A few years ago, leisurely foot or horse travel over scenic forest trails was considered by many as a part of the reward of forestry work. Foresters in general have not changed in this appreciation, but the steadily increasing cost of nonproductive trail travel is of considerable concern.

During the past 10 years, administrators have given serious thought to the possibilities of modified commercial scooters and other machines for use on selected trails. Experimental use has been attempted in various regions with not too promising results. Region 1 has been building, testing, and conducting a limited operational use program since 1945. Slow field acceptance has been due largely to an almost total lack of up-to-standard trails or to below-standard sections in the trail which are bottlenecks to scooter travel.

The comparatively recent program to mechanize trail maintenance, a cooperative effort of Regions 1, 4, 5, and 6, clearly demonstrates the need and the possibilities for faster and easier trail travel. Through this program, the development of scooters has been accelerated and present designs are proving highly successful in operational tests.

TRAIL SCOOTER DEVELOPMENT

Early commercial scooters tried on forest trails were underpowered for the steep grades and rough trail treads encountered. In 1946, a commercially made scooter was modified to obtain increased performance. This machine was powered by a 5-hp., 2-cycle engine. It incorporated a fluid coupling that eliminated the usual clutch and provided torque for holding the machine on steep grades by advancing the throttle. Other modified scooters were also tested to determine necessary performance requirements. The Forest Service completely designed and constructed a scooter for the first time (fig. 1).

A 1948 Forest Service model, built for testing over selected trails, provided loading space for equipment at the lowest possible position on the frame. Weight was again reduced slightly and performance increased. This machine is in current use and has worn out two sets of rear tires in trail travel.

In 1952, a "powered wheel" was constructed to test the balance and advantages of a large-diameter tire (fig. 2). With a trailing, stand-on platform, it became a slow-speed scooter. Although not successful, it was the first in a series of the stand-on type.

In 1954, a test scooter using the stand-on principle was constructed (fig. 3). The 2½-hp. motor provided power for 30- to

[1]This is a slightly shortened version of *Scooters for Trail Travel,* U. S. Dept. Agr. Forest Serv. Equip. Devlpmt. Rpt. 46, 10 pp., illus. 1957 [Processed.]

FIGURE 1.—This Forest Service 1947 model used a 6-hp., 4-cycle engine, with a fluid coupling incorporated in the drive arrangement. Weight was reduced by the liberal use of aluminum angles and tubing.

35-percent grades and a top speed of about 12 m. p. h. Where trail treads or grades did not permit safe riding, the handle over the gasoline tank actuated the clutch and provided power for "walking" the machine. With the operator in standing position, he needed only to step to the ground when trouble developed. Where treads were narrow and dangerous, one foot could be used in a manner similar to that of a boy riding a sidewalk scooter.

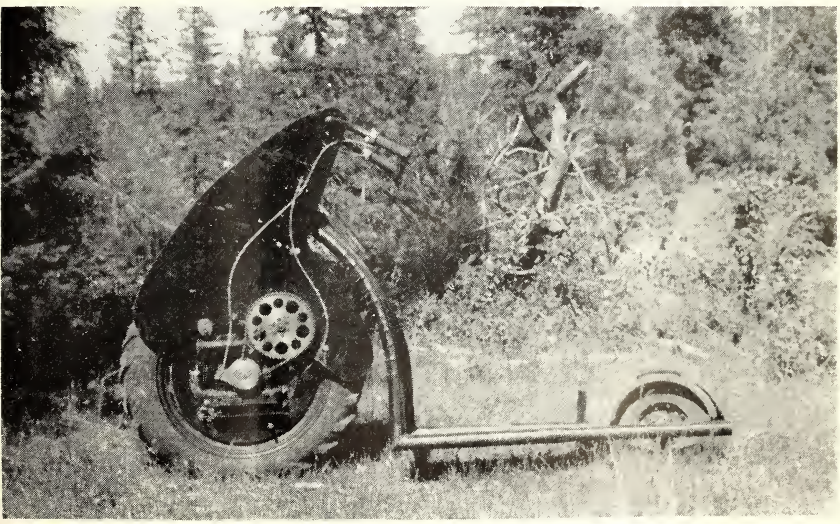

FIGURE 2.—"Powered wheel" with stand-on platform.

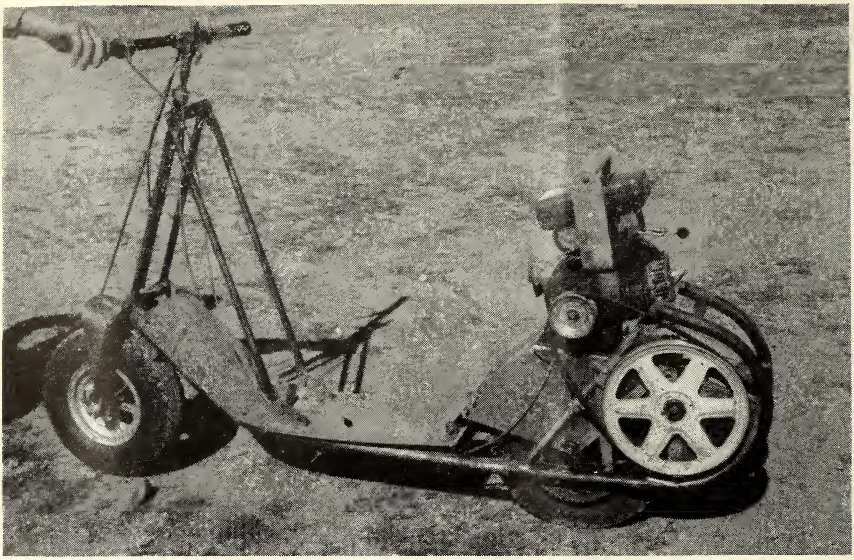

FIGURE 3.—This pilot model weighed only 126 pounds and could easily be manhandled at creek crossings and slides, or over logs. It could be folded for transportation in a passenger car.

A standard commercial model, modified in 1954 for trail travel, has adequate performance for any trail improved to a reasonable scooter standard. Initial cost, including modifications, is approximately $500. Space for hauling heavy loads or maintenance tools has been provided.

An improved model of the 1954 stand-on machine was built for field testing, and the next year performance was further improved and our experience broadened. Weight of the 1955 model was 135 pounds.

Another commercial model was modified for operational testing during the 1955 season, and a second machine, with modifications listed below, was used during 1956 (fig. 4). Riders state that the tank, located between the legs, gives better balance and control. They believe the advantages of this arrangement offset any reduction in safety compared with the open frame of the standard model. Considering that these heavy commercial machines are intended primarily for use on trails improved to at least scooter standards, any reduction in safety may be insignificant.

Modifications on this machine include the following:

1. Maximum possible reduction through enlarging the final driven sprocket and reducing to a minimum size the final driving sprocket.
2. Increase clearance of frame approximately 3 inches front and rear.
3. Remove footrests and modify frame so both feet are placed inside the frame for protection.
4. Rearrange brake and clutch controls so brake may be applied with either foot, and clutch is engaged by use of throttle only.
5. Rearrange carrier rack to accommodate greater load at minimum height.
6. Attach a smooth skid-pan to underside of frame to protect machine in rocky areas.

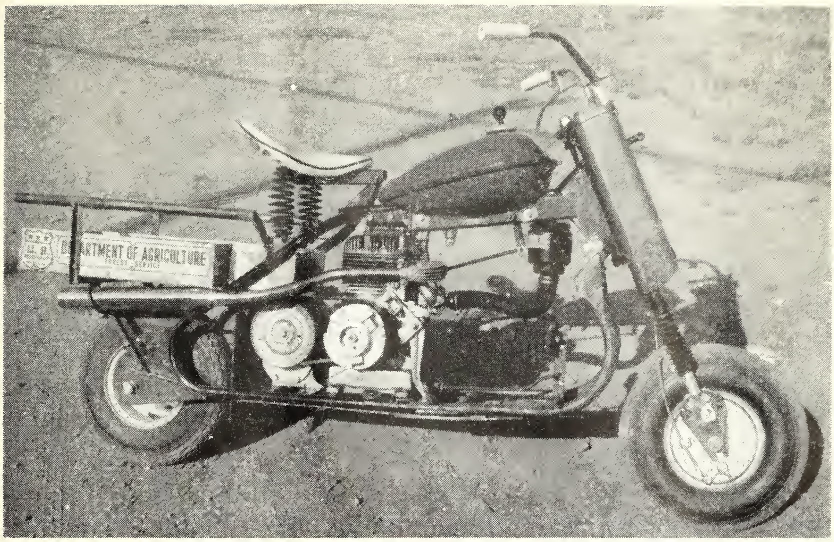

FIGURE 4.—The 1956 model has proved to be a nimble performer, and field forces in Region 1 prefer this machine for heavy hauling and travel over mechanized trails.

The 1956 model Forest Service stand-on scooter (fig. 5) incorporates several new features for observation and operational testing: (1) low-pressure air wheels without inner tubes used with special hubs that grip the tire bead to prevent any possibility of turning on the hub—a problem with conventional tires; (2) load space in front of operator for light loads such as

FIGURE 5.—This model has exceptional climb performance due to the increased traction. The low-pressure air wheels have also contributed materially to the clinging ability on sloping trail treads, and to a softer ride on rough trails. It is somewhat harder to steer and possibly slightly harder to balance than the previous models with smaller tires.

sleeping bag, personal gear, chain saw for "logging out," etc.; (3) simplified clutch and speed-change arrangement; (4) hydraulic front and rear brakes. Other features developed and tested in two previous models were generally maintained.

Our several years of exploratory and development work lead us to believe that there will be a need for two general types of trail scooters. The stand-on model offers maximum performance and safety for use on substandard trails. The cost advantage (commercial stand-on machines are estimated to cost less than $250) will permit a larger number for light maintenance work and administrative travel.

The standard and special commercial models, modified for improved safety and better trail performance, will be used on trails maintained to scooter standards. They are generally more comfortable to ride and can carry a substantial load in addition to the rider. If used on improved trails, where manhandling is not necessary, the heavy overall weight is not particularly objectionable.

A trail maintenance unit has been developed for scooter transport which permits one or two nights away from roads and stations. This usually provides sufficient time for maintenance men, riding scooters, to complete a continuous section without backtracking. Present plans in Region 1 contemplate mechanization for selected trails only. Their mileage is estimated to be about 50 percent of the total trail system or approximately 14,000 miles. The program will require 10 or 12 years with presently available financing.

CONTINUING DEVELOPMENT

We anticipate continued improvement in operational use, dependability, and handling characteristics over the next few years. Although no major programs are contemplated, a limited development program should be continued.

A design for commercial production of a stand-on machine for operational testing during the summer of 1957 had these important specifications:

1. Total empty weight not to exceed 135 pounds.
2. Air-cooled, single-cylinder motor of 3 to 4 hp.
3. Air-wheel tire in rear, 8:00 x 4 or larger. Front tire not less than 5:00 x 6 and may be normal pressure.
4. Usable trail speed 2 to 12 m. p. h. by means of variable-speed belt transmission with automatic clutch.
5. Dual wheel brakes; rear brake may be on jackshaft. Applied by hand pressure.
6. Arranged for "stand-on" operation.

Our experience has proved the stand-on principle for rough or dangerous trail use. There is a good possibility that the motor could be located immediately behind the front wheel to increase the torque leverage. (Present machines are limited in absolute climb by the tendency to "rear up" in front on 45-percent-plus grades, due to the considerable torque requirements and the exceptional tractive ability of the air wheel.) A seat could be provided (it probably would be desirable in some situations) that would swing back when the operator stood up or when he wished to "pedal" the machine with one foot for safety. All controls should be arranged on the handle bars to enable the operator to control the machine while walking alongside.

We have made arrangements to obtain a prototype air wheel, 16 inches in diameter, 12 inches in width, and with a 4-inch hub. This soft tire, which utilizes the "rollagon" principle, may be entirely suited to the stand-on scooter. A test program now under way will determine the possibilities.

Although the modified commercial scooters now available have proved very successful in operational use on improved trails, some development investigation should be continued. Early heavy-duty Forest Service designs proved the value of a fluid coupling in the final drive. We believe that if this coupling could be incorporated in the modification of heavy-duty commercial machines, there would be a considerable improvement in safety performance and handling qualities.

SCOOTER REQUIREMENTS AND PERFORMANCE

Any system for rating development progress will provide room for argument. A rating system does, however, provide a tentative comparison between machines and stress items of performance that are believed to be most essential. It is doubtful if any present carrier (scooter or motorcycle) would be rated 100 points (table 1). All would have some deficiencies.

Safety. The ideal personnel carrier for narrow trails and off-road use must first of all be a safe machine when operated properly.

Rough trail travel ability permits greater utility and contributes to many other performance features.

Mechanical dependability is achieved through proper design, skillful workmanship and the correct use of proper materials. The proof is found by experience.

Effective speed range. A machine capable of 25 m. p. h. would be useless for rough trail travel. To obtain an effective range from 3 to 25 m. p. h. is extremely difficult. The three scooters compared here have an approximate effective range as follows: USFS stand-on, 2 to 12 m. p. h.; modified commercial model #1, 4 to 18 m. p. h.; modified commercial model #2, 6 to 25 m. p. h.

The type of intended use has considerable bearing on the speed selection. The stand-on, for example, is intended for very rough trails, therefore, a slower speed is necessary. With a sacrifice of top speed, we were able to utilize a small and light motor to climb very steep grades, and maintain minimum machine weight for ease in manhandling when necessary. The modified commercial models would have rough going in these areas since the operator would need to travel too fast for maximum safety in order to obtain necessary traction.

Ease of handling has been rated 10 points, maximum. It is possible that a machine might rate zero for ease of handling but have superior performance in all other respects.

TABLE 1.—*Scooter requirements, tentative rating, and comparison of performance*

Requirement	Maximum rating point	Forest Service stand-on	Modified commercial model #1	Modified commercial model #2
Safety of operation (controls, brakes, skill requirements, position)	20	18	15	13
Rough trail travel ability:				
Climb grades of 45 percent or more (average traction)	5	5	2	3
Descend grades of 45 percent or more (average traction)	5	4	2	3
Travel rough, rocky trails; stream crossing	5	4	4	4
Traverse sloping trail treads (sidehills)	5	5	2	3
Mechanical dependability	15	10	12	12
Effective speed range (3 to 25 m. p. h. trail and road travel)	15	10	13	13
Ease of handling:				
Easy to balance and steer (crooked, rough trails)	5	4	3	4
Easy to manhandle (turning, walking, loading, lifting, carrying)	5	5	1	2
Load capacity, 100-pound load plus rider	10	5	9	9
Economy of operation	5	4	3	3
Comfort of operations, riding (fatigue elements; quality of ride)	5	3	3	4
Total	100	77	69	73

Load capacity of 100 pounds in addition to the rider would certainly add to the utility of any carrier. The stand-on scooter is limited in its ability to carry equipment and supplies in excess of 30 or 40 pounds. It is, therefore, rated accordingly.

Economy of operation.—Exceptional performance could easily offset poor economy.

Comfort of operations.—The same argument applies to comfort as to economy of operation.

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.


Smokey Says:
BE CAREFUL
WITH MATCHES
WITH SMOKES
WITH ANY FIRE
SMOKEY
Remember - only you can
PREVENT FOREST FIRES!

OL. 19 APRIL 1958 No. 2

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 19 Number 2

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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CONTROL OF AIRCRAFT ON FOREST FIRES

CARL C. WILSON
Forester, California Forest and Range Experiment Station[1]

The many new uses of aircraft in fire fighting have posed numerous problems in organizing air operations. This article describes the functions that are necessary for a safe operation and suggests one way of fitting them into the conventional fire fighting organization. This plan has not been adopted as the standard organization by the Forest Service.—Ed.]

If you have flown by commercial airline recently, you must e aware of the elaborate precautions taken to assure that each lane arrives safely and on schedule at its destination. Few conrols were needed when Lindbergh made his historic flight, but oday major airports are beehives of traffic and rigid air traffic ontrol is essential.

When the first air patrol was organized in California, few angers could foresee that air traffic over forest fires would ever e a critical problem; today air attack[2] has come of age and airlanes are commonplace over our forests. In 1957 air tankers ropped water and fire retardant chemicals on 101 forest and rush fires, and helicopters delivered specially trained fire fighters) 42 small fires.

DEVELOPMENT OF AIR ATTACK

The breakthrough in fire fighting techniques involving airraft probably began in 1919 when Regional Forester Coert du-oise and Major "Hap" Arnold organized a regular patrol for ie west side of the Sierra Nevada. It may have started in the arly 1920's when serious thought was first given to fighting re by dropping water from aircraft. It was given a big boost in 936 when extensive aerial bombing experiments were conducted 1 California by the Forest Service.

We like to think that modern air attack began during Op-ration Firestop in 1954 when all sorts of new tools, methods, nd techniques were studied in southern California. During this -year crash program, helicopters were used to lay fire hose, arry helitanks, and fan backfires. A torpedo bomber dropped 00 gallons of water from its bomb bay on a test fire.

Then in 1955 the Mendocino National Forest demonstrated iat a low-flying crop-duster plane could carry and drop as much s 120 gallons of water at a time. Trials on wildfires showed the ir tanker could be helpful to the ground forces.

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

This report is made in collaboration with the California Air Attack xecutive Committee. The committee coordinates air attack research and evelopment in California. Representatives are from the California Division f Forestry, and from Region 5, Arcadia Equipment Development Center, nd California Forest and Range Experiment Station of the U. S. Forest ervice.

[2]Tactical air support for ground forest fire fighters.

These trials were so promising that in 1956 a fleet of 7 agri cultural-type airplanes became part of the California fire fightin force. These planes fought 25 fires from the Oregon border to th Mexican border by cascading sodium calcium borate and plai water through the dump valve in the bottom of their tanks. Ai support was a deciding factor in assuring control of 15 of the 2 fires and was a definite help to ground forces on 5 others.

OPERATIONAL DIFFICULTIES GROW

But operational problems showed up. Air traffic was hard t control, and it was difficult to coordinate the air arm with th ground forces. These problems were magnified on large fires. Fo example, air traffic control was extremely difficult on the 10,250 acre McKinley Fire on the San Bernardino National Forest i 1956. In addition to the 7-plane air tanker squad, 1 experimenta TBM air tanker, a reconnaissance plane, several cargo ships, helicopters, and many sightseeing craft were over the fire area

Near misses occurred in the smoke. Scouts in helicopters ofte were forced to stay on the ground while the air tankers wer making drops. Condensation trails from jets blended with th smoke from the fire. An overtaxed fire organization was burdene by the problems of air traffic control, and local forest communi cation channels were jammed. Fortunately, no air crashes occur red.

As the 1956 season progressed it became more and mor apparent that aircraft, like any other specialized fire tool, have t be closely coordinated with other fireline action. When an ai tanker attacks a fire, for example, its effectiveness depends o timing and accuracy, and this can be assured only if there ar good air-to-ground and ground-to-air communications. The spee of these aircraft further emphasizes the need for careful contro

CONTROL NEEDS ANALYZED

In February 1957 specialists in ground fire fighting, aircraf and organization met at the California Forest and Range Exper ment Station to plan an organizational pattern for use on fire where there is tactical air support. First, all of the useful ai functions that can be performed by long-range transport, shor range transport, attack, and reconnaissance types of aircraft we summarized and classified. Next, present aircraft capabiliti were listed for all commercial models, both fixed-wing and r tary-wing craft, that are used or might logically be used by fi agencies in California. These categories were separated by t four types of aircraft already classified.

Fire situations were then classified in terms of changing ai craft requirements. These situations included pre-fire and fir detection reconnaissance, and Class A and B, Class C and D, Cla E, and multiple fires.

The most important part of the analysis job came next, i. e determining the method of control for particular air operation Each fire situation was built up from the simple detection nee after a lightning fire to the Class E fire conceivably involvi fixed-wing ships to deliver smokejumpers, make cargo drops, and serve as air tankers; and helicopters for reconnaissance, laying hose, dropping water, and delivering helipumpers and manpower.

NEW ORGANIZATION SUGGESTED

After the aircraft requirements and control problems for each fire situation were reviewed, it was evident that special control jobs had to be performed in each situation. For example, a man was needed to direct aircraft operations on each air mission and on each fire. On a large fire this man might serve under the direct supervision of the fire boss with close liaison with the plans, service, and line units. On small fires the fire boss logically could handle this job.

The primary assignment of this man would be to maintain direct control of all aircraft movements and supervise the officers who direct the airports or heliports within the immediate fire area. He would inform the fire dispatcher of the aircraft needed for missions ordered by the fire boss and maintain records and reports as required. The man chosen for this job should be familiar with the capabilities and limitations of all aircraft used and by all means should be well trained in fire fighting. This proposed assistant to the fire boss would be called an "Air Control Chief."

It was also evident that a man was needed to direct air operations at a specific airport or heliport—a job usually handled in the Forest Service by an Air Operations Officer. This man would orient and brief ground and flight crews and maintain all necessary records. At a commercial airport he maintains liaison with the airport manager. Officers in this job outside of a fire area ordinarily report directly to the central dispatcher. Inside the fire area they report to the Air Control Chief. This man would be called an "Air Traffic Manager."

It was agreed that an "Air Unit Leader" should be selected when two or more aircraft of the same type are assigned to a specific mission. (In California we have used a reconnaissance ship to direct each air tanker to its target. This plane is called the "Bird Dog," and the pilot and his passenger function as the Air Unit Leader.) In or near an airport or heliport this man would report to the Air Traffic Manager. In the fire area he would report to the Air Control Chief.

The interrelationship of these proposed positions and the established fire organization is shown in figure 1.[3]

PROPOSALS APPRAISED

The proposed organizational pattern was reviewed by representatives of the major California fire agencies, the California Forest and Range Experiment Station, and the Washington Office of the Forest Service, and was approved for field testing during

[3]To assure that these proposed air control jobs function smoothly, the need for good radio communications is emphasized. Often a separate air net will be required.

INTEGRATING AIR OPERATIONS
INTO
CONVENTIONAL FIRE ORGANIZATION

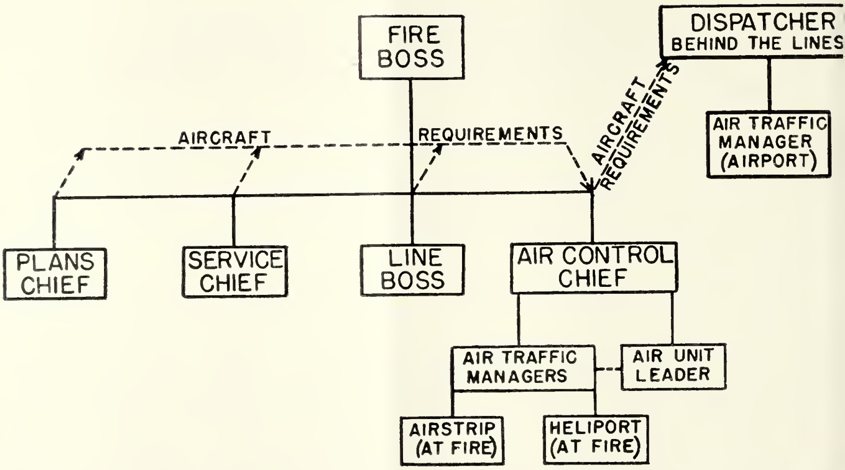

FIGURE 1.—How the suggested air operations positions fit into conventiona large-fire organization. The solid lines indicate the direct command relatio ship in a fire operation. The dash lines show coordinating or advisor relationships. This proposed organization for air operation in fire fightin was field tested in California in 1957.

the 1957 fire season. Reports from the field indicate that ther were numerous breakdowns in carrying the plan out. Lack o trained forest officers to fill the new air control positions and ir adequate radio communications were the main reasons.

On the other hand, there were reports to show that a wel planned air control organization produces excellent results. Or such report by experiment station employee James Murphy dem onstrates how such an organization was used effectively on th Angeles National Forest.

"The air arm consisted of 7 air tankers, a 'Bird Dog' plan and 3 helicopters. The air tankers and 'Bird Dog' were operatin out of the Palmdale Airport about 10 miles from the fire. Th helicopters used a base heliport near the main fire camp. Th situation was critical because there was another major fire o the forest, and some of the aircraft were shuttling back an forth to it. The fire boss assigned an assistant ranger to th Air Traffic Manager job at Palmdale; the Helitack foreman t the Air Traffic Manager job at the nearby heliport; and I becam the Air Control Chief. The 'Bird Dog' pilot functioned as Ai Unit Leader for the air tankers.

"Here's how we operated: When an air tanker drop wa needed on a particular section of line, the fire boss requested th drop through me and gave the location by sector number. I re layed the request to the Air Traffic Manager at the airport, an he assigned the air tankers to the mission. The Air Unit Leade led the ships to the fire. As soon as the tankers were airborne, I asked the heliport Air Traffic Manager to ground the helicopters operating in the drop sector. When the Air Unit Leader and the tankers arrived in the drop area, I notified the Division or Line Boss in that area and he worked closely with the Air Unit Leader in getting the drops where he wanted them.

"When the last tanker made his drop, the Air Unit Leader reported to me (Air Control Chief), and the tankers were cleared to return to the airport. I then notified the base heliport that they could resume operations. It sounds complicated, but it isn't if the communications system operates well. If it doesn't, the safety record can go sour in a hurry."

We know, of course, that the safe way is the most efficient way to fight forest fires. As ground fire equipment became more specialized, we recognized the need for specially trained men to supervise new tools. Cat bosses and pumper bosses are common on most big fires now. On the other hand, we have been slow to see the need for special personnel to direct our new system of air attack. Strict air traffic control is mandatory if we expect to have safe and effective air operations on forest fires. Safety and efficiency are functions of coordination, and coordination is possible only with adequate communications.

AIRCRAFT SUPPORT OF FIRE CONTROL IN NORTH CAROLINA

R. C. WINKWORTH

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The North Carolina Division of Forestry now owns and operates a small but highly efficient fleet of three liaison type aircraft for fire control purposes. This vital support unit has evolved during the past 9 years from a beginning when field fire control men attempted to satisfy the obvious need for air scouting by authorized use of local aircraft and pilots. Present operations are under established policy which includes planned expansion for the future. This article summarizes lessons learned during this period of development and outlines current thinking on the future use of aircraft in this southeastern State.

At present, air support is used in the presuppression jobs of detection and smokechasing and in several prevention jobs, including fire investigation and law enforcement. In suppression, planes are used for long- and short-range transportation of material and personnel, logistic support of remote ground crews, and scouting. Direct attack is in the experimental stage. Because of the number of large fires, the suppression values of the existing fleet far outweigh those of prevention and presuppression. In the inaccessible areas, particularly of the Atlantic Coastal Plain, scouting service alone more than justifies all costs.

PRESUPPRESSION AND PREVENTION

Detection from airplanes has proved to be a supplement but not a substitute for detection from towers. The critical factor in successful use of aircraft for various types of patrol service is the fact that the degree of intensity required sharply limits the size of the patrol area that can be covered. This ratio of intensity to area depends upon local conditions and must be established by local experience. For example, use of a patrol plane in high occurrence areas, or where brush and field burning is prevalent, must be restricted to a relatively small area because of time lost in locating and investigating the numerous smokes. Regular use of aircraft in lieu of a group of towers during periods of marginal danger, such as at the beginning or end of fire season, appears to have doubtful economic value in the big woods areas of the coastal plain region. Cost studies showed other parts of the State to be more promising. In contrast, aircraft patrol in specific high-hazard areas following dry thunderstorms and during periods of limited visibility has been highly successful.

Use of a plane to supplement smokechasers in "hot" areas during critical periods has also been of extreme value. By taking station between two or more primary towers, the pilot is able to monitor tower radio traffic. He can pinpoint smokes, identify wildfires, and determine best means of access almost before the smokechaser has time to leave his station. Smokechasers are thus saved unneccessary trips.

Excellent prevention work can be done by use of a plane-to-ground loudspeaker for warning brush and field burners. Doubtful cases are referred by radio to smokechasers for personal warning or assistance. As in smokechasing, the plane takes station in a "hot" area and utilizes the tower radio traffic. The planes are well marked and easily identified from the ground.

Chronic prevention problems require more vigorous measures. Handbills, copies of the fire law, and other prevention messages have been dropped to people in the woods in special prevention campaigns. A very serious deer hunter problem has been eliminated by repeated annual projects of this nature.

The possibilities of radio coordinated air-to-ground law enforcement have not been fully explored. The value of the aircraft as a deterrent to incendiarists is quickly apparent, and results in several areas can be amply verified. North Carolina has not actually sent an incendiarist to court as a direct result of aerial observation but sufficient observations of fires of a questionable origin have been made to develop field procedures which are accepted with confidence. Cameras are carried on all flights and photographic evidence has been used successfully in one critical felony case.

Brush burner law enforcement offers an easier field. Patrolling aircraft happen upon a considerable number of farm fires at the instant of origin, and coordination with the ground smokechaser offers no problem to a well-trained pilot. A polaroid camera has been used successfully to photograph escaping fires as they enter the woods. This type of evidence has been unquestioned in court cases to date.

The key to effective use of aircraft in prevention and presuppression seems to be in restricting the area covered. This concentration must be to such a degree that the local people recognize the aircraft. The Division of Forestry has now adopted a distinctive color scheme for its aircraft with this purpose in mind.

SUPPRESSION

Scouting of large fires and fires in large inaccessible areas has been the primary aircraft mission since the beginning. Dispatch of a plane to such fires is now automatic. All tractors in the big woods areas are radio equipped and marked for easy identification from the air. They are kept in sight and in communication practically throughout the daylight hours.

At times the fire boss actually directs critical operations from the air. This practice can be overworked, however, and could result in neglect of other important duties. This emphasizes the need for trained pilots and, equally important, trained observers. It also calls for the delegation of responsibility by the fire boss to these key men.

All of the normal scouting functions can be accomplished from the air. In the rough inaccessible swamps of eastern North Carolina the plane is actually the only efficient means of scouting. The time saved is too great to attempt to measure and supplementary ground scouting is seldom needed. By use of two-way radio, amplifier, message drop, polaroid camera, and visual signals, communications are very satisfactory. The success of aerial scouting depends entirely upon the use of the right aircraft and intensive training for pilots, observers, and ground crews.

One of the most vital services performed in scouting work is guiding tractor crews in areas of soft ground and heavy underbrush. In addition to keeping the tractor "afloat," this service makes tractor operation safer by insuring escape routes. Crew morale shows a marked improvement when fire fighters know that the plane will get them to safety in case of emergency and keep them from getting lost or traveling unnecessary distances. The plane observer is literally the eyes of the fire crew. Painting top surfaces of equipment yellow and painting radio calls on the tops of all tractors and other woods vehicles is a must.

Parachute dropping of equipment and supplies from Cub aircraft had to be developed from study of larger plane techniques and knowledge of local needs. A cheap homemade cotton parachute has been designed in 3¾-foot and 7½-foot diameters and has proved highly efficient operationally. Some materials are dropped free fall. Most commonly dropped are hot meals, drinking water, coffee, tools, and spare parts. Practically everything from aspirin tablets to items of clothing have been dropped and a fleet of four tractors was supplied with fuel for several hours on one occasion.

Air transportation has been limited by the normal use of two-place scouting planes, but enough has been accomplished, with help from contract planes, to clearly demonstrate the need for a fast four-place plane. In addition to transportation of key personnel such as project fire overhead and tractor drivers, freight transportation could be expanded to include machinery parts and other heavy or bulky items. The type of plane to be selected would have enough reserve power, weight, and stability to operate from roads and restricted strips in weather that limits normal operation.

A National Guard C-47 has been used on one project fire for long-range transportation of personnel. Tremendous savings of critical time and personal effort were realized. This item of military cooperation has been included in fire plans as a standard practice.

Progress in direct attack by aerial delivery of water, retardants, and other chemicals is being watched with considerable interest. Some preliminary experimenting has been done with packaged and free fall water. Intensive tests are planned by the Southeastern Forest Experiment Station of the U. S. Forest Service in cooperation with States and other agencies in the immediate future. Use of the PBY tanker, operated from water, looks like the best possibility for eastern North Carolina at this time. Aerial attack in some form could be the answer to many of the serious problems.

TYPE OF EQUIPMENT

The ideal scouting plane should have these characteristics for—

Observation.—High wing, two-place, tandem seats, slow speed operation (flaps), fast rate of climb, and good cockpit windows.

Safe operation.—Plenty of reserve power, inherent stability, low stalling speed, rugged landing gear, safe cockpit design, and short field takeoff specifications; auxiliary equipment including crash helmets and shoulder straps for the front seat; a bright color scheme on top surfaces for rescue purposes.

Cross-country flying and sustained operation.—Adequate speed, good fuel supply, primary instrument panel, landing lights, CAA (preferably omninavigational type) and forest service radio, comfortable and quiet cabin (to lessen fatigue and help communications), and low operating cost.

While no single aircraft will possess all of these features, the Super Cub type has many. Surplus military artillery spotting aircraft would be excellent.

The four-place plane should have as many of these features as possible with emphasis on the safe operating and cross-country ones. Reserve power is a must in fire work and justifies much higher costs in choice of makes and models. Good built-in radio equipment is also a necessity. All planes of the fleet should meet all critical standards, regardless of variations in local needs, so that all equipment can be used without restriction in an emergency.

TRAINING

Training of pilots, observers, and ground personnel is a never-ending job. Pilots must become rangers to the extent of being able to anticipate and understand what the observer wants to see and the fire boss wants to know. They must understand the fire control organization thoroughly. Low flying in the immediate vicinity of smoke, convection columns, and artificial drafts, and road and strip landing are routine. Even competent crop dusters have much to learn.

The observer is the key man in critical situations and he requires more training than any other man in the entire fire control organization. North Carolina gives formal training to beginners to assist them in mapping, recognizing fuel types, handling communications and drops, and becoming familiar with the aircraft. Only by trial and error over a long period of time can he develop ability to judge rate of spread, flotation of heavy equipment, degree of underground burning in peat bogs, and fire behavior. Personnel must be experienced as fire control overhead and have a love for flying to become qualified.

All regular observers in the North Carolina Division of Forestry are being given pilot training. In addition to the obvious advantages of safety and aircraft familiarization, this program is aimed at alleviating the serious problem of pilot fatigue on project fires. Routine flights, such as trips for fuel and supplies, will be flown by substitute pilots.

Ground crews must be trained to understand the limitations of the aircraft, to handle communications, including emergency signals in case of radio failure, to receive drops safely, and to make full use of the plane and observer. This is accomplished as part of the curriculum at regular annual ranger training schools.

HELICOPTERS

The practical use of the helicopter as an operating aircraft in North Carolina is still in question because of the tremendous cost difference and pilot skill required. A highly trained and experienced crew in a Super Cub can accomplish almost as much in aerial scouting as can a helicopter and with several advantages, including an operating cost about 5 percent of that of the helicopter.

Military helicopters have been used on fire work in the State for about 7 years. Such services as crew delivery and relief in inaccessible areas, rescue operations, hose laying, and direct pumping cannot be approached by fixed wing aircraft. But purchase of a conventional helicopter by the State is not anticipated in the near future.

A new design one-man rotor type aircraft that works on the old autogyro principle (no power to the rotor) is now available at a low cost. Very little is known about its performance as it is still in the developmental stages. But it is a fact that it can be transported in a station wagon, flown safely by any pilot after a brief checkout, and operated at the cost of a Cub. It is designed for tree-top use and can be slowed to about 15 miles per hour (cannot hover). Present flight range is about 2½ hours. Development of this craft is being watched closely.

ADMINISTRATION

Past experience and lessons learned from others have established a few principles of aviation administration that North Carolina personnel have accepted:

1. State-owned aircraft and regularly employed pilots allow a standard of quality and safety unobtainable from contract flying. When justified, maintenance men should also be employed.
2. Because the plane is a fire control tool, all flying operations should be supervised by fire control officers, not set apart in a separate branch of the organization. Operational supervision should be under appropriate field overhead. Maintenance, CAA regulation, certain aspects of training, and other administrative procedures and policies should be delegated by the fire chief to one central office administrator.
3. The central office administrator should be responsible for keeping written policy current and for future planning. All policy must recognize that the pilot is captain of his ship.
4. As a matter of good practice, all administrative personnel dealing with aviation should become pilots.

SUMMARY

An effective program of aircraft support for fire control operations has been developed in North Carolina. Its success has been due to good equipment, highly trained personnel, careful operational use, and written policy. The morale factor which results from a flow of information from the air to fire fighting crews is in itself an important development. With keen administration, careful research, and vision, the probable future growth of aviation as a fire control tool in the Southeast is almost unlimited.

AIRPLANES FOR DIRECT ATTACK ON FOREST FIRES IN THE NORTHEAST

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Airplanes have been used in forest fire control activities in the Northeastern States for many years. In Maine, for example, a hired plane was used as early as 1927 for detection and observation. Since 1933, State-owned and rented planes have been extremely useful in detection work, in scouting going fires, and in transporting men and equipment to fires in areas not easily accessible by road or trail. However, so far as I have been able to learn, airplanes have not been used in direct attack on forest fires in any of the Northeastern States.

A lively interest in the use of planes for dropping water and chemical retardants is being shown by several State forestry departments and fire control personnel in Region 7 of the U. S. Forest Service. There is also interest in helicopters for specialized use. New York State has tentative plans to acquire a plane for use in dropping water or chemical retardant on fires. Maine is reportedly considering the purchase of a helicopter. Forest Service officials in Region 7 are making preliminary plans with the States to obtain equipment and stage demonstrations of direct air attack.

Devastating forest fires will occur in the Northeast when conditions are right for such fires. One area in particular has a history of fires that have crowned and spread rapidly over large acreages. This area embraces about 4 million acres of rather flat land along the Atlantic coast, extending from the vicinity of Machias, Maine, through southern New Hampshire, eastern Massachusetts, Rhode Island, Long Island, and the pine region of New Jersey, to the Eastern Shore of Maryland. The soils in this area are mostly sandy and droughty. Humus types are mostly mors, which means the forest litter accumulates on the soil surface rather than being incorporated as humus. Hard pines, white pines, and various oaks, mostly of scrubby form, make up the bulk of the stands.

Over considerable portions of the coastal area mentioned above, real-estate development in rural wooded sections is advanced. This development consists of yearlong residences, summer homes, and an increasing amount of industry, which in recent years has tended to locate away from urban centers. Much of this real estate is subject to destruction by fast-moving crown fires, and human casualties are a definite possibility.

In view of the relatively level terrain and the generally low tree heights, airplanes could operate very effectively in the coastal areas. Recent reports indicate that under certain conditions, chemical fire retardants dropped in advance of a crown fire in second growth have succeeded in bringing the fire down out of the crowns so that ground crews could attack directly. In the Northeast it may be possible to knock down some fires in this manner. If prompt air attack were made on incipient fires in hazardous areas, when warranted by burning conditions, many of these fires which might otherwise escape from initial attack should be controlled without difficulty. In dealing with surface fires the plane would drop water or chemical retardant directly on the advancing edges of the fire. Ground crews would of course complete control and mop-up.

Airplanes for direct attack should be tried in this Coastal Plain area. Tests should include drops of both plain water and chemical fire retardants; and insofar as possible they should cover the major fuel types under a variety of weather or burning conditions.

Due to similarity of terrain and cover, a test in any one locality should be fairly indicative of what can be accomplished throughout the northeastern Coastal Plain. McGuire Air Force Base and Lakehurst Naval Air Station are both located within the high-hazard pine region of New Jersey. It seems quite probable that arrangements could be worked out to use their facilities in conducting tests in this area.

☆ ☆ ☆

Airplane Helps Catch Incendiarist

March 5, 1956, on the Poplar Bluff Ranger District in Missouri started as an uneventful day of an average fire season. No fires had occurred in the morning and none of any consequence were expected.

At noon that day two 22-year-old country boys, with criminal records, were eating lunch at a highway cafe and planning their afternoon activities. And Missouri Conservation Commission Pilot Bob Larkins was in the air patrolling the State-protected land west of the Shawnee National Forest.

An hour later the 2 boys parked their car, went north of the main highway, and set 2 fires. They crossed the highway and walked about a mile east through the woods where they made the third set. Then for approximately 2 miles in a southeasterly direction they set fires every 25 to 50 yards.

Within minutes after the first set, which was discovered by a Forest Service lookout, crews were dispatched to the fire and others were being organized. As Ranger Paul R. Larsson and the headquarters fire crew reached the fire, they received word by radio that Pilot Larkins was scouting the fire and had seen the two men making a set. The pilot added that he believed he could keep one of the fire setters in sight and that if someone would come to the vicinity he was circling there would be a good chance of catching him.

By a circuitous route of about 7 miles by car and then on foot, Ranger Larsson arrived below the plane which was circling just above the tree tops. On the ground, with his shirt off and his face buried in the leaves and needles, lay the fire setter. Pilot Larkins shouted down to the ranger, "That's him!"

The fire setter was taken to the ranger station and turned over to the FBI. His trial will be held in Federal court after he has been released from the State penitentiary where he is serving a 2-year sentence for a crime committed before his fire-setting spree.

This is an excellent example of airplane and ground coordination as well as cooperation between the State and Federal organizations.—*Shawnee National Forest.*

WATER DROPPING FROM FLOAT-EQUIPPED PLANES

Ontario Department of Lands and Forests

Development of equipment for dropping water from float-equipped aircraft in Ontario dates back to 1944-45. At that time a system of valves was built into the floats of a Norseman aircraft to enable the pilot to take water into the floats while on a lake and release it as required while in flight. This system was abandoned for several reasons, the main one being the inability to make a drop in sufficient bulk.

By 1950 we had developed a water bombing technique. This involved the use of latex-lined paper bags each filled with 3 imperial gallons of water, dropped in salvos of up to eight bombs from a roller conveyor mounted in the floor of the Beaver aircraft fuselage, the drop being made through the camera hatch.

Our most recent development, the installation of a 90-gallon rotating tank on each float of the DeHavilland Otter, is briefly summarized in this article. The tanks and control system were developed by the Air Service Division of the Ontario Department of Lands and Forests at Sault Ste. Marie, Ontario. The primary aim was "To drop the greatest possible amount of water in the shortest possible time with a minimum delay in pickup and assembly, the whole operation to be handled by one man—the pilot."

The "greatest amount of water" was governed by the weight load capacity of the aircraft. The time it took to release the water depended on the size of the discharge opening which, since the aircraft would be moving at approximately 120 feet per second, would have to be quite large if the water was to be concentrated at the target.

Investigations proved that the maximum discharge area allowable with an internal tank emptying through the camera hatch in the rear of the fuselage was 150 square inches. This was obviously insufficient. The port cargo door was then considered as an alternative and we built an internal mockup tank which allowed an opening of 400 square inches. This was still not considered satisfactory. We also had the problems of release mechanism and floor anchorage.

Because of these problems and limitations, the internal tank was abandoned in favor of two rotating tanks carried externally. This system offered the following advantages: (1) Total discharge area of 1,400 square inches; (2) carrying the tanks would not interfere with normal operation and load capacity of the aircraft; (3) no appreciable change in the center of gravity of the aircraft; (4) it could be applied to both Beaver and Otter aircraft which make up our air fleet.

Each tank, made of 0.081 half hard aluminum, is 6 feet long and 22 inches in diameter. The opening is 10 inches wide and runs the entire length of the tank (fig. 1). Total capacity of each

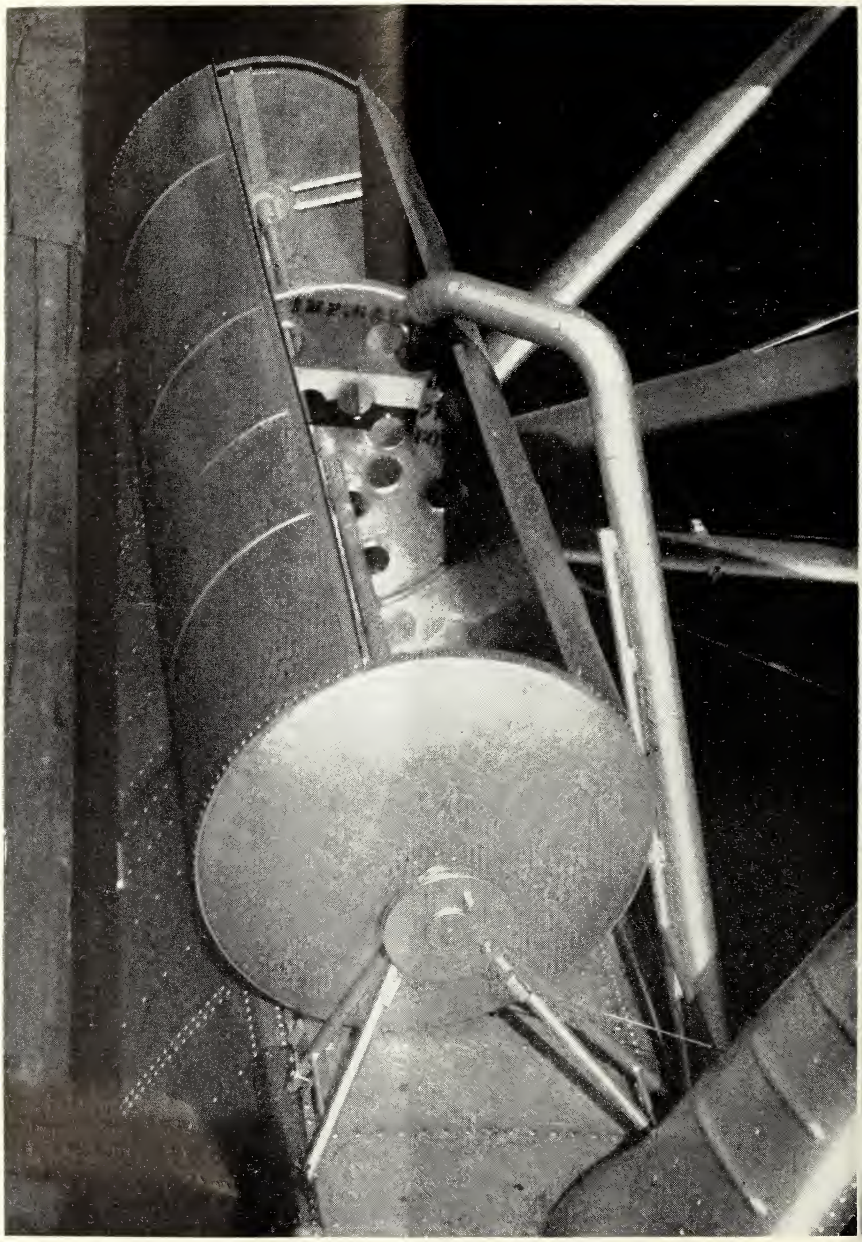

FIGURE 1.—Front view of starboard tank.

tank is 97.5 imperial gallons, operational load is 80 imperial gallons. Tubular frames support the bearings and provide attachment points to eye bolts mounted permanently on the floats.

The two filling scoops are made of $2\frac{1}{2}$-inch-diameter steel tubing welded to a tubular frame attached to the float at the beaching gear lug and supported by two additional eye bolts at the top of the float. Each scoop is removed by the withdrawal of the clevis pins from the eye bolts.

The tanks are filled in 10 seconds at an airspeed of 40 m. p. h. under calm conditions. Total time from "touch-down" empty to "take-off" full (wind 5 m. p. h.) is 18 seconds.

The tanks are rotated by means of a lever on the floor of the cockpit at the pilot's right hand. This lever actuates control cables connected to 5½-inch aluminum pulleys fixed to the front end of each tank axle. The tanks return to the upright position when the control lever is released.

Although the tanks do not interfere greatly with the normal operation and load carrying capacity of the aircraft, they can easily be removed. Two men can install the tanks in 10 minutes. Total weight of tanks and scoops is 175 pounds. The tanks can easily be carried inside the aircraft.

FIELD TESTS

Field tests were needed to determine pattern and density of water distribution. Several 160-gallon drops were made from an estimated height of 100 feet to a dry concrete surface (fig. 2). In addition, two drops were made with part loads equal to the carrying capacity of the Beaver aircraft (50 gallons per tank). For various flight directions in relation to wind, the water pattern had the following dimensions, with the longer along the flight line:

	Wind velocity (m. p. h.)	Pattern: Length (feet)	Pattern: Width (feet)
160-gallon drop:			
Into wind	10	285	85
Down wind	10	315	85
Cross wind	2	375	75
Cross wind	8	260	100
Cross wind	16	285	135
100-gallon drop:			
Into wind	10	320	90
Cross wind	8	260	100

Observations indicate that although the area of greatest saturation for a given height varies little under the above wind speed range, the wind does blow the lighter spray a considerable distance when no trees are present to intercept it.

An arrangement of rain gages set out in an open field, under a coniferous cover, and in a hardwood stand provided specific measurements of water density. Each area was subjected to ten drops into the wind aimed at a target in its center. The 25 rain gages in the open field, where wind velocity was 5-7 m. p. h., showed traces of water as far as 75 feet out on both sides and almost 300 feet along the line of flight.

The coniferous stand, typical black spruce-balsam fir, had 460 trees per acre with an average diameter breast high of 7.6 inches and an average height of 78 feet. The 24 rain gages were placed at 10-foot intervals in four rows 10 feet apart. Ten drops were made at 3-minute intervals from an estimated height of 100 feet.

FIGURE 2.—Water drop from tanks on the floats of an Otter aircraft.

Relative humidity, taken at intervals in the center of the target area beneath a large tree, rose from 65 to a maximum of 87 percent. After the fourth drop, a steady dripping of water from the trees similar to that experienced during a brisk rain shower continued throughout the test period and for 30 minutes after the last drop, at which time the relative humidity had decreased to 69 percent. Water density varied from 0.025 in some gages at the outer edge of the 30-by-50-foot target area to 0.25 toward the center. Distribution in general was fairly uniform, with an average density of 0.085.

The hardwood stand had 1,980 trees per acre with an average diameter breast high of 2.9 inches and an average height of 27 feet. This was an immature stand of aspen with scattered white spruce and birch having an understory of balsam fir and scattered willow, alder, and mountain maple. Here also the 24 rain gages were set out at 10-foot intervals in four rows 10 feet apart.

Ten drops were made at approximately 3-minute intervals from an estimated height of 75 feet. Trees in the center of the target were swayed violently by the impact of the water. After the tenth drop, the target area was completely saturated. Relative humidity in the target area rose from 73 to 93 percent after the third drop. Water density recorded by the gages ranged from 0.03 to 0.40 and averaged 0.225, about 2½ times that for the coniferous stand. Except for a few gages, water was very well distributed.

CONCLUSIONS

The factor that most influences water pattern and density is altitude. The lower the aircraft is flying at the point of release, the greater the knockdown effect of the water, the greater the density, and the smaller the area covered.

The trajectory of the water mass changes progressively as the water meets the resistance of the air, breaking up into smaller and smaller particles which do not maintain the initial forward speed but are increasingly affected by wind and gravity.

In practice, the direction of the dropping run will depend on topography, forest type, and smoke conditions. A rough formula for drift when dropping from a height of 100 feet above the ground is 8 feet of drift per mile per hour of wind regardless of the direction of flight, for example, when dropping from 100 feet in a 10-m. p. h. wind, the pattern will be offset 80 feet in a downwind direction.

The immediate tendency is to judge the potential of this equipment on the effect of a single drop. This, is like assessing a machine gun on the effect of a single round fired from it or judging the potential of a backpack pump on a single filling.

The total effect of the equipment must be measured by the number of gallons of water delivered to the fire in reasonable operating time. This obviously varies with the distance the aircraft must fly to the water source. The accompanying tabulation shows the number of loads per hour and the total gallons per hour that may be delivered under average conditions. Under adverse conditions or hilly terrain the delivery rate will vary slightly.

Distance of fire from nearest landable lake (miles):	*Water delivery per hour*	
	Imperial gallons	*Loads*
1	2,900	18.1
2	2,100	13.1
3	1,640	10.2
4	1,325	8.2
5	1,125	7.0
6	975	6.0
7	850	5.3
8	775	4.8
9	690	4.3
10	625	3.9

The tabulation may also be used to determine the number of aircraft that should be engaged on a fire or sector of a fire. For example, if the nearest water source is 2 miles away, one aircraft can drop 2,100 imperial gallons per hour, whereas it would take two aircraft to deliver at approximately this rate if the water supply were 6 miles away.

The most valuable features of this equipment are—

1. The speed at which the tanks can be refilled.
2. The whole operation is conducted by the pilot alone.
3. The equipment can be used simultaneously and in conjunction with other control measures without danger to the fire fighters.
4. The equipment may be carried at all times either in the operating position or within the fuselage of the aircraft (two men can complete the assembly in 10 minutes) without undue interference with the ability of the aircraft to perform other work.

A blender unit is presently being considered to introduce a wetting agent into the water as it passes through the intake pipe. Due to the abundance and convenient location of water, the addition of chemical fire retardants is not being considered for the present at least.

Construction of water dropping tanks and fittings for all six Otter aircraft has now been completed. Experimental work on Beaver adaptation has also been completed and plans are now under way for manufacture of the units.

Although it is realized that this may be only another step forward toward a better means of aerial fire attack, the future for this new development is extremely bright. Inquiries regarding further detail are welcome and should be addressed to the Division of Forest Protection, Department of Lands and Forests, Parliament Buildings, Toronto 5, Ontario, Canada.

AIR TANKER REPORT—CALIFORNIA, 1957

HARRY R. MILLER, *Forester, California Forest and Range Experiment Station,*[1] and H. P. REINECKER, *State Forest Ranger, California Division of Forestry*

In 1956 air tankers became a reality as tactical support for ground fire fighters in California.[2] They demonstrated their value as a new fire tool with great success. They also showed they had many limitations.

In 1957 the number of fires on which air tankers were used quadrupled, as did the number of air tankers available for use:

		1956	*1957*
Plane type (capacity):			
Stearman and N3N (100-180 gallons)	number	7	20
TBM (400-600 gallons)	do	1	4
PBY (1,500 gallons)	do	0	1
C-82 (2,000 gallons)	do	0	1
Fires attacked	do	25	101
Water dropped	gallons	83,000	125,000
Retardant dropped	do	66,000	500,000

This expanded use provided an opportunity to study the limitations of air tankers and to determine what must be done to make the most effective use of this new tool. Since the aircraft were used on fires throughout the State, a large variety in fuels, topography, and burning conditions was encountered.

AIR TANKER EFFECTIVENESS

Analysis of reports indicated that air tankers were completely effective on about 25 percent of the fires; that is, all drops either extinguished the fire or retarded it so that ground forces were able to complete control. On 65 percent of the fires effectiveness varied widely. On the remaining 10 percent all drops were termed noneffective.

Fire bosses said that the air tankers were generally most effective on initial attack. The small fire offered less opportunity for misplacement of drops. If the fire was not extinguished, the air drops held the fire down until ground crews arrived.

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[1]Maintained at Berkeley, Calif., by the Forest Service, U. S. Department of Agriculture, in cooperation with the University of California. This report was prepared in collaboration with the California Air Attack Executive Committee, which coordinates air attack research and development in California. Representatives are selected from the California Division of Forestry and from Region 5, Arcadia Equipment Development Center, and California Forest and Range Experiment Station of the U. S. Forest Service.

[2]Ely, Joseph B., Jensen, Arthur W., Chatten, Leonard R., and Jori, Henry W. *Air Tankers—A New Tool for Forest Fire Fighting.* Fire Control Notes 18 (3): 103-109, illus. 1957.

On larger fires the air tankers helped secure control and held burned acreage to a minimum by dropping on key points such as running fingers, spot fires, and slopovers. In some places, where inaccessibility or lack of time had prevented mechanical construction of firebreaks, borate lines were laid down by the air tankers ahead of the fire and successfully retarded the spread of the fire. These lines were generally most successful in the lighter fuels.

AIR TANKER LIMITATIONS

Ground action.—Practically all air drops had to be backed up by ground action. Delays in ground action frequently resulted in loss of temporary control gained by the air tankers.

Interception by fuel canopies.—Interception by dense brush or timber canopies reduced the effectiveness of air drops on ground fires. Two or more drops on the same spot were often necessary to penetrate the crowns and hold the fire. Crown fires in these canopies, however, were often knocked down by accurate drops, thus permitting ground forces to move in.

Topography.—Rugged topography adversely affected the height and direction of flight, airspeed, and accuracy of drop placement.

Winds.—Strong or gusty winds prevented low approaches at minimum speeds and caused drift or complete dispersal of the dropped material.

Radio communication.—Many field reports stated that the air tankers would have been more successful if radio communications had been available. "Bird-dog" planes flying experienced fire personnel were of great help in visually directing the placement of air tanker drops but did not completely fill the need for direct air-to-ground and air-to-air contact with each pilot. The need for direct communication to each air tanker pilot was especially noticeable on larger fires where close support of ground action was required. Uninstructed pilots often made their drops on the hottest burning spots. These spots were frequently inside the fire front and presented no real threat. Lack of communication also affected air safety, which was of critical importance on large fires where close control of the various types of air activity was necessary.

Pilots.—Many reports again emphasized that all air tanker pilots should receive basic instruction in fire control strategy and tactics and fire behavior.

Air tanker facilities.—The round-trip time for the air tankers also affected their efficiency. Distance of refill ports from the fireline and limited facilities at these refill ports added to round-trip costs. Planning of such facilities is urgently needed to eliminate confusion and loss of time when staging a large air attack operation (fig. 1).

Air tanker design and mechanisms.—Continuing investigation and improvement in air tanker design is another need. Some of the existing gate sizes and opening mechanisms proved to be inadequate. The ability of tankers to make multiple drops was found to be desirable at times (figs. 2 and 3). Pilots with such

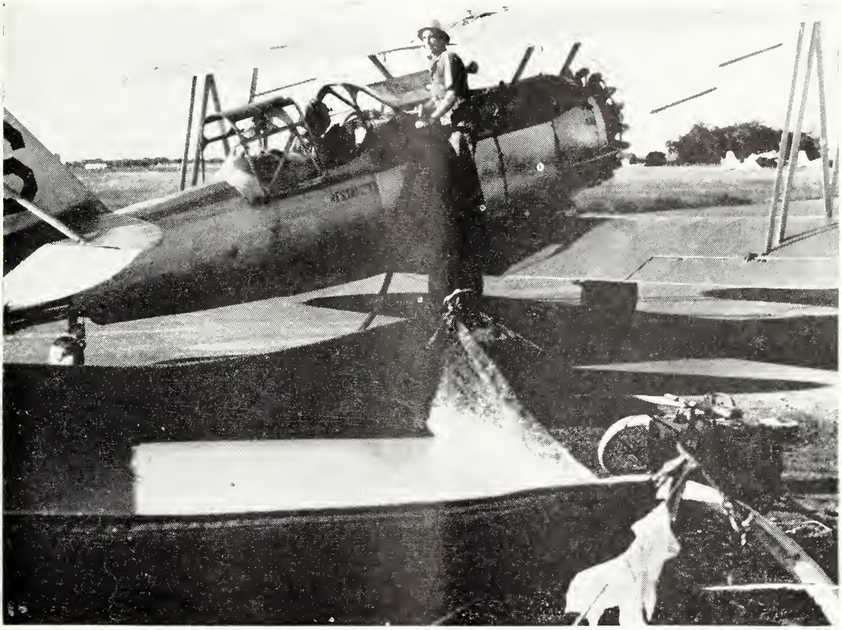

FIGURE 1.—N3N taking on load of borate from a portable refilling station.

FIGURE 2.—TBM tank designed and built by the California Division of Forestry.

FIGURE 3.—TBM with California Division of Forestry tank making drop.

planes were able to release the amount of material needed for a given situation, either to test wind effect or to drop on a fire of certain size and heat volume. To be effective, however, it was necessary that the amount of material released in each drop be matched with the airspeed so that the material reached the ground in sufficient quantity.

Dispatching.—Air tankers often were dispatched to fires after control had been achieved by ground action. In many situations fire bosses believed that if the air tankers had been dispatched earlier, the fire could have been controlled at much less cost in suppression effort and values destroyed.

AIR TANKER COSTS

Rental for air tankers is not low. Considering the additiona costs of fire retardants and of personnel necessary to handl ground and air operations, tankers can be an expensive tool. Th decision to use them must be made with great caution by budget minded administrators. This decision is of utmost importanc when we stop to consider that in California approximately 9 percent of all fires are controlled in the "A" and "B" size classe with current equipment and methods of operation. Reviewing th past two seasons of air tanker use, it is apparent that much mor study will have to be made of costs and returns before we ca specify the proper time and place for their use.

1957 AERIAL-TANKER PROJECT FOR REGION 6

ROBERT M. BEEMAN
Fire Control Officer, Wenatchee National Forest

The Wenatchee has 2 million acres lying east of the summit of the Cascade Mountains to protect from fire. From east to west, fuel conditions change from steep cheatgrass slopes along the Columbia River to typical open ponderosa pine forest, through dense lodgepole pine stands, and into the typical heavy fuels of the Douglas-fir-hemlock type. Three hundred thousand acres at higher elevations have no fixed detection. Fuel types there vary from dense fir timber in the valley bottoms to scattered subalpine clumps at higher elevations, and the terrain is often rugged and precipitous.

Lightning and man-caused fires are generally evenly divided in number. In 1956, however, we had 200 fires of which 160 lightning fires occurred within a 10-day period. Forty of these were handled by smokejumpers. The man-caused fire season lasts from early April into November, with debris-burning fires the early problem and hunter fires the late problem.

In 1957 the Wenatchee conducted a pilot aerial-tanker project financed by Region 6. The operator of a local agricultural aerial spraying service gave us space for installation of borate mixing apparatus (fig. 1), and devised and installed a gate release valve on two of his planes at his own expense (fig. 2). The

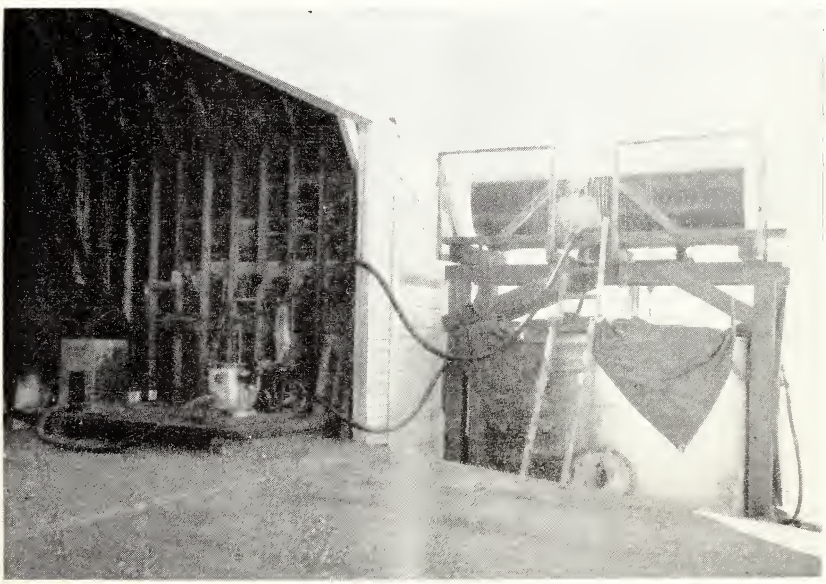

FIGURE 1.—Slurry mixing setup. Borate storage on left. Water storage in large bottom tank. Slurry storage in 1,200-gallon tank on top.

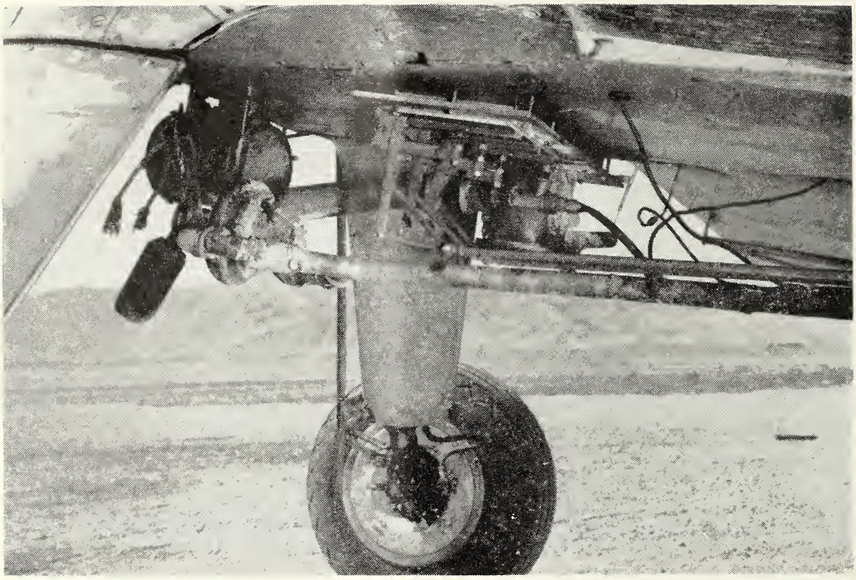

FIGURE 2.—Gate release valves. Pilot can use any of three opening sizes. When the large-sized opening is opened and closed quickly, 2-second dumps of 30 gallons can be made. This is advantageous on small fires.

Piper Super Cub could operate safely with only 60 gallons of borate slurry, but it carried enough fuel for a 4½-hour flight; this permitted rapid dispatching to distant back-country smokes. The Stearman could operate safely with 100 gallons of slurry, but carried enough fuel for only a 1¼-hour flight. We made no commitment on minimum hours of use for the planes, and no standby time was paid. Actual flying time cost $120 an hour for the Stearman tanker, $90 for the Super Cub tanker, and $21 for the Super Cub reconnaissance plane.

Our instructions were to use the tankers on a variety of fires over the full spread of our fuel types and terrain conditions. A light fire season resulted in tanker attack on only seven fires. However, these seven gave a good spread. Two were fast-moving cheatgrass fires on steep slopes. One was an operator fire in selective logging slash. One was a fast-moving dry lightning fire, another a high-country hunter fire in the subalpine type.

The largest of the 7 fires was a 60-acre railroad fire burning on a steep slope in dense second-growth Douglas-fir. Aerial attack by the 2 tanker planes, dumping 400 gallons of borate slurry and 520 gallons of wet water on this hot crown fire, did not knock it out of the crown completely. Fire overhead generally agreed, however, that the aerial tankers were the decisive element of the attack in that they prevented the fire from blowing up and spreading over 2 to 10 times the 60 acres. The dumps were made first across the top of the fire about 50 yards ahead of the flames, and then down the hottest flank. Consistently, as the moving crown fire hit the treated strip, it slowed down for a few minutes. This checking of the rate of spread was just enough to permit the 75-man control crew to complete their lines and burn out, with control accomplished at 11:45 p. m. of the day the fire started.

The 2-acre dry lightning fire occurred in ponderosa pine second growth on a moderate slope and with a 20 m. p. h. wind. One Super Cub tanker plane, 4 smokejumpers, and an 8-man ground crew all arrived on the fire at about the same time. The first dump of 70 gallons 30 to 50 feet ahead of the fire, applied in 2 passes, prevented further crowning.

The 6-acre grass fire occurred on a 60-percent southeast slope with a 12-mile west wind. The Super Cub dumped two 90-gallon loads of wet water, the first load across the top and the second down the hottest flank. The dump was made directly on the fire edge and dampened it down quite thoroughly. There is no question that aerial-tanker attack on a fast-moving grass fire is highly effective.

The 2-acre, high-country hunter fire picked up by aerial patrol was just starting to crown in subalpine timber on a 40-percent slope. One dump of 100 gallons of borate slurry by the Stearman knocked the fire down so that it had not spread farther when the smokejumpers arrived 30 minutes later.

A unique use of the aerial tankers was made on an October cheatgrass and sagebrush fire of 50 acres. The fire moved rapidly up a steep slope and threatened the hangars of the Wenatchee Air Service at which our tanker project is based. The Air Service manager promptly loaded up the Super Cub with wet water and the Stearman with borate and dumped five loads of each on the approaching fire. By the time the rural fire department arrived, the fire had been completely stopped with no property damage done.

Our borate slurry mixing technique is the same as that developed in California (fig. 1). By placing the slurry storage tank about 12 feet above the ground, we have enabled the pilot to pull in his plane alongside and load by gravity (fig. 3). The gate release mechanism gave us flexibility in application, permitting more effective use of the borate or wet water on light fuel grass fires and also on small lightning smokes. Despite the high cost of plane rental and of the mixed borate slurry, the use of aerial tankers on fires of this type is economical. Although our experience with aerial tankers is limited, we have listed tactics to be employed and key points to be considered in meeting our conditions.

TACTICS

Lightning smokes and other small fires.—Either wet water or borate is effective. Use the large gate opening and make several passes, with the pilot opening and closing the gate at the minimum 2-second interval. This permits several 30-gallon drops directly on the smoke. If the fire is in a snag or green timber, change direction on each pass (providing topography permits more than one safe approach and getaway).

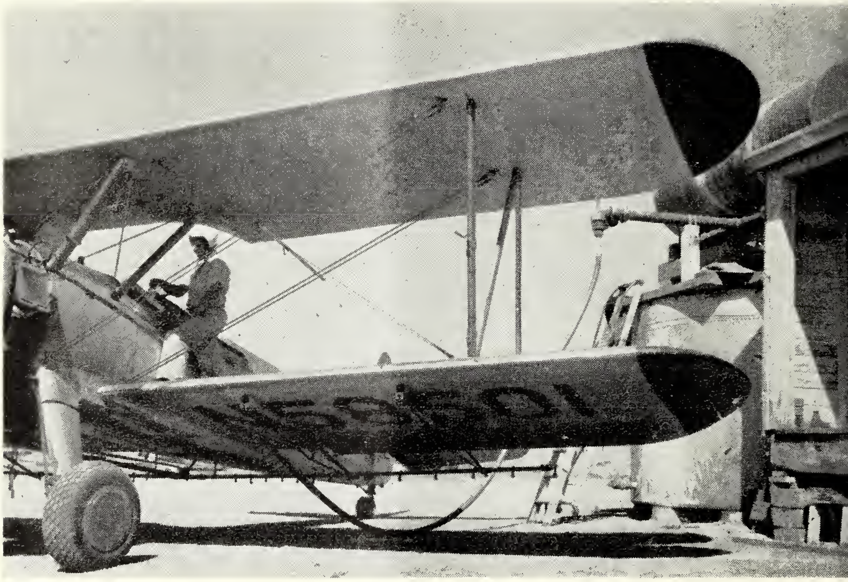

FIGURE 3.—Pilot loading Stearman by gravity.

Running fire in light fuels.—Wet water is just as effective a borate, and it is cheaper and requires no mixing apparatus. On pint of the liquid wetting agent (Solvoid Fire Wet or equal) poured into the 100-gallon load of water just before the plan takes off will mix itself in flight. Tanker should attack hot spot directly, working independently of ground crews. A cheatgras fire on a steep slope should be hit with the first plane load at th uphill point; this involves several passes across the face of th slope, on the flames or immediately ahead. Use small or mediur gate opening and short interval passes. Following planes shoul then make a run down the hottest flank directly over the fir edge, using the small opening. A downhill run with a loaded plan is much safer than an uphill run. If the fire edge is fairly straight the tank can be emptied with one long pass. If not, 2 or 3 shorte passes will utilize the load more effectively.

A running fire in medium to heavy fuels.—Use borate only, un less the fire can be hit directly. Hot spot the fire, working inde pendently of ground crews. This gives the ground crew time t build lines and burn out. Use same plane tactics as with ligh fuels, except use large gate opening. Ground-air coordination i required on one point; aerial tankers should not dump on a bac fire unless requested to do so to reduce heat and spotting.

Fire too hot to check by direct tanker attack.—Use borate only Use the middle opening of the gate valve for light fuels, the larg opening for heavy fuels. Stay away from the main fire; strengthe the lines being prepared by the ground crew. Dump slurry alon the outer edge of lines on ridgetops, roads, and other firebreaks also over the entire area of a saddle. Attack spot fires across the line directly, using the 2-second, open-and-close technique and the large opening.

Project fire or lightning bust.—During night move mixing setup to the nearest airstrip. Mobilize all available tanker planes. Attack at daylight (winds normally light, smoke normally drifted downslope, humidity normally up). Dump wet water on fire edge where the main ground crew is using a direct method of attack. Then dump borate slurry to supplement the fire boss' plan of indirect attack. Hit it hard while wind and smoke are down.

KEY POINTS

1. An aerial-tanker project requires an aerial-tanker boss. He must be an experienced fire man. He must be physically capable of riding a small plane in turbulent air and during steep dives and abrupt pull-outs. He must be capable of making independent fire decisions. His job involves not only riding the "bird dog" plane and keeping in touch with the fire boss by radio, but also setting up the slurry mixing apparatus, planning mobilization of plane and overnight moves to a new airstrip, and developing new techniques to fit this new method of fire control.

2. The pilot of the "bird dog" plane should be a man with much experience in mountain flying and in agricultural spraying or other flying that requires close-to-the-ground maneuvering. He should develop wing signals so that he can convey to the incoming tanker-plane pilot how and where the tanker boss wishes the load deposited. Plane to plane radio would perhaps be more effective than wing signals; in our limited operations, we found that the latter were adequate.

3. The pilot of a tanker plane must be fully capable of handling the plane in fire conditions and over rough terrain. Except when safety factors do not permit, he must be willing to accept the plan of attack established by the tanker boss.

4. Initial attack with the aerial tankers is highly important on a fire that starts during severe burning conditions. The monitor of our forest radio net (a centrally located district headquarters assistant) is authorized to dispatch the unit immediately to any fire when available information indicates it would be useful. This insures that the effectiveness of aerial-tanker attack is taken advantage of during the crucial first few minutes. The district ranger can decide later whether to continue the tanker attack or terminate it. If several fires develop, the forest dispatcher must determine priorities.

5. Good visibility is essential to safe and effective operation of the aerial tanker. Obviously, a pilot must have daylight and a cloud ceiling high enough to permit approach and attack. Nor can we expect a pilot to operate close to rugged terrain when his visibility is obscured by smoke. The smoke limitation is a very real one and sharply limits the use of aerial tankers once a fire has become large.

6. Air turbulence during lightning storms limits use. It is not safe to bring a loaded plane within 50 feet of rugged terrain if the air is turbulent. Moreover, the material dumped will be blown away from the target. If a lightning storm is wet, effective use can still be made of the tanker after the air has quieted down. In the event of a dry lightning storm, however, fires often spread rapidly and we should not expect too much help from small aerial tankers.

7. Strong prevailing winds also limit the effectiveness of this technique, particularly if topography is rugged and the fire has begun to crown. Both safety of the pilot and dispersion of the dropped material are affected. Our 60-acre, second-growth fire brought out an interesting sidelight on this point. The fire started on a day of light wind. If the aerial tankers had not assisted in controlling at a modest 60 acres and a much larger fire had resulted, we would have been in serious trouble the next day when the prevailing wind was quite strong.

8. The fuel type has a direct bearing on aerial-tanker use. Our 60-acre fire in dense second growth on a steep slope demonstrates that the slurry is of some value in this fuel type, and that aerial-tanker attack certainly should be used. However, the wind was very light that day. Also, the second growth was only 30 to 40 feet high. We do not feel that the small aerial tanker would be of much value on a crown fire in old-growth Douglas-fir, particularly with a strong prevailing wind.

9. Distance from the air field to the fire or fires. Stearmans carry only 1¼ hours' gasoline supply. Be prepared to move to the nearest airstrip.

10. A forest that depends upon agricultural spray planes should not take availability for granted. One problem is that an agriculture air service is apt to be reluctant to tie up most of their planes on fire suppression during the height of an agricultural season. This problem can be met by signing up one or two planes from each of several companies within an hour's flying time of the forest. Prior arrangements for standby, ferrying, plane service at other airstrips, and mobilization of daylight attack are important.

CONCLUSION

The indications are that aerial-tanker attack can be effective on perhaps half of our fires. The cost-benefit ratio of aerial tankers goes up in proportion to roughness of terrain and to inaccessibility of the fire to ground crews. Even smokejumpers cannot land directly at a fire in cliffy terrain or in a snag patch. Aerial tankers can operate effectively under such conditions, providing the air is reasonably quiet, the terrain permits approach and getaway, and visibility is good. When operating conditions are right, the aerial tanker is a wonderful tool for initial attack.

TESTING THREE NEW AIR TANKERS

Arcadia Equipment Development Center, U. S. Forest Service

In the spring of 1957 three new air tankers of a new class were in the last stages of being fitted with tanks of differing designs and capable of carrying from 400 to 1,500 gallons of water (fig. 1). Since we had no data regarding drops from these aircraft, the Development Center was requested to conduct tests.

Some of the objectives desired were (1) to establish distribution patterns for water drops from these aircraft at different elevations and various gate opening combinations; (2) to evaluate gate release and control mechanisms; and (3) to determine impact forces on the ground from the water drop.

The three air tankers submitted for testing were a PBY-6a owned by a private operator in Long Beach, Calif., a TBM owned by an operator in Santa Ana, and a TBM owned by the Forest Service.

The owner of the PBY utilized the unique feature of his amphibious craft, the watertight hull, to hold fire suppressants. The fore-and-aft compartments on either side of the wheels were equipped with internal tank walls fastened to the hull. A pair of hydraulically operated doors were located on the bottom of each tank, thus providing all, one-half, or train dump combinations. Furthermore, the doors could be quickly closed and sealed by the pilot. Total capacity of both tanks was 1,500 gallons, although

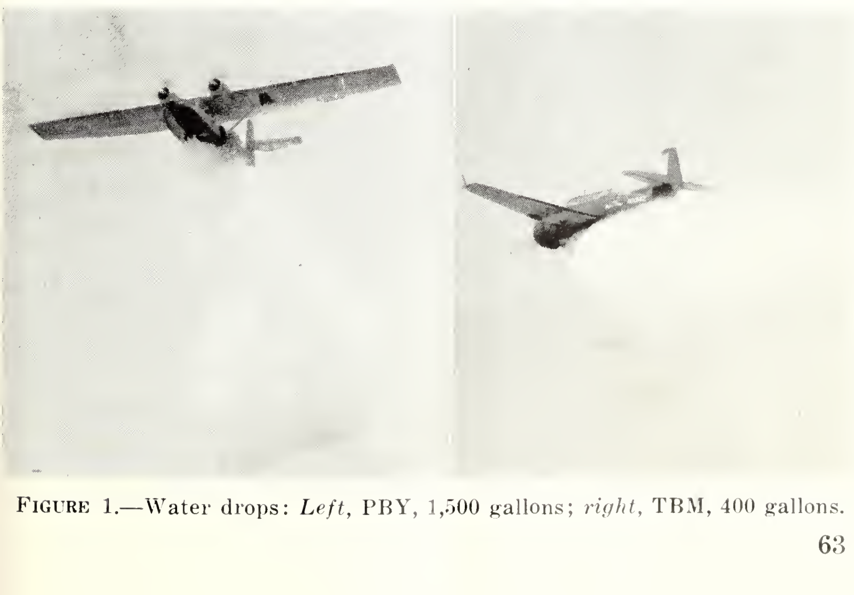

FIGURE 1.—Water drops: *Left*, PBY, 1,500 gallons; *right*, TBM, 400 gallons.

normal fire flying since these tests has been about 1,000 gallons of borate. Each door has approximately 1,000 square inches area.

The privately owned TBM had a 515-gallon tank fitted into the torpedo bomb bay. The tank was divided longitudinally into three compartments, each having a single door with an opening approximately 575 square inches in area. Electric bomb shackles were used for locking and tripping the doors, which necessitated manual closure on the ground. Individual, combination, or sequence drops could be made with this arrangement.

A 400-gallon tank installed in the Forest Service TBM had two doors which completely covered the bottom of the tank. Since the tank was separated longitudinally, each side dumped 200 gallons. These doors also could be operated independently. After the latches were tripped and the doors dropped open, hydraulically operated levers automatically returned the doors to the closed position. By reversing the release levers the pilot could then relock them. Each door had approximately 900 square inches of area, and in essence "dropped the bottom" of the tank.

Conducting the tests.—An unpaved area on the airport at Santa Ana, Calif., was obtained for setting up a grid collection system 150 feet wide and 600 feet long. This grid system consisted of 121 specially built steel paper-cup holders for a standard 10-ounce cup. The cups were maintained at a uniform height above the ground, and the cups were completely enclosed except for the open top. Each holder bore a number defining its position in the grid, so that the cups could be numbered and identified after each drop. Each cup and a lid was weighed to the nearest tenth of a gram prior to the drops. After each drop, the cups were covered, numbered, and reweighed. By plotting values of the grid, contour lines of concentrations could be drawn.

To determine the impact force of drops, a box having hinged panels one square foot in area was located in the grid. Two panels, one in the vertical and one in the horizontal plane, were held by force rings employing strain gages. Forces were recorded electrically through cables to a recording oscillograph.

Other instruments were on hand for measuring weather conditions. Height of aircraft above the ground was checked by an abney mounted on a tripod. Ground to air communications were maintained at all times. Forty-four drops were made at heights varying from 15 to 200 feet.

Results of tests.—From the study of all patterns (fig. 2), it appears that gate openings of 1,000 square inches for each 200-250 gallons yield good clean drops. Proper venting of tanks also helps. Optimum altitude for the TBM's appears to be 50-150 feet, and 75-150 feet for the PBY. Small patterns will result from altitudes below 50 feet. A 10-m. p. h. side wind will shift the pattern of a drop made at 100 feet about half its width from the drop line.

The PBY had the highest consistent concentrations in the patterns, with values up to 19 gallons per 100 square feet recorded.

Gates that can be relocked in flight appear to have an added safety advantage in the event they fail to open.

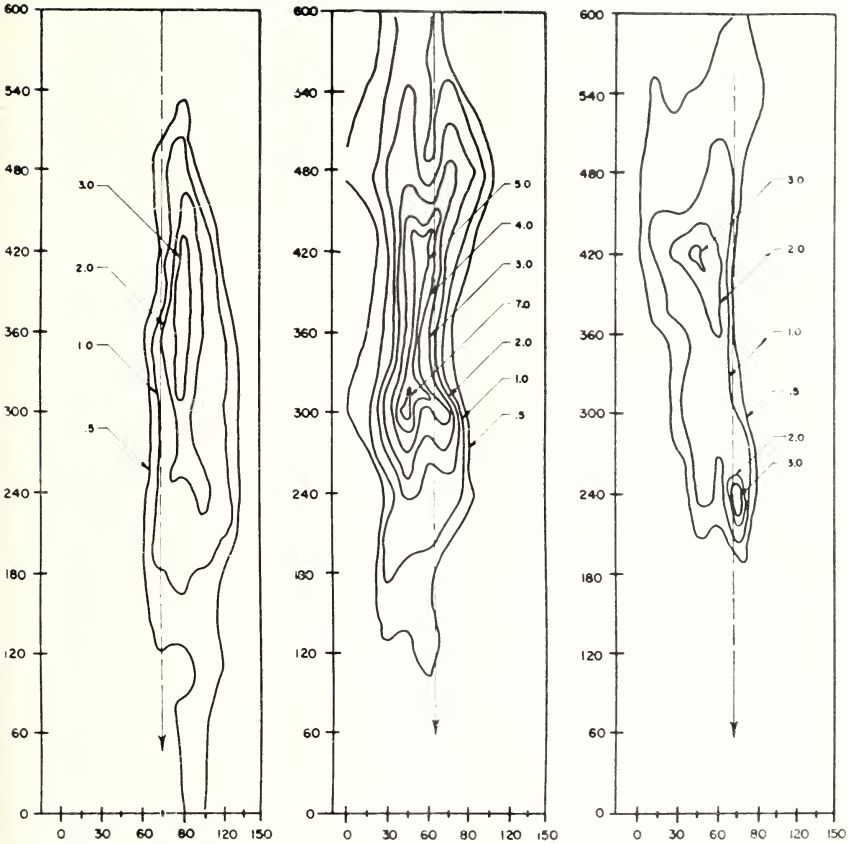

FIGURE 2.—Three typical drop patterns: *Left,* Santa Ana TBM, 515 gallons at 50 feet; *center,* PBY, 1,500 gallons at 70 feet; *right,* F.S. TBM, 400 gallons at 100 feet. Contour lines show concentrations in gallons per 100 square feet. Airspeeds averaged 110 m. p. h.

Impact forces from drops below 25 feet can be very great, particularly in the horizontal direction. An instantaneous acceleration of about 4 G's was recorded. The safest procedure for ground crews who might be subjected to very low drops would be to lie prone with heads, protected by hard hats, toward the oncoming aircraft.

FIGHTING FIRES WITH AIRPLANES AND SODIUM CALCIUM BORATE IN WESTERN MONTANA AND NORTHERN IDAHO—1957

H. K. HARRIS

Forester in charge, Missoula Equipment Development Center, U. S. Forest Service

On August 8, 1957, the Northern Rocky Mountain Region of the U. S. Forest Service initiated experimental operations to determine regional possibilities for retarding the spread of wildfires by aerial applications of sodium calcium borate and water, based upon earlier developments in California. A local contractor of flight service equipped a Ford Tri-motor with three 100-gallon tanks, each with a separate dump valve and control. The 300 gallons was believed to be the maximum safe load if the borate and water mixtures were to be dropped from low elevations in the excessively rough topography common to the Region's remote areas. Three tanks were selected for control of the loading and to permit adjustment in the event the pilot erred in "spotting" the first tank on the selected area. Three charges or loads are also believed necessary if the pilot needs to place retardant entirely around a small spot-sized fire on a single trip.

On August 9, two loads of water were dropped on the ramp at the Aerial Fire Depot. Spread and concentration of the water were observed and operation of the dump valves was checked. We followed these tests by field application in open grass and timbered areas to observe effects, conduct flammability studies, and check our information on concentration. These preliminary runs were good training for pilots as well as selected smokejumpers who were to report the results on fire application (fig. 1).

Following the training period the Ford tanker was dispatched to 8 selected fires. Smokejumpers were available in most cases for

FIGURE 1.—Ford Tri-motor cascading borate over timber.

fast control action and to observe retarding effects. A spotter accompanied the plane on each load to assist in selecting the dump spot and record the effects as observed from the air. Participating personnel later met to discuss the action and the possibilities. The following details were reported:

Fire number	Loads[1] (number)	Flight time (minutes)	Fire character	Report
1	2	75	6 acres. Running.	Fire flanked borate—insufficient number of drops.
2	1	120	13 acres. Spreading in scattered timber.	Load ineffective in timber.
	1	120	Smouldering spots in snags, windfall, and brush.	Good coverage; held fire down.
3	1	175	Class A. Creeping in scrub timber and duff. Several small fires.	Held some smouldering duff; coverage good on snags and windfalls.
4	1	70	Heavy duff with thicket of fir and pine; some open, rocky area.	Ineffective in duff and under trees; some benefit in open.
5	1	120	Creeping. Dense brush cover; several snags and a few windfalls; no green timber.	Retarded advance temporarily. Control obtained before plane arrived. Did good job on brush.
6	1	85	Spot size. Alpine-type heavy duff; some windfalls.	Drop made in very strong winds. Light application resulted but effective on duff.
7	1	30	Alpine fir with several windfalls and considerable heavy duff.	Held fire; simplified control and mopup.
8	1	50	1.5 acres mill debris, grass, brush. Spreading.	Hit hot spots—good judgment in dropping—highly effective.

[1]300 gallons per load; 4 pounds borate per gallon.

General results were definitely encouraging. The fire observers brought out that effectiveness was greatly reduced by a heavy tree canopy. Where such a condition existed, retarding effects were limited, and general opinion held that much heavier concentrations will be required.

Cost of borate, applied on the fireline, averaged $280 per fire. All the fires were considered to be of smokechaser size and were selected with possible benefits from borate drops in mind.

A single load (300 gallons) averaged 86 minutes flying time, which indicates the considerably restricted area used in the test. Borate is estimated to cost approximately $1.50 per gallon on the minimum size operating area (average cost per gallon during these operational tests was $0.747) for application to fires of smokechaser size.

Although our 1957 testing was definitely limited, we believe the possibilities of retarding the spread of small fires by cascading borate, or the use of some other aerial technique, are worthy of further investigation. We are confident that costs will be reduced with greater use, faster flying and larger capacity aircraft, and careful selection of operational bases. The special performance possibilities of the Ford Tri-motor and the helicopter also must not be overlooked in future planning.

PLANNING FOR SMOKEJUMPING

L. M. STEWART
Air Operations Officer, Region 1, U. S. Forest Service

Smokejumping is no longer experimental and is paying fire control dividends in the mountain areas of U. S. Forest Service Regions 1, 3, 4, 5, and 6 (Montana, Idaho, Arizona, New Mexico, California, Oregon and Washington), as well as Yellowstone and Glacier National Parks (fig. 1). In addition, the Province of Saskatchewan operates a 16-man unit and the U. S. Bureau of Land Management plans to activate a small Alaskan unit in 1959.

There is steadily growing recognition of the value of smokejumpers as trained and highly mobile reinforcements for the control of threatening fires in relatively accessible areas. However, it is believed that such use must be considered as incidental from a planning standpoint. Evaluation of proposed jumper units should be limited to probable value in areas otherwise deficient in manpower where, because of poor access by other means, smokejumping promises improvement in first-attack action. Smokejumping is far from a cure-all for all back-country fire suppression problems. Before seriously considering initiation of a unit, land managers should obtain competent advice on the effect of the following factors, singly or in combination, in the specific areas under study:

Elevation.—Ground elevations above 8,000 feet may limit jumping.

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FIGURE 1.—Smokejumper descending to jump spot in mountain terrain. Jumper is facing camera. Note two slots in parachute canopy. These are used by the jumper to change his direction. Also air escaping through the slots propels the airborne jumper forward in the direction he is facing.

Terrain and soil, insofar as these affect availability of suitable jump spots within acceptable distance from fires.

Cover.—Unbroken areas of heavy windfall and snags or of certain timber species and age classes may make jumping unduly hazardous.

Weather.—Consistent high winds or turbulence may cause undependability of jumper attack when such air conditions make parachuting highly dangerous.

Given acceptable conditions in these four factors, further planning will include studies to determine size, organization, and location of crews by calendar periods, equipment complement, type of aircraft, etc. Analysis of fire occurrence and behavior is the best basis for calculating probabilities in fire fighting work load, both gross volume and distribution by areas. Given similar conditions, this phase may be greatly simplified by drawing on the experience of an existing unit in such factors as average manning, time away from base per fire jump, etc., and applying these to expected occurrence.

Lacking similar conditions, planners are advised to study carefully individual fire records over an extended period and tabulate, for each fire, their best judgment of hypothetical smokejumper action in terms of (1) distance of fire from road or airport; (2) number of jumpers required; (3) time and date they would leave base; (4) time, date, and method of return to base; (5) ground reinforcement action, if any; (6) extra flying required for supply of jumpers or ground crew, if any; (7) date and method of return of jumper gear.

When assembled and charted, this information is used to determine probable seasonal loads and the requirements in (1) number of jumpers to meet peak fire loads; (2) jumper equipment: amount, frequency of use, rate of return from field; (3) number of aircraft by type by periods for outgoing traffic; (4) trucks, packstock, helicopters, and fixed-wing aircraft for return of men and equipment; (5) base facilities and airfields.

For most proposed operations, planners will find that economics do not permit smokejumper organization on a scale to care for worst probable situations because such situations occur too infrequently. They then compromise upon units of sufficient size to handle loads at some practicable level below the worst probable peak, planning to supplement smokejumper action by other methods of attack as needed. Smokejumping units are relatively limited in ability to expand on short notice as critical seasons develop, and this characteristic forces preseason commitment as to size of unit. This handicap is, of course, due to the degree of advance preparation involved—specialized, expensive, and time-consuming training and equipment procurement.

However, on the credit side, mobility and wide range of quick striking power greatly increase the potential coverage per man in terms of area protected or fires manned. These characteristics also permit unprecedented pooling of first-attack manpower, in effect, and widespread use of jumpers as needed without regard to regional or other unit boundaries. As an example, it is not un-

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FIGURE 2.—Army and Forest Service records show that feet, ankles, and lower legs are critical points in prevention of landing injury, especially for the smokejumper who often lands on rough ground. Careful selection and conditioning of candidates are major factors in maintaining a low rate of injury.

common for a given Forest Service smokejumper to make fire jumps in four separate Forest Service regions during a season. In addition he may also jump to fire in a national park, an Indian reservation or on area protected by a private timber association. Such use tends to reduce the impact of localized highs and lows in fire incidence upon the jumpers, as compared with less mobile ground facilities.

Smokejumping is for young men. Forest Service policy precludes continuation of jumping beyond age 40 and new candidates must be 18 to 28. Weight limits for new men are 130 to 180 pounds in most units, height 65 to 75 inches. Sound physique, good general health, mental stability, and good hearing and eyesight are prerequisites (fig. 2), as are work experience in fire protection and a better-than-average work record. This is important; the pay-off is at the fire and you cannot justify the high investment in a man who does not produce accordingly when he gets to the fire.

The initial basic training of a new smokejumper will cost about $650, not including any prorated share of such items as base facilities or project overhead. Equipment to outfit him will cost $475 to $750, depending on degree to which double equipping is necessary (fig. 3). Some units double equip all jumpers. Equip-

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FIGURE 3.—Smokejumper trainee receiving an equipment check prior to loading into the airplane for a practice parachute jump.

ment first cost may of course be amortized over a period of years, depending on established service life of individual items.

Aircraft of proper type and number for the particular operation is a key factor. Smokejumping aircraft are also readily fitted to paracargo work. In most areas of heavy smokejumper activity the extreme peaks in jumping and paracargo demands do not ordinarily coincide and heavy dual use of airplanes may be depended upon if they are suitable to both types of missions. Careful study and planning to obtain maximum correlation is well worthwhile.

For large smokejumping areas planners often have a difficult time deciding between centralization and multibasing. Both have certain apparent advantages, some of which may be misleading if not analyzed.

Multibasing: (1) Shorter travel distance to fires; (2) quicker get-away to first call fires, at least; (3) more localized control of dispatching and communication; (4) better opportunities to use men on productive work when not on fire.

Centralization: (1) Greater flexibility in manning; (2) more efficient use of aircraft and other equipment, with proportionate economies; (3) better average elapsed time through ability to take manning action on more fires concurrently.

SIGNAL SYSTEM FOR SMOKEJUMPER AND PARACARGO AIRCRAFT

William C. Wood
Missoula Equipment Development Center, U. S. Forest Service

In the early days of smokejumping and cargo dropping all signals between spotter and pilot were either verbal or manual. Permanently installed bells, horns, buzzers, and lights were used for cargo discharge signals, but until recently, smokejumper spotter signals were made primarily by hand. Voice intercom systems have been used since 1944, but the high voice level and vibrations around the open doors of airplanes in flight made these systems unworkable in most airplanes. Headphones and microphones with connecting wires are cumbersome and restrict movements of spotters and cargo droppers.

In recent years the increasing interregional exchange of airplanes, pilots, and jumpers has shown the need for standardizing the cargo discharge and smokejumper signal system.

The Intermountain Region of the U. S. Forest Service made the first practical use of an electric signal system for smokejumper signals. The unit consisted of red and green lights located in the pilot's compartment and a two-way toggle switch mounted near the jump door. Flashes of appropriate colored light indicated amount and direction of turn needed. Alternate flashing of both lights told the pilot when to cut engine power for jumps. A cargo discharge signal was not an integral part of this system.

The Missoula Equipment Development Center was assigned the project of developing a standard signal system for jumper and cargo aircraft. All Forest Service units engaged in smokejumping and paracargo operations cooperated.

Pilot models of an electric signal device were made up for preliminary field testing. Briefly, these units were small electrical makeup boxes containing red, green, and amber lights energized by flashlight batteries and controlled by toggle switches. A pilot-to-dropper buzzer served as a paracargo discharge signal.

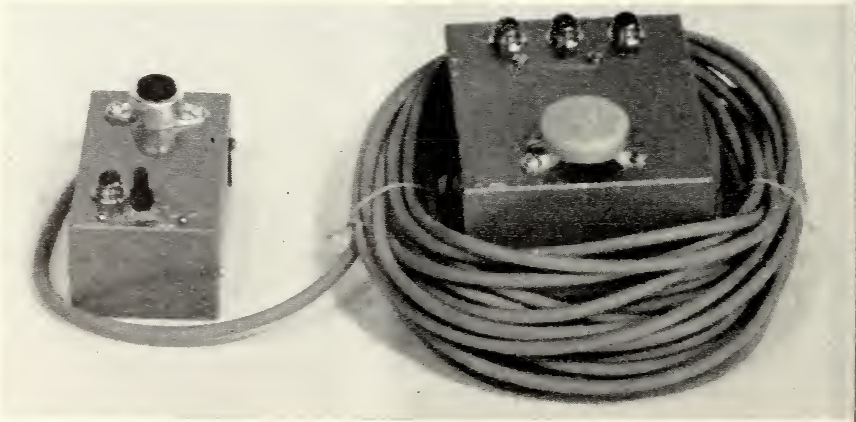

Figure 1.—Temporary installation model of the signal system for jumper and paracargo aircraft.

Generally, preliminary test results were favorable. Insofar as possible, suggestions for improvement were incorporated into the final model. The most noteworthy change was in the cargo drop signal where a simultaneously combined light and bell with greater audibility were substituted for the buzzer. Larger makeup boxes were required to accommodate the bell and light assembly. A 6-volt battery was substituted for the flashlight batteries. The overall size of the unit was kept to a minimum.

Field trials of the improved models during the 1957 fire season were satisfactory. Some units favored the use of the light system in conjunction with radio intercom. Others felt the light signal system to be unnecessary where workable intercoms were available. All regions recommended that the signal device be adopted as a servicewide standard for use in contract aircraft where the installation is of a temporary nature (fig. 1).

One suggestion was to replace the cargo discharge bell with a landing gear warning horn. This was not done as it was felt that use of a gear warning horn would be confusing. Many of the jumper aircraft are equipped with gear and stall warning horns as integral safety equipment. Gear warning horns cannot be operated with 6 volts.

At the completion of the field tests, signal light systems were permanently installed in several Government and contract aircraft. These were advantages of the electrical light system:

1. It allows the pilot to do a better and safer job of flying by eliminating the necessity of looking over the shoulder while attempting to fly on course.

2. Better response to signals is possible. With hand signals the pilot cannot keep his eyes on the spotter's hand at all times; consequently, the spotter whose head is out the open door or window frequently signals while the pilot is not looking.

3. More freedom in loading and positioning cargo and jumpers within the ship is possible since an unobstructed line of vision between pilot and spotter need not be maintained. The jumpers can observe the drift streamer without interfering with the signal procedure.

4. The spotter has freer use of his hands during signaling.

5. The pilot can keep both hands at the controls of the ship during the final and critical stages of the cargo approach and can easily signal for the drop by depressing a button. An audible signal gives the cargo dropper greater freedom to make a last minute check of cargo bundle and static line.

6. Temporary installation models can be quickly installed by the pilot or mechanic since no cutting of air frame and no connection to plane's electrical system is involved.

Recommendations.—This light-signal system should be adopted as a servicewide standard for use in contract planes or other aircraft where temporary use is desired. The signal light box should be installed where it can be continuously observed by the pilot as well as where the danger of injury from bodily contact during rough landings or turbulence is eliminated. In the cabin the wiring and switch box should be located where it will not be damaged during cargo loading and dropping, jumping, and other normal activities.

GROUND OPERATIONS FOR HELICOPTERS

JAMES L. MURPHY
California Forest and Range Experiment Station[1]

So you're going to use a helicopter? Good idea! Outfits all over the country are finding the helicopter valuable in fire control work. The Angeles National Forest has used a permanent standby ship for the past eight fire seasons. We found that there is a lot of work to be done before the helicopter can take to the air. The following suggestions are a result of our experiences.

ESTABLISHING PERMANENT BASE HELIPORTS

Location.—The most important consideration in planning a helicopter operation is the selection of the base heliport. The base heliport for the Angeles is located at Chilao Fire Camp near the center of the forest. The heliport is at a 5,200-foot elevation—high enough that it isn't an uphill pull to every fire in the forest, yet low enough for safe, dependable helicopter operation. The landing area was constructed on a high point so that a helicopter can always take off or land into the prevailing wind and can drop off into the canyon when taking off.

The Chilao base heliport is large enough to accommodate several ships safely. The landing surface, or "pad," is 75 yards wide and 100 yards long and has an asphalt surface to prevent dust from being picked up by the rotor blasts. The field name, "Chilao," a "North" arrow, and the elevation are painted across the pad to insure positive identification from the air (fig. 1).

Ground operations crew.—All heliports require ground crews. The crew usually consists of an air traffic manager and two or three men. The traffic manager directs air operations and orients and briefs the ground and flight personnel. He is responsible for enforcing safety relations. He also maintains necessary records. The crew helps him load and unload personnel and prepare, weigh, and load cargo. On unpaved heliports, the crew also dustproofs the heliport. Otherwise dust might injure the men's eyes or enter gasoline and oil containers and dispensers in the refueling area. Personnel working at the heliport should wear goggles when the rotor is turning.

Air traffic manager.—The air traffic manager has a big job. He must plan and coordinate all cargo dropping, reconnaissance, and transportation of personnel. He must establish priorities and

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[1]Maintained at Berkeley, Calif., by the Forest Service, U. S. Department of Agriculture, in cooperation with the University of California. Work covered by this report was conducted while author was employed as Air Officer on the Angeles National Forest.

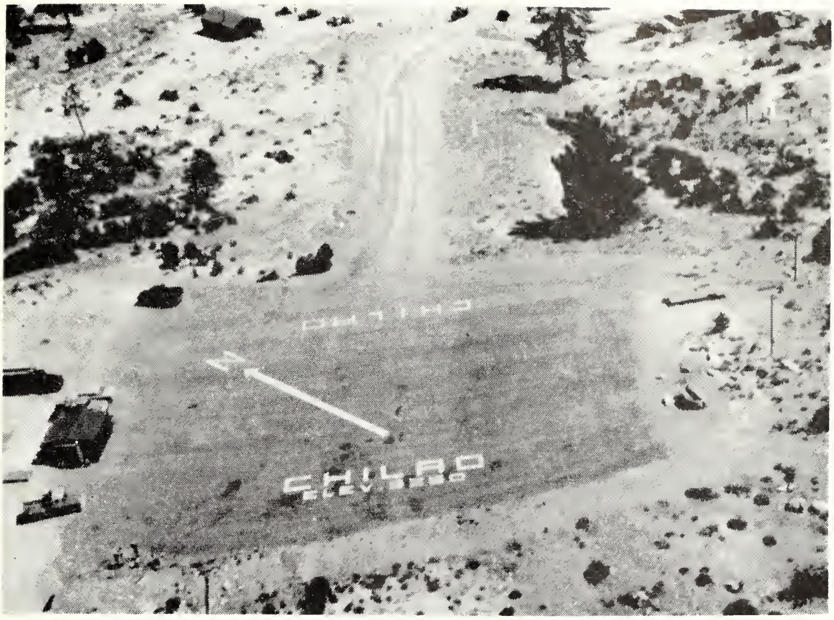

FIGURE 1.—The Chilao base heliport can accommodate several ships.

schedule all flights, and therefore should be supplied with daily fireline crew assignments and fire maps. He is also responsible for all ground operations at the base heliport, including instruction of all personnel in the safe methods of approaching, loading, and departing from the ship.

The air traffic manager should have full control over scheduling trips from his heliport. Even if the fire boss wants to use the ship away from the base heliport, the air traffic manager should be notified. Any time the helicopter has completed its assigned mission it should be returned to the heliport. If all pilots understand this procedure, it will prevent commandeering of the ship by unauthorized personnel.

Base heliport facilities.—At Chilao we installed an 8-foot wind sock on a swivel and mounted it on a 25-foot section of 1-inch pipe. This wind indicator was placed in a visible spot on the edge of the heliport safely away from the normal takeoff and landing lanes.

All preventive maintenance must be done at the base heliport by the assigned helicopter mechanic, usually at night when the helicopter is not operating. To help the mechanic, we built a work bench and installed an electrical outlet.

High octane aviation gasoline is delivered to the base heliport from a central distributor in large quantities at infrequent intervals. We built a latticework house in which to store the 50-gallon drums of gas. The floor of the house is raised for quick loading of the drums into a pickup truck. Many forests place a gas supply at several accessible landing spots throughout the forest.

Good communications are vital at the base heliport. We installed a telephone with a loud Klaxon that can be heard above the motor noise of the helicopters.

Safety is important in all phases of the ground operations. The Chilao heliport was posted with "No Smoking" signs. Fire extinguishers were placed at the work bench and at a convenient spot near the refueling areas. To warn curious sightseers, we posted "Danger—Heliport" and "No Smoking" signs across the entrance to the pad.

Helicopter accessory equipment.—The helicopter may be dispatched at any moment during daylight hours. Accessory equipment for any type of mission must be readily available at the base heliport. Inventory lists of kits prepared for the Chilao operation will be provided by the California Forest and Range Experiment Station upon request.

Operational maps and records.—Daily flight-time records are needed whenever a rental helicopter is used. The most efficient system is for both the air traffic manager and pilot to keep a record in pocket-sized field notebooks. At the end of each day the two flight records are compared, and the final entries are made in the permanent flight record.

Most helicopter operators are guaranteed a minimum number of flight hours as a condition of the contract. It is important to the contracting agencies to know whether full use is being made of this time. At Chilao we placed a large bulletin board in the heliport operations shack and displayed two charts. The first chart gave a day-to-day total of all flight time and the remaining time available during the rest of the contract period. The second was a line graph with each date of the contract period as the vertical axis and the total flight time as the horizontal axis. Two lines were plotted on the graph. The first was a uniform slope line of expected flight time, and the second was the fluctuating line of actual flight time. By comparing the actual with the expected we could see how quickly the time was being used.

Helicopter operation map.—A master helicopter operation map of the Angeles National Forest was started in 1956. It was made from small-scale topographic maps of the 15-minute series and was displayed on the bulletin board. To be useful the following information must be current and accurate on the map: Aircraft hazards, such as utility lines; areas of extreme air turbulence; helispots and field heliports approved by the pilot; flight time from the permanent base heliport plotted by circles in 5-minute intervals.

ESTABLISHING SEMIPERMANENT FIELD HELIPORTS

Location.—Here are some important points to consider before selecting a field heliport:

1. Accessibility to men and supplies or to the fire camp.
2. Presence of hazards such as power lines.

3. Location so that a drop-off can be made *into* the prevailing wind.

4. Area level and free from all obstructions.

5. Higher than surrounding ground so that men approaching and leaving the ship will be well below rotor-blade level.

6. Accommodations for several ships (each small helicopter requires about 2,500 square feet).

7. Should be fireproof.

Field heliport operation.—Once the field heliport has been selected, ground operations must be established. When the helicopter was dispatched to a fire from the Chilao base heliport, the mobile base heliport kit was sent at the same time on the helicopter maintenance truck.

The ground crew should stockpile a good supply of fire tools, water, and other items at the heliport. The storage area should be at least 100 feet from the landing spot for maximum safety.

Communications also are an important part of field heliport ground operations. Radios are a must. Telephones may be installed but they are not always adequate. Helicopter-to-fireline communications are necessary to coordinate cargo drops. It is also imperative that the air traffic manager be in contact with the pilot while the ship is in flight. It may be necessary to ground the ship while other low-flying aircraft are in the area. This can be done only by radio.

FIGURE 2.—An ideal field helispot offers a 360° choice of takeoff and landing direction. The vegetation is cleared well below the level of the landing area, and the touchdown pad is level and free of obstructions.

TEMPORARY HELISPOTS

Specially needed helispots can be built at key locations requiring very little improvement. The pilot should select these spots and then give instructions and the location to the crews on the ground by radio or a dropped message.

Helispots must furnish takeoff and landing choices into the prevailing wind (fig. 2). For small helicopters, they should be about 50 feet in diameter and fairly level with no obstructions. A 15-foot square touchdown spot may be elevated to raise the rotors to a safe height above personnel. A wind indicator must always be placed as close to the actual landing spot as is safe.

SUMMARY

Helicopter ground operations demand considerable planning and work. Permanent base heliports must be located, constructed and equipped for efficient, fast, and safe action. Semipermanent field heliports call for expert location and close supervision of ground operations by a trained ground crew. Temporary field helispots located at strategic spots on the fireline in response to a momentary need present special hazards because of less supervision and control.

Experience during the past few fire seasons on the Angeles National Forest has shown that well-planned and well-executed ground operations are essential for the efficient and successful use of helicopters.

THE HELICOPTER FLIES HIGH

JOY BALDWIN
Fire Staff Officer, Gila National Forest

The Gila National Forest of Region 3 sprawls across the Arizona-New Mexico State line, the Mogollon Mountains and the Black Range, which is also the Continental Divide in this part of New Mexico. The forest is just short of being 3 million acres in size. The Gila Wilderness Area—the first wilderness area created in the United States, the Black Range Primitive Area, and a part of the Blue Range Primitive Area are within its boundaries.

In this area fire occurrence is thought to be the highest of any such roadless area in the United States. Lightning is responsible for 95 percent of the fires which concentrate in number during the critical period between May 15 and July 15 and occur in lesser numbers in the pre- and post-season.

As an example of concentration density at one time in 1956, men were actually working on 109 going fires. These fires, all lightning-caused, were in the highest and most inaccessible country in the Mogollon and Black Range Mountains in New Mexico and that part of the Mogollon Rim extending into Arizona. Elevations range from 6,500 feet to more than 10,000, with very high fire occurrence in the range of 6,500 to 8,500 feet.

THE PROJECT

The Gila uses a combination of aerial and ground fire organization with each being assigned a given hour-control zone for initial attack purposes. The zones are not rigid in that each group assists the other as needed, or when one group is occupied—whether ground or aerial—the other covers or reinforces it. Some 2 dozen initial attack ground stations are used, and a crew of 18 smokejumpers is based at Silver City.

But there was deficiency in this initial attack organization. It was a common occurrence to have all jumpers out on fires with no way of moving them back in less than 12 to 24 hours; they had to come back on foot. This also involved using one of our ground control men and mules to pack out equipment (average 105 pounds per jumper). The men could have been used for initial attack purposes. Three possibilities of overcoming some of this deficiency were considered: (1) Increasing the number of men and ground stations; (2) enlarging the smokejumper crew; and (3) finding a rapid means of retrieving jumpers and equipment from the back country.

The increase in men in the back country was eliminated as a possibility because we are unable to obtain men properly qualified in the use of livestock who are willing to go in and stay there. Economics also entered into this decision. It would be hard to keep such men gainfully employed even if they were available; horses and mules are scarce, and feed for the animals is extremely expensive to either pack or airdrop. Thus we chose the third possibility and elected to try the helicopter.

All of the people in our organization with helicopter experience, as well as people in the helicopter business, helped in the preliminary planning, and specifications by helicopter manufacturers were examined. After analysis of performance requirements to meet difficult high-altitude and high temperature conditions, a late model 3-place helicopter was chosen. This helicopter was provided by a commercial operator under a bid contract.

RESULTS TO DATE

The following summary of helicopter use in 1957 speaks for itself:

1. 128 jumpers were retrieved from 64 fires. As mentioned earlier, walkout and return to base of smokejumpers is anywhere from 12 to 24 hours, and other personnel is tied up retrieving them. Conservatively, use of the helicopter saved 1[illegible] hours per smokejumper or a total smokejumper time of 1,44[illegible] hours. The big advantage, of course, is in having the jumpers available to meet another possible fire emergency.

On one fire, when all jumpers were out, the helicopter made it possible to retrieve 4 jumpers to jump on another fire in the wilderness area. The 4 men plus 3 others, 2 of whom were jumpers walking in, were able to control a fire at 20 acres. I[illegible] took approximately 17 hours to get assistance to this force by ground. Possibly several thousand dollars was saved in this particular case.

2. 16 jumpers built 18 helispots and, with the exception of 4 all were built by smokejumpers without assistance from other personnel. Without the "chopper" to retrieve the men, we could not have advanced so rapidly in our program.

3. On one fire 11 firemen were returned to their cars by "chopper" at a savings of 3 hours per man. The important thing was that the men were immediately available for other fires had they occurred.

4. Four men put on 2 fires by helicopter for initial attack saved about 2 hours each and, in addition, both fires were held to small B size. Otherwise, additional men would have been required 2 hours later and damage would have been much greater.

5. One rescue mission—injured lookout. This mission would have required the jumper plane for 2 hours, 8 men for 10 hours and 1 ambulance for 80 miles. The "chopper" did the job in [illegible] hour, thus alleviating a great deal of suffering for the injured man. We were not exposed to a major disaster by tying up our smokejumpers and plane.

6. 13,126 pounds of freight, the equivalent of 88 mule loads were hauled for fire suppression; 480 man-hours and 704 mule hours were saved.

7. One emergency repair to remote radio equipment with radio technician.

8. Three reconnaissance flights selecting helispots.

9. 330 flights were made in the helicopter from altitudes of 6,000 feet (home base) to 9,300 feet over a wide temperature range. Landings were as follows:

Altitude (feet)	*Number*	*Altitude (feet)*	*Number*
5,501-6,000	78	7,501-8,000	56
6,001-6,500	2	8,001-8,500	41
6,501-7,000	30	8,501-9,000	0
7,001-7,500	107	9,001-9,500	1

Payload had a wide range depending on altitude and temperature; however, a general average of 200 to 220 pounds was handled at 7,500 feet and up to 350 pounds at 6,000 feet.

MISCELLANEOUS

One standby crew was placed in an isolated, very high occurrence area. All supplies were by plane, and the parachutes plus remnants were returned by helicopter.

During the 1957 season, the Packsaddle, McKenna, Turkey, Rocky, White Creek, and Flare Fires were all potentially dangerous and gave much trouble to initial attack forces. The helicopter, through all uses, played a major role in preventing one or more of the fires from becoming project size.

THE LOOK AHEAD

During 1957 a study was started to determine what upper limits of altitude are imposed by temperature and turbulence at any given time. The test is continuing and we hope to establish a few spots in 1958 that will permit more testing at altitudes from 8,500 to 10,000 feet. When completed, we will be able to determine density altitude for a particular location and from a conversion table, we should be able to safely state what performance in load may be expected. The testing in marginal altitudes is to be done in a safe and prudent manner, and under no circumstances do we intend to experiment where life or property is placed in jeopardy.

New developments in rotary wing aircraft are coming rapidly, and helicopter limitations as they exist today are being so rapidly overcome that it is hard to visualize all we may be doing with these machines in the future.

FIRE ACCESSORIES FOR THE LIGHT HELICOPTE[R]

Arcadia Equipment Development Center, U. S. Forest Service

Many who have flown over and around fires in a helicopter hav[e] thought, "If only I could drop a couple of gallons of water on tha[t] spot," or "these 'copters are terrific, but there must be other thing[s] we can do besides haul men and sightsee." Well, we now have a[n] equipment system which will do four basic fire jobs with th[e] speed and mobility that is inherent with a helicopter. They ar[e] (1) bulk drop 35 gallons of water or chemicals, (2) lay up t[o] 1,000 feet of 1½-inch fire hose, (3) transport a lightweigh[t] pumper outfit complete with hose and water, and (4) delive[r] other cargo with a simple dual sling, electric-release device.

This equipment has been developed at Arcadia as part of th[e] joint Air Attack (helitack) Program being conducted in coopera[-]tion with the U. S. Engineers, California Division of Forestry and Los Angeles County. The aim of this program is to exploi[t] the potential fire fighting abilities of the helicopter.

What started out as one piece of equipment has developed int[o] a family of accessories designed around a standard carryin[g] device.

Bomb shackle adapter assembly.—The heart of all attachment[s] is an assembly (fig. 1) using a standard Navy bomb shackl[e] (1,600-lb. capacity), fitted with an external solenoid release. [A] manual cable release D-ring is also provided the pilot for emer[-]gency use in the event of electrical failure. The entire rac[k] weighs 29 pounds, quickly clamps to the cross-tubes beneath th[e] helicopter, and is fitted with slip joints to allow for dimensiona[l] differences. It is constructed entirely of 4130 steel rectangula[r] aircraft tubing.

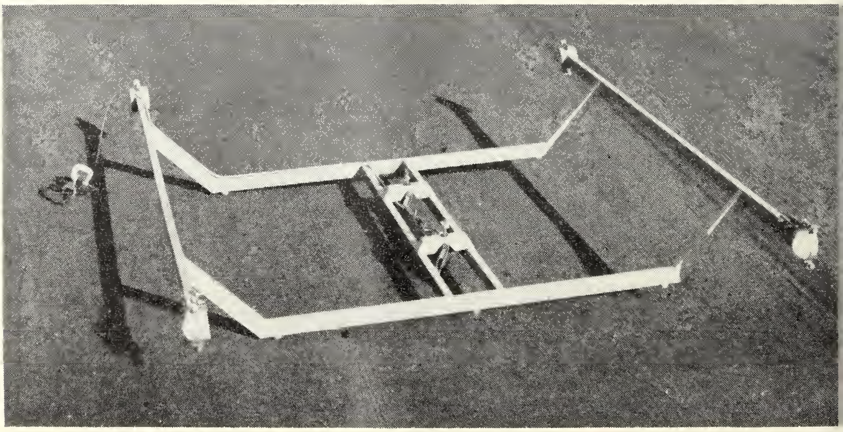

FIGURE 1.—Bomb shackle adapter assembly.

Some operators have wired the 24-volt solenoid directly to the dust hopper release button on the cyclic control stick, thus providing an instantaneous operation of the shackle.

The assembly has been CAA certified for use in an unrestricted category when not carrying accessories.

Helitank.—An accessory which has proved itself on fires during the past season is the helitank (fig. 2). The tank shape evolved from the standard pyramidal shape of the canvas relay tanks and is designed to be self-supporting while the tank is being filled on the ground. The 35-gallon capacity was selected to limit the load to a reasonable amount for operation under marginal flight conditions at high altitudes and temperatures. The tank is made of lightweight neoprene-coated nylon fabric and weighs 4¼ pounds. Certain dimensional limitations were maintained so that loading operations can be done underneath the helicopter and to keep sling length as short as possible.

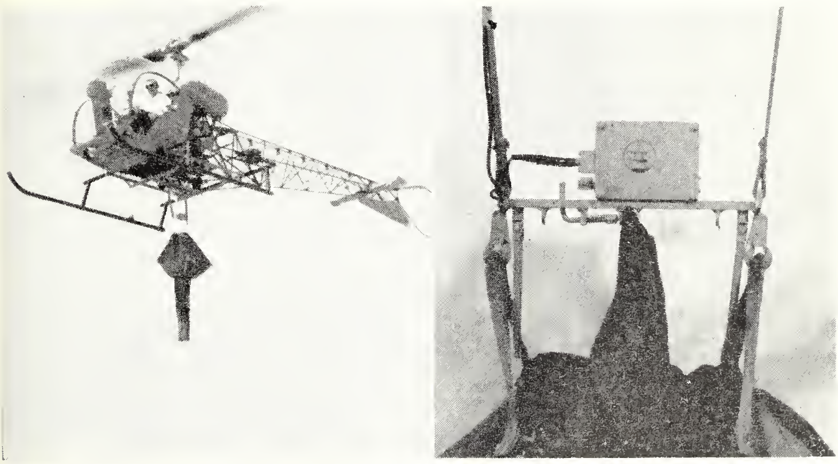

FIGURE 2.—*Left,* Helitank dropping 35 gallons of water. *Right,* Helitank sling release.

Several snout release methods were tried; the one selected consisted of turning the snout inside-out and suspending it up through the tank. As a result, the fastening is centrally located and better accuracy is provided by the discharge of water straight down when released.

The tank is suspended by nylon straps on a short spreader bar equipped with two parachute snaps on the ends. This bar in turn is attached to the bomb shackle by short web slings, and is equipped with a pin release in the center, operated electrically by a 24-volt solenoid (fig. 2).

This solenoid can be activated from the radio button on the cyclic stick, or it can be wired through a small switch taped to the stick and powered by a battery taped to the adapter. Grommets are located in the end of the drop snout of the tank through which the pin passes, thus holding the snout above the tank during flight prior to the drop.

In operation, the tank is placed inside the skid on the ground and hooked up to the sling release. Filling can be accomplished in this position, or the helicopter can land over the filled tank. It has been found practical to land over the filled tank when returning with an empty unit, and disengaging and taking off with a full unit in less than one minute. After setting up the operation, a marker or line alongside the skid on the ground will spot the ship exactly for hooking up. On one fire operation utilizing a pair of tanks, drops were made ¾ of a mile away by one helicopter every 4 minutes.

At 15-25 m. p. h. a good wetted area is obtained about 10-15 feet wide and 50-75 feet long. The pattern is of course shortened as speed decreases. Excellent coverage on single snags has been obtained. It is not normally safe to hover above fires because of rotor blast.

Since the sling is suspended from the bomb shackle, the pilot has the safety feature of being able to jettison the entire sling and tank in an emergency.

Fire hose dispensing tray.—A tray, approximately 4 by 8 feet, which can hold up to 1,000 feet of packed hose can be easily attached to an H-bracket which in turn is rigidly secured in the bomb shackle. The H-bracket weighs 15 pounds, and the tray 30 pounds. The same sling assembly used for the helitank can be fastened on the tray for electrically dropping a roll of hose which in turn starts the folds of hose in the tray flaking out while the helicopter is in flight. (figs. 3 and 4).

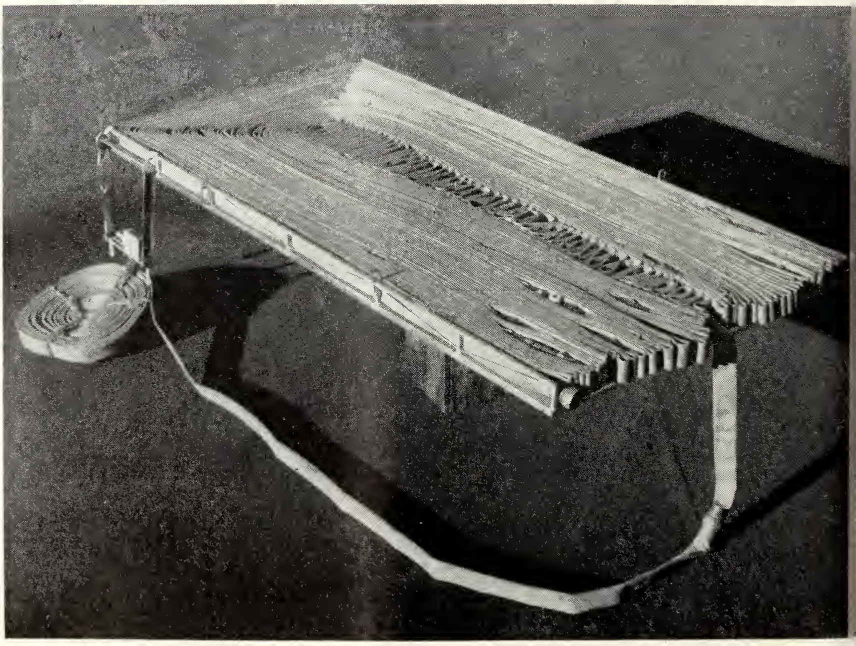

FIGURE 3.—Packed hose tray ready for flight.

The horseshoe pack minimizes center-of-gravity changes and permits smooth discharge. The hose is also tied in the tray at the forward end in sections with 21-pound break-away thread to prevent discharging in bunches.

Normally the tray is removed by lifting it out of the parachute snaps and sliding it from underneath the ship. In event of an emergency, tripping the bomb shackle lets the H-bracket and tray fall free.

Flight speeds of 10 to 20 m. p. h. were found to be the safest, although ground test studies have been safely conducted up to 50 m. p. h. An early model hose tray was flight tested by a helicopter manufacturer at maximum allowable center-of-gravity limits and it was found that helicopter controllability was well within the allowable range.

The first use of this hose lay method on a going fire occurred July 5, 1956, on the 400-acre Sterling Fire, San Bernardino National Forest, when 1,000 feet of hose was laid on the northwest edge of the fireline.

Electric sling cargo release.—Helicopter flight tests have shown that cargo slung beneath on a single point tends to oscillate and rotate causing unbalanced forces. The use of a double sling largely eliminates the fore-and-aft center-of-gravity changes in takeoff

FIGURE 4.—Hose lay by helicopter.

and landing. The sling release, therefore, has been equipped wit release arms that can electrically drop two cargo lines simul-taneously (fig. 5). Although the bomb shackle can be used fo handling cargo, it is somewhat inconveniently located for fas accessibility, while the sling release is handled off to the sid beneath the helicopter.

The release arms do not impair operation of the release pi when used with the helitank. Thus the sling serves three pur-poses: Starts the hose lay, operates the helitank, and carrie cargo. The prototype model has been load tested to operate a 1,050 pounds. Again, the pilot can jettison the entire cargo slin should the release arms fail.

Helipumper.—This useful piece of cargo was developed fo helicopter transport. The unit consists of a lightweight portabl pumper (7.5 gallons per minute at 150 pounds pressure per squar inch), 200 feet of 1-inch lined hose, and a water hopper whic can hold a pair of 5-gallon metal or disposable cardboard wate cans for initial delivery (fig. 6).

In operation the hose is coupled to the pump, the pump started and water poured into the hopper tank. A pressure relief valv is provided in the system to bypass the water when the nozzl is shut off. The helicopter can stockpile or supply water in can or boxes by using the cargo sling release. Delivery of helipumpe and water may thus be accomplished without landing.

Overall dimensions of the unit are low to permit placement o the ground inside the skid. This again keeps sling length as shor as possible. Full weight of the unit is 187 pounds, empty 6 pounds.

Other equipment.—After using some of this equipment on fire it became apparent that the speed of attack was sometimes los as a result of slow delivery to the heliport. Calling the warehous

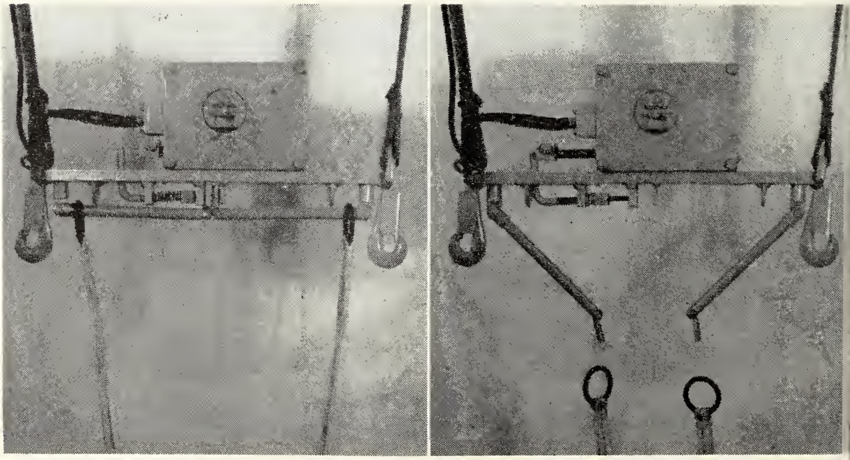

FIGURE 5.—A prototype design of a dual release attachment on the slin showing cargo lines in place and released.

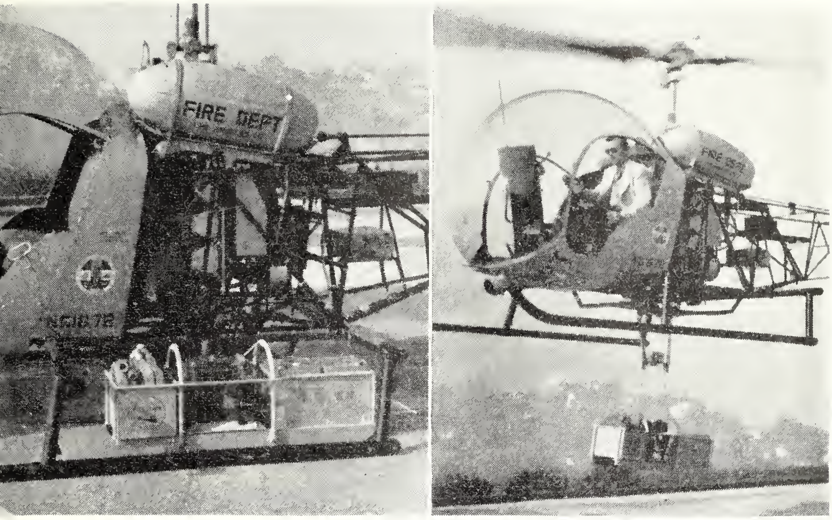

FIGURE 6.—Helipumper unit: *Left,* In position inside skid; *right,* being delivered.

and then waiting several hours for delivery cancels the entire potential speed advantage. To solve this problem the project has scheduled design of a truck-mounted slip-on, equipped with all the accessories and servicing tools so that it can be promptly dispatched to the flight scene. With the adapter assembly permanently mounted on the helicopter the accessories can be hooked up in minutes.

THE HELICOPTER JOINS THE HOSE-LAY TEAM

FLOYD W. WAKLEE, *Forestry Equipment Engineer, Californi Division of Forestry;* HERB SHIELDS, *Mechanical Engineer, Ar cadia Equipment Development Center;* CARL C. WILSON, *Chie Division of Forest Fire Research, California Forest and Rang Experiment Station.*

The helicopter proved it could lay fire hose over brush rapid ly and safely in 1956.[1] Additional tests conducted in 1957 showe that it can do the job over timber and other cover types, an revealed some of the work still needed to make this versatile to even more effective.

The 1957 tests,[2] carried out at Sorefinger Point near Weima California, covered three specific methods. First, we checked th time and performance of a ground crew making a 2-mile lay b hand; next, the ground crew did the job with a helicopter assist finally, the pilot alone laid the hose from the helicopter.

Hose lay by hand.—A specially trained 6-man crew of th California Division of Forestry was used. Each man in the cre carried 200 to 300 feet of hose in conventional pack sacks, an the only assistance received was 5 hose deliveries by truck.

We found that a 2-mile hose lay by a small crew isn't th "impossible" job we had visualized. The 6-man crew took only hours and 55 minutes to lay 10,900 feet of 1½-inch hose ove the 10,819-foot course. This time included delays of 4½ minute while the crew waited for hose deliveries by truck, 5 minute while killing a rattlesnake encountered en route, and 23 minute lost because part of the crew had to walk back uphill to ge more hose. Thus, net time was only about 2 hours 22 minutes.

For the first 4,728 feet, the crew laid hose at an average o about 100 feet a minute. Fatigue began to show at about 4 minutes from starting time, and the men became increasingl tired as they fought through heavy brush. In spite of fatigu with a brief rest this 6-man crew would still have been an ef fective suppression unit even after laying 2 miles of hose.

Hose lay by hand with helicopter assist.—During this phas of the tests 1,200 feet of hose was attached to a cartridge fo dropping (fig. 1). In a preliminary test, the hose package wa jettisoned from 60 feet by the pilot. The hose fell into a clum of brush and rolled across a rock-covered slope. The cartridg was so badly bent that it had to be repaired before further us In addition, one length of hose was cut. The remainder of th hose was tested at 350 p. s. i. and found okay. Damage to th couplings was negligible.

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[1] *Improved Fire Hose Dispensing Tray for Helicopters.* Arcadia Equip ment Development Center. U. S. Forest Service Equip. Devlpmt. Rpt. 4 26 pp., illus. 1956. [Processed.]

[2] *The Helicopter—A New Member of the Hose-Lay Team.* Waklee, Floy W., Shields, Herb, and Wilson, Carl C. U. S. Forest Service Calif. Fore and Range Expt. Sta. Res. Note 129, 11 pp., illus. 1957. [Processed.]

FIGURE 1.—A package of 1,200 feet of 1½-inch fire hose attached to cartridge and ready for installing on adapter assembly of helicopter.

After dropping 3 loads (3,600 feet of hose) at preselected spots, we called the operation off because of excessive hose damage. Several couplings were damaged, and 7 lengths of hose were ruptured or cut by the impact as the 300-pound load and the cartridge hit the ground. The two men who fitted the hose package to the helicopter found that there wasn't room to work under the helicopter and the cartridge straps were too short to allow any freedom. If this method is to become practical, we need to develop a way to package the 1,200-foot hose cargo so that it can be jettisoned from a helicopter 75 to 100 feet above the ground without damaging the hose or couplings.

Helicopter hose lay.—We then made the entire lay by a helicopter with the hose-lay tray. To speed up the operation, hose was prepackaged on plywood sheets and stockpiled at the heliport ready for immediate use. At first, the tray of hose was delivered by having a man on the ground start the lay by grabbing the dangling hose as the helicopter hovered overhead. But in timber stands, the cover was so thick the pilot could not hover close to the ground, and the other lays had to be started by the pilot (fig. 2). He released a 100-foot coil of hose tied to the skid gear, and the weight of the coil pulled the hose out of the tray.

Prepackaging the hose on plywood transfer pallets partially solved the problem of loading the helicopter hose tray. We still need better ways to strap the hose package to the plywood and tie the sections to the tray, but these problems can be solved by equipment development.

We found that the helicopter using the hose-lay tray can lay fire hose over gentle to steep topography and above brush and light timber. The key was in finding a way for the pilot to start

FIGURE 2.—Hose lay started by pilot. Hose pays out over tops of oaks an pine trees.

the lay at his convenience—using a length of hose for a weight Total time for the 2-mile lay by air was 2 hours and 29 minute including 42 minutes lost because of mechanical problems—2 minutes less than was required by the hand crew. Although 4 me were used to connect the hose when it reached the ground, the said that 2 could have done the job.

We also learned that the helicopter lay takes much more hos over timber and heavy brush. It required 12,570 feet, compare with 10,900 feet for the hand lay—about 16 percent more. Hos laid from the air catches in the tops of trees and drops down be tween them. We found that the extra 100 feet of hose used t start the lay is useful for splicing when the hose sections don quite come together. This extra length could also be helpful fo replacing ruptured lengths in a long lay.

Another point learned was that reduced airspeed during th hose-lay operation is important. The pilot should never fl faster than 20 and preferably between 10 and 15 miles per hou

The pilot told us that the lay would have progressed faste and with a wider margin of safety if he had been able to contac the ground crew by radio. Not only can the ground crew be un aware of special hazards visible from the air, but also the pil may be unable to see ground hazards. Ground-to-air and air-t ground communications are as vital for helicopter hose lays a for other aircraft operations.

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[3]An electric device for releasing the 100-foot (25-pound) coil of hose t start the hose lay is reported in *Fire Accessories for the Light Helicopt* in this issue.

TRAINING THE HELITACK CREW

JAMES L. MURPHY
California Forest and Range Experiment Station[1]

"Help!" the voice on the radio screamed, "I'm trapped, the fire's all around me!" The year, 1947; the fire, the Bryant Fire on the Angeles National Forest in southern California. The situation: a radio operator running an emergency radio relay station on a remote ridgetop was in the path of a blowup. Five minutes after his call, he was safely off the mountain. The helicopter had made its forest fire debut.

The helicopter is now a common forest fire-fighting tool in California. Its value and effectiveness are beyond question. But the helicopter is not an ordinary fire tool. It is expensive and is potentially as dangerous as it is valuable.

To obtain the safest and most efficient use of the helicopter the Helitack program[2] has included the organization and training of Helitack crews. In 1957 almost 300 fire fighters from 12 national forests, the California Division of Forestry, and the Los

FIGURE 1.—The San Bernardino National Forest base heliport is accessible by road, has a drop-off into the prevailing wind, and has an asphalt touch-down pad.

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[1]Maintained at Berkeley, Calif., by the Forest Service, U. S. Department of Agriculture, in cooperation with the University of California. Much of the work included in this report was conducted under terms of a cooperative student-aid agreement between Utah State University and the experiment station.

[2]A cooperative research and development program of the U. S. Army, the California Division of Forestry, and the U. S. Forest Service.

Angeles County Fire Department were trained in helitactics. A outline of the training plan follows.

I. Organization and qualifications of the Helitack Crew
   A. Helitack foreman: Qualified as sector boss (U. S. Forest Servic fire rating) and experienced in air operations on forest fires.
   B. Assistant Helitack foreman: Qualified as crew boss and experience in air operations on forest fires.
   C. Helitack crew member: Must have two seasons of fire experience.
   D. Helicopter pilot: Must be an experienced mountain pilot.

II. Ground operations
   A. Locating permanent base heliport (fig. 1).
   B. Installing base heliport facilities.
   C. Safety regulations.
   D. Equipment kits.
   E. Preparation of helicopter operations map.
   F. Flight and other records.

III. Training the Helitack Crew
   A. Pilot training.
      1. Helicopter-use policies not included in general CAA instruction (One source is the Region 5 Supplement to the National Fores Manual for Forest Service Use Policies and Working Instru tions.)
      2. Fundamentals of fire behavior.
   B. Crew training.
      1. Safety.
         a. Precautions while on ground
            (1) Keep at least 50 feet from helicopter at all times unles job designates otherwise.
            (2) Dustproof all landing areas by wetting down or oilin Wear goggles at all times when helicopter is at helipor
            (3) Approach and leave helicopter from the front so tha pilot can see you at all times.
            (4) Do not approach or leave helicopter over ground highe than that on which the ship is standing.
            (5) Keep clear of main rotor and tail rotor. Watch long handled tools.
            (6) Provide a wind indicator at all landing spots.
         b. Precautions before takeoff.
            (1) Obtain pilot's approval on all missions.
            (2) Check wind conditions. (Helicopters should never be di patched for mountain flying when average wind velocit over a 5-minute interval at exposed peaks is more tha 30 m. p. h.).
            (3) Fasten and adjust safety belt.
            (4) Keep clear of controls.
         c. Precautions while in the air.
            (1) Keep safety belt secured until pilot signals release.
            (2) Keep oriented at all times.
            (3) Watch for special hazards.
      2. Job familiarization.
         a. How the helicopter works.
         b. Maintenance and use of all Helitack equipment.
      3. Development of skills.
         a. Physical conditioning.
         b. Refresher course in fire behavior, use of tools, and lir construction.
         c. Map reading and use of compass.
         d. Forest Service ground-to-air visual signal code.
         e. Use of radios.
         f. Hover-jump (dropping from ship hovering 6 to 8 feet abo ground) training:
            (1) Protective suit.

(2) Jumping procedure.
   (a) Make a high-level pass to determine general area safest for jump.
   (b) Make a low-level pass and pick the jump spot.
   (c) On third pass, at pilot's signal, drop tools near jump spot.
   (d) On fourth pass, jump in compliance with established procedures (fig. 2).

g. Hover-landing procedure.

h. Helispot location and construction. (One of the big responsibilities of the Helitack Crew.)

i. Fire suppression procedure.
   (1) Initial attack on small fires.
      (a) First response. pilot, Helitack foreman, one crewman.
      (b) Reconnaissance of the fire.
      (c) Crew landing.
      (d) Initial attack.
      (e) Helispot construction.
   (2) Large fire procedure (where Helitack Crew will not make initial attack).
      (a) First response: pilot, Helitack foreman, one crewman.
      (b) Ground response: remainder of crew with Helitack Crew equipment.
      (c) Heliport location: foreman and pilot.
      (d) Traffic management: Helitack foreman.
      (e) Operation of base heliport: Helitack crew.

4. Standby duties: prevention, presuppression, insect and disease control, search and rescue, aerial seeding.

Experience during the past 10 years on California forest fires has proved that safe and efficient helicopter operation requires a specialized crew well trained in every use of helicopters on forest fires. This training can pay big dividends in cutting fire fighting costs and reducing overall damages.

FIGURE 2.—At the pilot's signal, Helitack crewman grips both sides of the open door firmly. He swings his right foot out to the skid. His lower right leg and knee are placed snugly against the skid gear leg.

HELITACK CREWS PAY OFF IN CALIFORNIA

JAMES L. MURPHY
California Forest and Range Experiment Station[1]

"Catch 'em while they're small" has been the goal of fores fire fighters since the beginning of organized forest fire suppres sion. Even the largest and most disastrous fires could have beeı stopped in their early stages had a few experienced men been abl to reach them and take immediate action. Early detection and fast efficient action are the only practical answers to successful in itial attack.

The helicopter, introduced to California fire fighters in 1947 has shown promise in reducing the time interval between de tection and initial attack. But helicopter use can be expensive particularly if not closely supervised. We also know it can b dangerous to anyone not aware of its hazards.

HELICOPTER SPECIALISTS

A team of specialists, highly trained in using helicopters oı fires, may offer a solution to these problems. This was demonstrat ed in 1954 when the Angeles National Forest organized a 4-maı crew of specialists trained in initial attack by helicopter, in lo cation and construction of helispots, and in air operations oı large fires.

Limited experience indicated that this type of crew could be come an important part of the fire suppression organization Consequently, when Helitack was organized in 1956,[2] one of th objectives was to study the use of crews in performing certaiı specialized fire jobs with helicopters. California was selecte for the training area. During the 1957 fire season some 30 fire fighters from the national forests, the California Divisioı of Forestry, and the Los Angeles County Fire Department were trained in "helitactics."

USE OF HELITACK CREWS, 1957

In 1957 Helitack crews were used in a variety of ways iı California. They made 42 initial attacks throughout the State controlling 32 fires in the early stages with no other aid. On five

[1]Maintained at Berkeley, Calif., by the Forest Service, U. S. Department of Agriculture, in cooperation with the University of California. Much of the work covered by this report was completed under terms of a cooperative student-aid agreement between Utah State University and the experiment station.

[2]A cooperative research and development program of the U. S. Army, the California Division of Forestry, and the U. S. Forest Service to integrate helicopters into fire suppression activities.

fires the Helitack crews were helped by another new fire tool: air tankers. On four other fires the Helitack crews were soon joined by ground or smokejumper crews who aided in suppressing the fires. Only once was a Helitack crew unable to stop the fire in initial attack.

Average travel time for the Helitack crews was 33 minutes, including flight time from the company base for those helicopters not on standby contract. Followup ground crews averaged 3 hours and 48 minutes travel time. The effectiveness of such fast initial attack is evidenced by the report of the fire boss of the Ditch Fire on the San Bernardino National Forest: "Helitack crew made initial attack, knocked down head and hot-spotted flanks."

Where the Helitack crews could not control a fire on initial attack, they paved the way for fast followup crews. This type of operation was reported on the Pate Fire on the Los Padres National Forest: "Fire in inaccessible area on ridgetop. Crew made hover-jumps near the fire and constructed helispot. Relief crews, supplies, and equipment were flown in and out by the helicopter. At least 30 acres and $900 in costs were saved."

OPERATIONS ON LARGE FIRES

The Helitack team of specialists can also perform important jobs on large fires: Reconnaissance and scouting, management of air traffic, maintenance and service of heliports, location and construction of helispots, servicing helicopter accessories, and hot-spotting isolated sectors of the fireline. Helitack crews also proved effective in northern California as mopup and patrol crews on lightning fires following initial attack by smokejumpers.

The Devore Fire on the San Bernardino National Forest demonstrated another ability of the Helitack crew. Their efficiency in packing and installing helicopter hose trays and in helping lay 4,000 feet of 1½-inch hose was a vital factor in bringing the 96-acre fire under control in a brushy, rugged area.

OTHER USES OF HELITACK CREWS

Because of their specialized knowledge, Helitack crews are especially valuable for training other fire fighters in helicopter use and safety. They also aid presuppression programs in other ways. They construct helispots. They increase detection coverage on days of low visibility and high fire danger by serving as observers. At least one national forest said that the helicopter and its crew were a valuable aid in fire prevention work: Once forest users were aware of the helicopter patrol, they remained out of areas closed to public use.

Helitack crews also have been used on nonfire projects, such as detecting and treating insect-infested trees in inaccessible timber areas on the Klamath National Forest.

HOW HELITACK CREWS HAVE PAID OFF

In summary, field reports in California in 1957 showed th the following dividends can be obtained from well-trained Hel tack crews:

Safety.—Helitack crews are trained, and can train other pe sonnel, to recognize and avoid helicopter hazards. Helicopter-d livered crews get an aerial view of the entire fire and its hazard are not fatigued by long hikes and, as a result, are better able cope with emergency situations.

Versatility.—The Helitack crew can be trained in all forestr uses of the helicopter.

Availability.—Specialized crews with equipment specificall designed for helicopter use are kept available at all times. Th assignment of untrained men could result in an inefficient ar unsafe helicopter operation.

Efficiency.—Use of the helicopter reduces travel time to th fire. Aerial reconnaissance assures quick, decisive initial actio that can result in prompt control.

Economy.—Fieldmen of the agencies participating in th Helitack crew training program estimate substantial saving in suppression costs and more than 15,000 acres saved on 2 fires as a result of Helitack crew activities during the 195 fire season.

Even with these advantages, Helitack crews must still b viewed as an additional fire tool to be integrated into the ove all fire organization. They can be efficient and economical onl when used at the proper time and place. They are not intende to replace ground crews, smokejumpers, bulldozers, and fixe wing aircraft where such units can perform better and cheape The next job is to determine the limitations of Helitack crew and to establish guidelines for their use.

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.

Fire destroys <u>his</u> trees, too

REMEMBER—

ONLY <u>YOU</u> CAN PREVENT FOREST FIRES!

OL. 19 JULY 1958 No. 3

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 19 Number 3

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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Forest Service, Washington, D. C.

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CONTENTS

RADIO PROCEDURE—YOUR KEY TO EFFECTIVE OPERATIONS

JOHN H. ATKINSON
Assistant Communications Director,
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The use of radio as a major weapon in fire control activities as well as in general forestry operations has progressed at such a phenomenal pace since the end of World War II that many users have lost sight of proper operating procedure. Radio equipment is now installed in vehicles operated by State foresters, and in dozers, helicopters, and other Service equipment. The ability to utilize the full potential of these adequately equipped radio systems is fully dependent upon proper procedures and practices. Your system is only as good as your worst operator.

Good operating procedure must start at the top administrative level and carry down through the lowest unit by training and example. A standard operating procedure manual describing the radio system in nontechnical terms is the first criteria for successful operation.

The manual should contain the complete procedure as applied to field forces, including many examples of typical transmissions so that even the most unfamiliar crewman can substitute his own case for the example and find a usable message.

Each employee who will operate the radio must be issued a procedure manual. Each station, whether radio equipped or not, should have sufficient manuals assigned to it so that all employees can have an intimate knowledge of proper operating procedures. Prime examples must be set by the dispatcher, rangers, and other supervisory employees. A supervisor who uses sloppy procedure cannot expect anything better from his employees. The ranger, his assistant, or the dispatcher should spend as much time as possible instructing new personnel in proper radio usage before they are permitted to operate. Only in this way can reasonable success be expected. In large forestry agencies, administrative communications personnel should be employed to help in these matters and to provide nontechnical communications assistance to Fire Control and other policy divisions.

STATION IDENTIFICATION

Each base station is assigned a Federal radio call sign, generally 3 letters and 3 numbers. This call sign is the legal identification of the station. In a large system, the number of call-sign combinations is excessive, and the radio channel is a mass of confusing letters and numbers. Obviously this makes it difficult, if not impossible, to remember the call sign of every station. Under such circumstances, geographical call signs are preferred. These are assigned by the system administrator and generally are the name of the ranger station, lookout, or activity where the radio is located.

The geographical call sign is used in all communications be tween stations and between stations and their respective mobile: If the Miami Ranger Station calls the Bass Lake Guard Statio the transmission would be as follows: "Bass Lake—Miami." Yo will note that the name of the called station is transmitted firs followed by the name of the station doing the calling. If the orde is reversed, *all* base stations must listen when they hear "Miami in order to determine whether the call is for them. By using prop er procedure, the called station is alerted in time to hear th identification of the station making the call.

The assigned legal call sign must be given at the end of eac transmission or series of transmissions. This means the full cal including both letters and numbers, because the use of only th numbers is a violation of the Federal regulations for station ider tification.

Stations used as temporary base stations are in many case licensed to only a single call sign, such as KMB453. The license then must add a unit identification to the call, such as "Unit KMB453; Unit 2, KMB453." The use of the geographical call sig would still apply to these units, however; in signing off at th completion of the transmission they would identify as "Unit KMB453."

MOBILE IDENTIFICATION

Most mobile units and handie-talkies are identified by un number and there are few problems. Several methods are used i establishing uniform mobile identification. For example, Cal fornia employs a four-number identification for all units. Th State is divided into six districts for administrative purposes. Th 1st digit of the 4-number assignment identifies the district; th 2nd, the ranger unit; the 3rd and 4th, the unit or vehicle num ber. For example 5424 would be vehicle 24, in ranger unit 4, di trict 5. Such a mobile identification system eliminates confusio and readily identifies all units.

As in other transmissions, the mobile identification is used firs when being called by a base station—"5424—Miami." The mobi need only state his number to signify that he is receiving the cal Other phrases such as "5425 bye," and "5424 go ahead," are nc necessary. Because of the increased use of radio-equipped aircraf the mobile identification number, or a part of it, should be painte on the roof of each vehicle to facilitate air-to-ground identificatio and communication.

GENERAL PROCEDURE

The strictest procedure possible without loss of efficiency is t be desired. All personnel should be cautioned to keep all me sages brief and to the point. One fault common to many opera tors is their inability to know when they start to repeat them selves. Give the message in brief detail; if more information required, the other station will ask for it. It should not be nece sary to ask initial attack units for an appraisal prior to thei arrival at a fire. Good forestry procedure requires that the firs unit issue a size-up on arrival. Likewise, lookout reports should be precise and in a predetermined manner. How many times have you heard a lookout give a very detailed report and then have the dispatcher ask "What's it look like?"

All personnel should be impressed with the need for monitoring the radio channel prior to transmitting. Nonmonitoring causes interference and unnecessary repeats. Particular attention should be given to this by lookouts and aircraft. From high elevations, signals travel many miles and cause considerable out-of-area interference.

One other common fault that increases radio traffic usually occurs at the dispatcher level. General-information broadcasts are transmitted to several stations and/or mobiles by the dispatcher. He signs off with "All units acknowledge" or similar phraseology. The acknowledging units then do as requested, and usually at the same time. This results in a jumble of acknowledgments and many repeats become necessary. It is desirable that the dispatcher at the completion of his broadcast state each station's name or mobile number in order and obtain an acknowledgment before going on to the next one. This is a little more work, but the results are positive because in the long run traffic is reduced.

CODES

A standard radio code that uses numbers to replace standard phrases should be adopted for use by all personnel in a system, because it materially reduces radio traffic. Such a code is given at the end of this article.

LOGGING TRANSMISSIONS

The method of logging a dispatcher's messages varies between agencies, but generally it is done word-for-word in a page-type radio log. In the initial stages of a going fire, the assistance of a second person is usually needed to keep the log up to date. Units going in and out of service are lost in the log pages, and continual rechecking is necessary to find them. Actually, the Federal Communications Commission's Rules and Regulations under which non-Federal agencies operate require logging only the name of the operator of each base radio station (ranger, lookouts, guard stations, etc.) and his period of duty. Systems administrators should review their procedures to determine whether unnecessary log work is being done. Approximately 90 percent of all administrative broadcasts could probably be eliminated from the logs.

One method of keeping track of units is to use a series of pegs upon which are hung 1½- by 3½-inch white tags with the status of each unit written on them. As a unit reports a change in status, its tag is changed. Thus, the status of each unit is readily available at all times.

Another method of keeping track of units is for the dispatcher to keep a fire-alarm log for each fire. It has a place for first report and the time. Each station is listed in order, and a space is available to record the time each station was dispatched. Also a series of columns is available to show the following: 1, Unit number; 2, time in service; 3, time canceled and returned to sta tion; 4, time of arrival at fire; 5, time assignment completed an in service to station; 6, time of arrival at station. There is space for "Control-time" and who reported it. This preprinte form keeps a complete record before the dispatcher of units as signed to a fire as well as their progress in reaching the fire, an it becomes a handy aid in completing the formal fire report.

The amount of radio traffic possible on any radio frequency i directly dependent upon the way the system is operated. One of th most valuable natural resources in fire control today is the radi spectrum. Once radio frequencies become saturated, they canno be replaced. Only by use of effective operating procedure can w conserve this vital natural resource.

RADIO CODE USED BY STATE AND COUNTY AGENCIES I CALIFORNIA

All calls not accompanied with the statement code two, three, are routin calls and should be considered code one.

CODE ONE—At your convenience.
CODE TWO—Proceed immediately without siren or red light.
CODE THREE—Proceed immediately with siren and red light.
CODE FIVE—Additional assistance may be needed.

10-1	Receiving poorly
10-2	Receiving well
10-3	Stop transmitting
10-4	OK or acknowledgment
10-5	Relay
10-7	Out of service
10-8	In service
10-9	Repeat
10-10	Out of service at home—subject to call
10-11	Transmitting too rapidly/overmodulating
10-13	Weather
10-19	Return to your station or returning
10-20	What is your location?
10-21	Call the dispatcher by phone
10-21a	Advise my home I will return at........................
10-21b	Call your home
10-22	Disregard last message
10-23	Stand by
10-25	Do you have contact with ....
10-36	Correct time
10-37	Who is the operator?
10-39	Can.........(Name).........come to the radio?
10-40	Is.........(Name).........available for phone call?
10-45	Use code
10-48	I'm now ready to take infor mation
10-49	Proceed to........................
10-55	Confine message to offici business
10-69	Have you dispatched........................?
10-86	Traffic check
10-87	You are to meet........................
10-89	Need radio serviceman at........................
10-97	Arrived at scene
10-98	Finished with last assignmen
10-99	Unable to copy, change lo cation
903	Airplane crash
904B	Brush fire
904F	Forest fire
904G	Grass fire
904I	Illegal or incendiary fire
904P	Plane fire
904S	Structural fire
904V	Vehicle fire
909	Traffic conditions need CHP
910	Can handle
950	Burning permit fire
951	Need C.D.F. investigator
952	Report on conditions
953	Check smoke
954	Off the air at scene of fire
955	Fire under control
956	Need mechanic

A TRAINING COURSE IN AERIAL SCOUTING

RALPH C. WINKWORTH
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N. C. Department of Conservation and Development

The North Carolina Division of Forestry has been using both contract and State-owned aircraft for scouting large fires for several years. Most extensive use of this service is in large, inaccessible areas of the Coastal Plain section of the State where aerial scouting has become routine in the suppression of the swamp fires.

Before the State purchased aircraft, the contract system was used exclusively for several aircraft at scattered points to insure coverage. It was found that the success of these scouting flights depended entirely upon the ability of the man in the plane to analyze the problem of the fire boss and to provide him with information that was both accurate and relevant to his suppression problem. It was also discovered that neither an experienced pilot nor an experienced fire control man made a good aerial scouting observer until experience was gained in this particular type of work. Consequently, the time required to get one of the few qualified observers to the plane often offset the value of the flight.

The most practical solution seemed to be to train selected forest rangers throughout the area in the technique of aerial scouting. Beginning in 1951, this training was conducted during the annual ranger training schools for eastern districts. Twelve hours of instruction were devoted to the course, and the course was repeated 3 times during the 2 schools to insure small classes and individual instruction. Several men were able to take the course each year. After acquisition of State planes and employment of regular pilots, this training was on an on-the-job basis, but the same subject-matter structure was retained.

Since all the students were experienced fire bosses, emphasis was placed on the type of information that could be obtained from the air and how it could be transmitted to the ground. This was accomplished through intensive instruction and practice in aerial mapping and radio and message-drop communication.

The course followed this pattern. The estimation of distance and direction in locating a fire and of size in plotting it were approached through navigational methods, and the aircraft compass was used to obtain bearings. After preliminary lecturing, all of the navigation techniques were covered in hypothetical problems worked out individually by the students with assistance from the instructor. This was followed by an orientation flight in a four-place aircraft with the instructor present. On this flight the students located ground points on their maps by plotting bearings from known landmarks and by computing distances by time and speed. The purpose of the flight was to introduce the students to flying.

A second flight was made over a distinct old burn with only the student and the pilot in a conventional two-place scouting aircraft. This flight allowed the student nearly an hour over the burn. He mapped the fireline, sketched in the breaks, determined the cover types, answered questions about the nature of the fire and dropped messages to a party on the ground. Radio contact was maintained throughout this flight, and the pilot acted strictly on the instructions of the student.

This flight was followed up by a trip to the burn on the ground where the student could compare his impressions from the air with the actual terrain.

The final step was either a third flight or a series of colored slides showing the burn at several angles and from different altitudes. Aerial photos and a type map of the area were also provided after the students had completed their mapping flights.

By using the four-place plane for the first flight, carrying two trainees and the instructor, the cost of instruction per student was kept very low. Most of the men who received the instruction have scouted several fires from the air since receiving this training. They have gained confidence in their ability and are using aerial scouting to a much greater advantage. A short course of this type cannot be expected to fully qualify aerial observers, but the men who have received this training gain proficiency much faster in subsequent actual experience than they would otherwise.

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Red, White, or Blue—Wear an extra Shirt on the Fireline

A fire fighters efficiency is often greatly reduced by heat when he makes a direct attack on a fire edge. Tests at Pilgrim Creek on the Shasta-Trinity National Forest, reported by E. L. Alpens, C. P. Butler, and others in Research & Development Technical Report USNRDL-TR-84, NM 006-015.[illegible] in 1955, have shown just how much heat is given off in some common fire situations and also have suggested how to minimize its effects.

The heat received 6 feet away from a wood crib fire was 100 times that received from the sun on a summer afternoon. Less than 1 percent of this is visible since nearly all of a fire's heat energy is in the infrared region of the spectrum. From these facts we can draw two conclusions about proper clothing.

First, the color of a fire fighter's clothing is unimportant in absorbing the heat from a fire because all cloth is "black" to infrared radiation. Also we know that two layers of cloth are four times as effective as a single layer in reducing the heat penetrating to the skin. Conventional summer underwear fails to give maximum protection because it does not cover the arms and legs. Therefore, a lightweight jacket or extra shirt will reduce the discomfort of close-quarters fire fighting.—Arthur R. Pirsko, *Forester, California Forest and Range Experiment Station*, maintained at Berkeley, Calif. by the Forest Service, U. S. Department of Agriculture, in cooperation with the University of California.

A FOUR-PURPOSE ENCLOSURE CARD FOR TRAINING FILMS

ALVA G. NEUNS
California Forest and Range Experiment Station[1]

Motion pictures are excellent visual aids to training when they are used correctly. Using them correctly means that as a part of a training session they must supplement other methods of instruction in a way that increases the speed and effectiveness of learning. We have found that an attractive descriptive folder helps meet this objective.

To make the most of films, a forest officer needs the answers to many questions. Is there a motion picture available on his specific subject? Exactly what part of the training material does it cover? How? Is it an orientation or a skill-training film? What points does it emphasize?

If he happens to be where films are readily available, he can find these things out by the long, slow process of projecting them one at a time. The man at an isolated headquarters is slowed down even more as he waits for review copies to arrive. Descriptive literature can save time for both men, but it needs to be more specific than most catalog listings are about the subject and the training job. When film literature is consistent in form, brief and to the point, and available for all training films, the training leader can use it four ways:

1. To include inside the film can with each copy of the movie. For this purpose it must fit the film can without bulky folds so that it can easily be removed and replaced. The name of the motion picture, its purpose, who it is for, running instructions, and points of emphasis should be identifiable at a glance.

2. To mail out to district personnel concerned with training as an advance notice so that they can consider the movie for use before ordering it. For this purpose, the folder should provide whoever is doing the mailing with the "meat" of the movie. Then he can amplify the material in his letter of transmittal and suggest adaptations for particular training problems.

3. To keep in a file case at district headquarters or training-aids library with similar cards on other training movies and visual aids for handy review when preseason plans are being drawn up. Consistency is most important if the cards are to be usable for this purpose. The cards for each movie should be identical in size and similar in appearance. For easier reference, they can be printed in different colors to denote various subject-matter training series; for example, red and blue for all those used in teaching the use of water on forest fires.

4. To provide a brief guide on how to use a motion picture as a training aid.

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

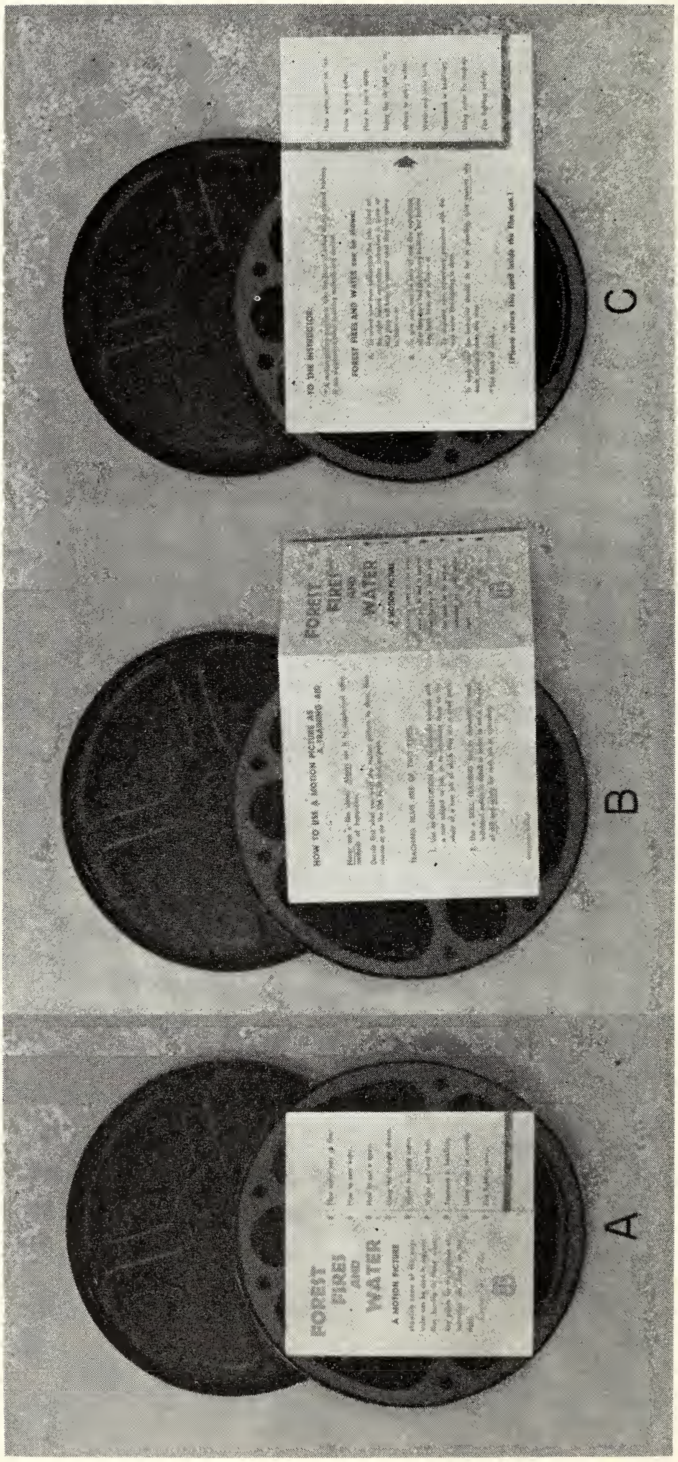

FIGURE 1.—Printed on standard 8- by 5-inch size stock, the four-purpose enclosure card folds to fit a 400-foot film can.

Two enclosure cards that fit these specifications have been released. Both cards were reproduced on 2 sides of readily available 8- by 5-inch white cardstock. The cards were scored and folded to form a 5-inch square that exactly fits a 400-foot reel film can (fig. 1, A). The folded 3-inch end appears on the left of the card and lists the picture name, what it is about, who it is for, running time, and who produced it. On the right, indicated by small arrows, are the key points emphasized in the film. When the card is opened the key points remain on the right for immediate check reference (fig. 1, C). The ways the movie can be used—plus hints to the instructor—now appear on the left, but are still related to the key points on the right. The back of the folded card contains the material on using a motion picture as a training aid (fig. 1, B).

One of the cards was prepared before making the movie, "Training in the Use of Water on Forest Fires." This card served as a statement of purpose, a base for the shooting script, and a guide to actual filming.

"Capsule" cards like these help state the problem behind every training movie, how it was solved, why, and what the solution can mean to the practical work force. They can clarify the purpose of the movie in advance and serve as a permanent aid to its use.

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Turning Pump Motors Over During Storage

Motors of pumps packed in shipping boxes for field use must be turned over every 6 weeks so that the pistons and crankshaft will be in a new position. This helps to retard scarring and etching. Much time will be saved if a 2-inch hole is cut in the box directly in line with the flywheel nut. A socket wrench that fits the nut can then be used to turn the motor. If the motor has a rewind starter, a ⅜- or ½-inch hole can be drilled opposite the rewind handle and the end of a ¼-inch sash cord tied to it; other end of cord is run through hole in box to the outside and a knot tied in it so that it will not slip back in. We have 54 pumps at the warehouse that can now be turned over in 30 minutes. When it was necessary to unpack them, turn them over, and repack them, an average of 30 minutes per pump was required, or 27 hours of labor. Time saved by method that permits leaving pumps in boxes, 26½ hours.—ROY O. WALKER, *Warehouse Supervisor, Region 6, U. S. Forest Service.*

A CAMPAIGN AGAINST HUNTER FIRES

Ralph C. Winkworth
Regional Forester, Division of Forestry,
N. C. Department of Conservation and Development

Hyde County, in coastal North Carolina, is characterized by vast unbroken swamp and dismal areas of peat soil and flash-fuel types. Ground fires are common during dry summer and fall seasons. Suppression of these ground fires often extends over periods of a month or more until rainfall is sufficient to raise the water table to the burning peat. The State fire control organization in this county is extended to the limit to suppress one of these project fires, and two or more ground burning fires at one time present an impossible situation.

Such a situation was encountered during the opening days of the deer hunting season almost every fall up through 1948. On opening day in 1948, 2 hunter fires started almost simultaneously and the resulting loss was a total ground burn of more than 2(thousand acres for the summer and fall season.

The prevention problem was unique. Total occurrence in an average year was only ten to fifteen fires representing several causes. Yet the occurrence of two or three hunter fires during late October meant the tremendous loss in acreage. It was decided that the prevention of just one or two fires at the right time would justify a concentrated prevention effort.

Hyde County is sparsely populated and heavily hunted. A large number of the male population are licensed guides, and the county literally lives on the hunting business. By noon on opening day of the 1949 hunting season every hunter and every loca resident interested in hunting had been contacted personally with a fire prevention message.

The campaign was centered around a handbill that carried a message of welcome and warning from the local people over the signature of the County forest ranger. The damage from the 1948 hunter fires was cited with an earnest plea for cooperation In addition to the usual rules of safety, directions were given concerning what to do in the event that a fire was discovered The law-enforcement angle was introduced indirectly by mention ing the fact that a ranger in a radio-equipped truck was "in your vicinity now" and that his assistance would be prompt upon receipt of a call to designated phone numbers. To strengthen this point, two or three outside rangers assisted in patrolling the county, and both trucks and drivers were changed daily.

Under direction of Hyde County Forest Ranger A. G. Berry the county was divided into routes and covered systematically beginning one day prior to the season's opening. District Office men were provided with local wardens familiar with the area Every hunter encountered was contacted, and copies of the hand bills were left at every place where hunters might be expected to visit. All the local guides were requested to distribute bills and to talk to their hunters. Storekeepers cooperated by issuing a handbill to each hunter customer.

On the morning of opening day, the campaign was stepped up by the use of an airplane to drop handbills, wrapped with copies of the forest fire laws, to hunting parties in the woods. Bills were placed under the windshield of every parked car in the wooded area and a patrol greeted each party as the hunters left the woods. This activity was continued in a diminishing degree until the hunting pressure dropped to normal. Radio and press cooperated throughout the campaign.

In 1950, the campaign was repeated with one notable exception. The handbill was revised to center the theme on a message of appreciation from the local people to the hunters for their care and thoughtfulness in preventing fires during the previous year. Similar programs have been carried out with less vigor but with complete coverage in each subsequent year.

It may be stated safely that this campaign has been successful. Several fall seasons since the beginning of the program have been extremely dry, and only one hunter fire has been recorded in Hyde County since 1948, later evidence indicated that there was a strong possibility that this was actually a grudge fire involving local landowners.

It is recognized that this program must be continued indefinitely to assure continued success. Undoubtedly its success to date has been due to the fact that a specific prevention problem in a localized area has been given a vigorous local treatment.

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The Ozark Swatmaster—A Swatting Tool For Grass Fires

Control of fast-moving grass fires has always been a problem in inaccessible areas. Limited field tests indicate that the Ozark Swatmaster will be an effective aid in controlling such fires in fields and open glades. Treating the water with a wetting agent may result in more efficient use of manpower and water.

The swatmaster is an adaptation of previous swatter principles, with innovations. Water in the back-pack can is used sparingly to keep the swatter wet. The water flows through a ½-inch conduit, 5 feet long, which forms the handle of the swatter. The water is channeled by a 4-way pipe T into three ¼-inch feed pipes 4 inches long. Each of the 3 feed pipes has two ⅛-inch drilled holes to facilitate flow and distribution of water. The amount of water input to the swatter is controlled by a garden valve set 1 foot from the end of the handle. Flow can be regulated to keep the swatter wet, yet not waste water.

The 16- by 21-inch swatter was made from a piece of salvage, heavy canvas. The canvas was doubled and the edges sewed; a zipper at the top on each side of the handle keeps water escape due to back pressure at a minimum. The three feeder pipes fit into water flues sewed in the swatter. Inside seams allow water to flow into the "water pockets"; they also keep the swatter flat.—JOHN L. KERNIK, *Assistant District Ranger, Missouri National Forest.*

A FIBERGLASS CUPOLA FOR LOOKOUT TOWERS

Alberta Department of Lands and Forests

Until 1953, cupolas used on steel lookout towers of the Alberta Forest Service were made of wood. That year an effort was begun to find a material that would eliminate some of the following undesirable features of the wood cupola: (1) expected lasting time of the cupola is poor as compared with that of the steel tower; (2) erection problems; i. e., too much is left to discretion of the builder, and ratio of weight and bulk to strength is too great; (3) glass width too narrow as compared with corner posts; (4) weatherproof qualities, fair to poor; (5) windows difficult to open in wet weather—loose in dry weather.

During the summer of 1953, all-metal cupolas were designed and manufactured, but they proved unsatisfactory for several reasons. Their construction was far too expensive, and complicated assembly problems arose. Damage to panels and window-frame assemblies occurred in transportation. Repair, such as welding and riveting, was not practical at the tower site.

The next material considered was fiberglass. The Edmonton Transit System had used it as replacement body panels on their buses with considerable success. A rough design for a fiberglass cupola was drawn up and submitted to them for an opinion of its feasibility. The proposal was enthusiastically received, and arrangements were made with E. T. S. for a test on one panel. The first mold was made of plywood, and a rough panel or section of fiberglass was cast. The result proved that further work was warranted. A steel mold, which provided its own complications, was then manufactured.

In July of 1955 a prototype cupola (fig. 1), was completed and declared a success. The total weight of the cupola is approximately 750 pounds, which is roughly two-thirds that of the wooden ones, and the cost is not expected to exceed $750 per unit. (Cost of wood cupola, $400.) Due to the nature of plexiglass, the cupola is expected to last as long as the steel tower on which it is erected. Repairs of all kinds can be made at the site without special tools, and maintenance costs have been reduced to a minimum.

The total panoramic view from the cupola has been increased approximately 33 percent, the narrow corner posts facilitating easier use of the fire-finding equipment. Because the wall structure is less bulky, interior space is approximately 20 percent greater than formerly. A double diamond glass with steel frames is used in the windows, and the window slides or frames are made of fiberglass, which eliminates former window troubles. The floor is made of double sheets of ¾-inch plywood nailed on 6-inch centers, thus eliminating floor sills and cupola understructure. The angle beams, which are a part of the tower, provide

FIGURE 1.—The prototype cupola. Each prefabricated flanged panel comprises a wall and roof section as one segment. The panels are formed from fiberglass and polyester resin in a hinged mold that has a steel insert for the window opening.

sufficient support for the 1½-inches of plywood floor. This floor system eliminates many assembly problems, and 2 men can easily assemble the weathertight cupola in 2 days.

Details of construction and design of the cupola can be obtained on request from the Department of Lands and Forests, Edmonton, Alberta, Canada.

WAR SURPLUS CRASH TRUCK CONVERTED TO FOREST FIRE USE

DON M. POST
School of Forestry, University of Florida, Gainesville, Florida

The University of Florida School of Forestry converted a war surplus crash truck for fire control on the school forest. This unit was originally designed for use with foam or fog to combat aircraft fires on landing strips. It is equipped with a 100-hp gasoline engine connected directly to a 3-inch high-pressure centrifugal pump capable of pumping 200 gallons per minute at 150 pounds pressure. The 6 x 6 all-wheel drive can handle the load under most conditions easily.

The conversion consisted of removing all excess gear not necessary for forest fire control and increasing tank capacity from 800 to 1,200 gallons. All foam equipment was removed because it was impractical for our conditions; the foam nozzles on the main gun were replaced by two ⅝-inch solid stream nozzles. There are two 2½-inch and/or two 1½-inch standard hose outlets on the sides and rear of the machine. The most useful and convenient outlet is the large gun on top of the unit with a $\frac{3}{16}$-inch fog nozzle and two ⅝-inch solid stream nozzles. A man standing on a platform on top of the unit controls the gun with a pair of handlebars. He can change from fog to solid stream parallel nozzles by flipping a single lever (fig. 1).

FIGURE 1.—Unit with fog nozzle at maximum capacity of 150 g. p. m. at 150 p. s. i.; the water has hurricane force at 25 to 30 feet with a maximum range of 50 feet. The solid stream at maximum capacity of 200 g. p. m. at 150 p. s. i. with twin ⅝-inch nozzles has a range of 80 to 90 feet.

The unit works very well on direct attack but its greatest advantage comes when used for wetting down the side of a fireline or road opposite a backfire where sparkovers can be common during dry, windy weather. It will thoroughly soak a strip 30 to 40 feet wide for ¼ to ½ mile, depending on the amount of fuel. The use of a suitable wetting agent is highly recommended as this increases the efficiency of the water tremendously. The unit is equipped with an exhaust primer which can fill the tank in less than 1 minute from a suitable supply of water.

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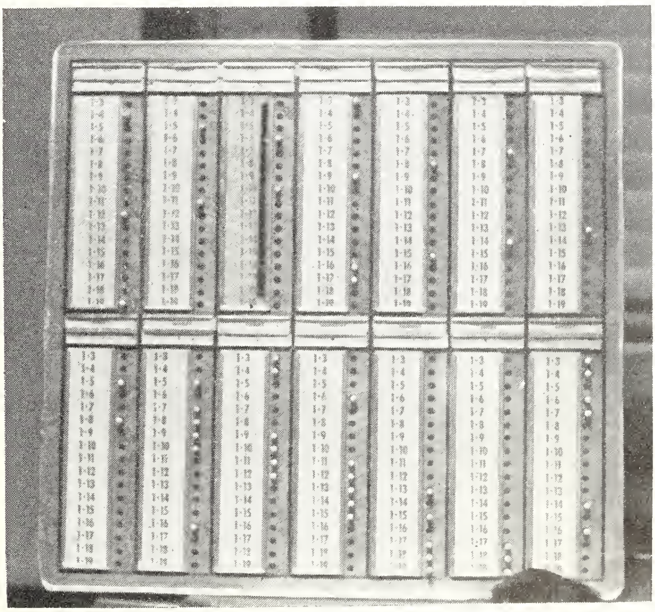
Personnel Scheduled Pass and Leave Chart Board

Quick action may be required at any place in this five-county district. The chart board tells district supervisors, radio dispatcher, and office personnel at a glance which of the 17 conservation officers are on duty that day or any day during the 2-week pay period. Colored ¼-inch dowel pins show the officers *not on duty* because of pass days, compensatory time, annual or sick leave. No pin indicates officer is on duty. The board is posted at the beginning of each period and kept current. A movable red plastic strip mounted vertically indicates the day of the week.



The board is ¾-inch plywood, 23 by 23 inches, edged with chrome molding. It is divided into two sections (weeks) of 7 days each. Beneath each day are the radio call numbers of each patrol car (officer) with a ¼-inch hole, drilled ½-inch deep, beside each number to hold a dowel pin as needed.—JOHN J. MARNICH, *Office Manager, Baraga District, Michigan Department of Conservation.*

TILT-BED TRACTOR TRANSPORT

Willard J. Vogel
Fire Control Officer, Yakima Indian Reservation
Bureau of Indian Affairs

The Yakima Indian Reservation on the east slopes of th Cascade Mountains in Washington has an area of approximatel 500,000 acres of timber and 525,000 acres of grass and brush lan that requires intensive protection against fire. The reservatio is roughly 50 miles wide and 70 miles long with most of the area requiring protection containing only substandard roads. Trans porting of tractor equipment in the past has posed many problem with slowness of delivery to the fire being the most serious.

Because of the arid conditions and heavy, flammable growt present on the reservation, speed in placing suitable first-attac equipment on a fire becomes a must. Transportation of this equip ment by means of a semitrailer or a low-boy is impractical becaus of steep, narrow, twisting roads, particularly in the back country For this reason, it was decided to purchase a heavy truck an to construct on it a tilt-bed body originally developed by the Stat of California, Department of Resources, Division of Forestr (fig. 1).

The truck used is rated at 35,000 GVW with the frame modifie to the exact dimensions of CA 110″ and CEF 147½. The tandem drive rear axles are straight-line-drive to provide clearance for a cylinder on each side of the propeller shaft. The transmission i 5 speed with an auxiliary 3 speed. The large 406-cubic-inch engin and the many available gear ratios enable the truck to transport our OC-12 tractor with dozer at speeds of 50 to 55 m. p. h. o highways and to maintain satisfactory speeds on all the variou grades encountered. Since the truck operates over both heavily traveled highways and back mountain roads where handling ease and safety are essential, it is equipped with power steering and air-over-hydraulic brakes. We consider it essential that heavy trucks to be operated in such rough country be equipped with power steering.

The tilt-bed body, which has a capacity of 19,000 pounds, hinges just ahead of the rear set of drivers. Two systems, one hydraulic and one air, control operation of the bed. The air system is used only to raise or lower the bed empty and is controlled by a three-way valve in the cab. The hydraulic system is merely a hydraulic cushioning cylinder that determines the speed at which the bed will tilt or lower with the tractor. The hydraulic cylinder is controlled by a globe valve requiring only an initial adjustment at the beginning of the season. The bed is locked in running position by an automatic safety lock.

To unload the tractor, it is necessary to release the safety lock, back the tractor until its weight tilts the bed and then back down the ramp (fig. 2). The bed will stay in the raised position until the tractor is reloaded or, if desired, the bed can be lowered with the air control. Chock blocks set in stakepockets at the front

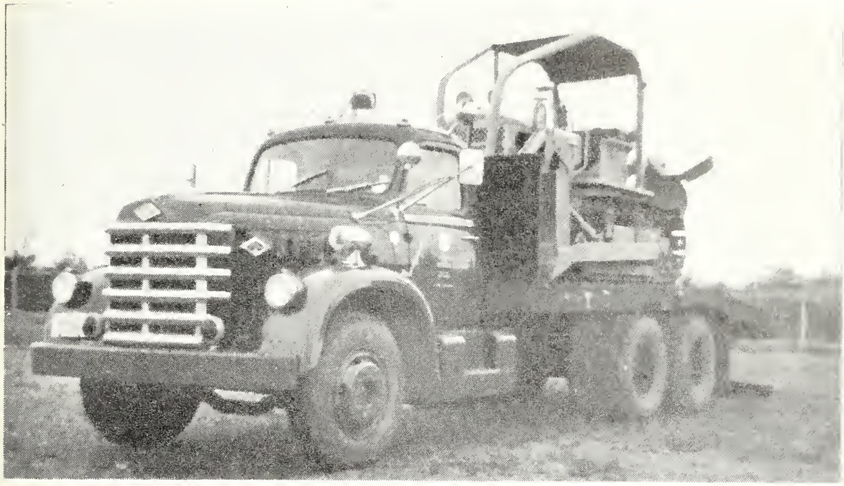


FIGURE 1.—Tilt-bed tractor transport.

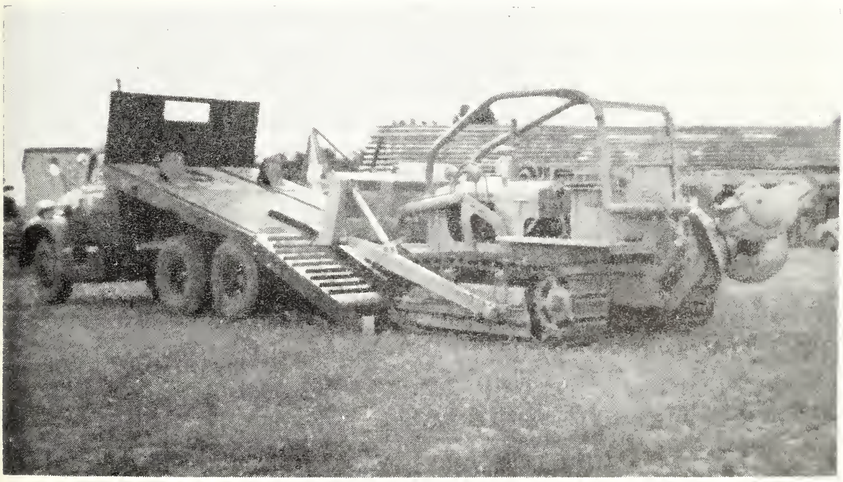


FIGURE 2.—Truck bed in loading or unloading position.

of the tread runway prevent the dozer blade from striking the back of the cab. These also enable positioning of the tractor in such manner that weight is properly distributed.

Experience during the 1957 fire season indicated no need for modification of the unit, although practically all conditions were encountered in transporting the heavy tractor dozer equipment. Because of the tilt-bed it is not necessary to waste time in picking an unloading site and the tractor can be quickly unloaded by one man. When necessary to change the tractor's location on a fireline, it is often quicker to reload and move by the tilt-bed truck rather than by "walking" the tractor. It is felt that with a heavier truck this type of bed would be suitable for transporting tractors that are larger than the OC-12, D-4, or TD-9 class.

A TRAINING COURSE IN PRINCIPLES OF ORGANIZATION FOR FIRE SUPPRESSION

Region 7, Division of Fire Control, U. S. Forest Service

In the Eastern Region, comprising 14 States from Kentucky West Virginia and Virginia, northeast through Maine, oppor tunities for developing skills in organizing large fire suppressio forces are limited. There are numerous fast-spreading and dan gerous forest fires most years, but these are controlled withi hours by well-seasoned small crews. Campaign fires requirin large forces occur only rarely during the critical years. Ten year may pass before the skill of a fire control man in mobilizing an managing a large fire organization is put to a test. Some youn firemen have never seen a large fire organization in action.

For these reasons, the Regional Fire Training Committee se out to perfect a fire organization training course that would mee needs peculiar to this region. Their desire was to make full use o available excellent handbook information and to stay out of th old wheel tracks of previous training courses by organizing an developing a new approach.

The scope of the task was narrowed by focusing on three ke items for the 1957 training program. A lesson plan was develope for each item; a test training session was run; the results of th test were evaluated and revisions made as required. The com mittee used this restricted approach to pay respect to the trainin principle of "one thing at a time." It answered the question o what was basic and why, and set up a standard of proficienc expected of trainees for each key item.

Lesson one had for its subject "Principles of Organization." The command, plans, service, and line functions were explained i a series of organizational setups beginning with a 2-man fire an proceeding through a 3-sector fire. Charts were used as trainin aids. This is about as exciting as a multiplication drill to a school boy, but the test training run established the soundness of thi approach; namely, that specific knowledge of organization prin ciples must be a part of the trainee's equipment. He is not read for the steps ahead until he has become grounded in the prin ciples. The textbook used for this subject was "Principles o Organization for Forest Fire Suppression," 1953.

The next step in the training process was the application o principles of organization. The subject of "recruiting, training and maintaining in a state of readiness the organizational force planned for a protection unit" was covered in Lesson No. 2. Fo this, the demonstration method of instruction was used. A three sector fire organization was set up for a particular district. Live organization charts were built up from a form devised for this purpose. The details of size of an organization required, where it will come from, and other considerations vary by protectio units, but the basic principle does not change. Lessons No. 1 and 2 are required to prepare the trainee for the next stage of instruc tion, the application of principles to a specific suppression problem

In Lesson No. 3, the operational procedures of a fire headquarters in the suppression of a specific fire were demonstrated.

Before the demonstration, the trainees were briefed in the following: (1) the geographical location of the fire, the topographic features and fuel of the fire area; (2) the fire weather preceding and leading up to the fire; (3) a sequence of events from time of discovery up to time fire boss gets on the fire.

Special props were used for briefing and for the demonstration that followed. One end of a ranger warehouse provided the required classroom space, a space for a fire headquarters setup, and a relief model of the part of the ranger district on which the fire occurred. The fire headquarters was furnished with a table, chairs, 2 bulletin boards each 4 by 8 feet for display of easel-sized (27 by 36-inch) charts. To one side of the fire headquarters and in front of the trainees was a relief model of the fire area.

The model was made out of 1½ cubic yards of sawdust and shaped to bring out the main mountain ranges, prominent spur ridges, and drainages, to approximate features of the actual fire area. The fire edge was shown by a red paper ribbon with sector locations plainly marked. Topographic and operational features were identified on the model by a small cardboard poster secured in a cleft of a twig stuck in the sawdust. Another important prop was a chart that showed the sequence of events from the time the fire was discovered until the fire boss got to it.

The props added a touch of realism that gave the trainees a feeling of looking in on the entire situation. Most important, the props helped them to arrive at a common understanding of the problem. Since the trainees had in the previous lesson worked on the organizational setup for the protection unit, their background included this information. Trainees were instructed to disregard all tactical considerations and concentrate on organization. The presentation up to this point could be summed up in these words "Here is the problem."

The next phase, the actual demonstration, in effect said, "Here is how we handled it." The demonstration was built around the acceptance of responsibility of the fire boss for the fire, his preliminary analysis of the problem, and how he assembled a staff for plans, service, and line functions; also, how the fire suppression plans were made and executed through the headquarters staff. This demonstration was made by the fire boss as he explained the action he took from the time he received the report of the fire.

Demonstration of functional responsibility of staff members through discussion and with the help of charts made clear staff responsibilities. Staff work was demonstrated by the use of skits that were carefully prepared and rehearsed prior to the demonstration. No attempt was made to recite lines, but the essential action was acted out in a natural manner. The demonstration was climaxed in a planning and strategy meeting of the fire boss with his staff.

The following organization fundamentals were emphasized:

1. Decision making by the fire boss, including his initial decision that as fire boss he is responsible for aggressive suppression action.

2. Mobilization requirements as met by the fire boss.

3. The initial estimate of a job and the aggressive action to ge staff appointed, briefed, and at work. (In deference to the "on thing at a time" principle of training, instruction was limited t fire headquarters operations.)

4. Operations based on full consideration of fire weather and special fire forecasts.

5. Safety predicated on natural hazards and the effect of fire weather.

6. Operations conducted on a timetable basis that require proper coordination of planning and execution of plans and service.

7. Fire boss exercises his command function through a fire staff.

The task of developing competent organizers to function on an occasional big fire is complicated and difficult. Training methods must be expert if they are to offset the lack of actual practice and experience of the trainee. The 1957 regional test training session was favorably received by the trainee group of rangers and staff men.

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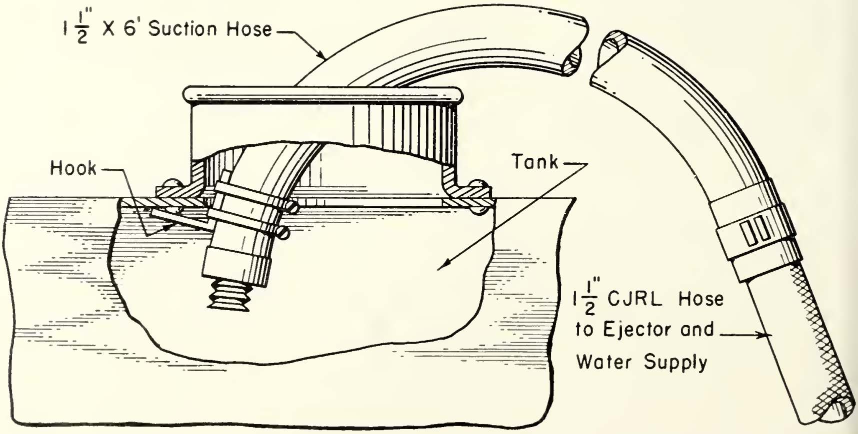
Improved Ejector Drafting

We have experienced difficulty in drafting water into a demountable fire tanker because the cotton-jacket hose to the ejector kinks when it is bent into the filler-cap opening. The kink results in an uneven flow of water, and it has been necessary for a man to be in attendance at the filling to see that the hose doesn't slip out. Both of these problems have been solved by substituting a length of 1½-inch suction hose for the final length of hose into the tank and using a wire hook to hold it in place.



The release of the services of the man at filler-cap opening can be very important where drafting and discharging to hose lines are being done simultaneously. Most slip-on fire tankers are already equipped with the 1½-inch suction hose, but the addition of the wire hook would be beneficial. —RAYMOND E. JUAREZ, *Fire Control Aid, Shasta-Trinity National Forests.*

AIRCRAFT USE IN MISSOURI

OSAL B. CAPPS
Chief of Fire Control, Missouri Conservation Commission

The Missouri Conservation Commission uses aircraft for administration, waterfowl and game surveys, law enforcement, forest land inspection, forest fire control, and many related activities. It acquired its first airplane in 1946, a war surplus L-5. Three years later this unit was replaced by a Stinson station wagon that was used for all activities until 1954 and then replaced by a Cessna 180. The Cessna 180 is still in service. A Piper PA-18 was also purchased in 1954 and assigned directly to a fire control district that has a large acreage of State-owned land. This particular district had been plagued each year with incendiary fires.

Full-time pilots are employed to operate and maintain the two State-owned airplanes, and when not engaged in these duties they are assigned other work. Direct operating costs amount to $6.50 an hour for the Cessna 180 and $5.50 an hour for the Piper PA-18. This includes gas, oil, maintenance, overhaul, and miscellaneous expenses, but not the pilot's salaries, insurance, hangar, depreciation, etc.

Each of the 10 fire control districts is authorized and encouraged to lease aircraft from private operators within their district or close by, either with or without pilots, as needed. The State-owned Cessna 180 can also be obtained when urgently needed to supplement district aircraft. Types of aircraft leased have been the Cessna 140, Aeronca 7 AC, Aeronca 7 BC, Piper Tripacer, etc.

The rate per hour for leased aircraft, including all flying time, was raised from $9.25 to $10.00 in 1957. Some operators with much experience are paid $10.75. We are paying $15.00 per hour for a Piper Tripacer, 150 hp., which is used on an experimental basis for night work. An aircraft and operator on standby costs $2.50 per hour. Standby time is limited and is normally not authorized at the home base of the airplane.

Radio equipment is installed in the leased aircraft by State radio technicians. Army surplus SCR-610 equipment has been used in the past but transistorized commercial-type equipment is now being installed. State-owned aircraft have multifrequency radio equipment.

Detection.—Fire control aircraft are used to supplement detection work of towers on days when visibility is limited and/or when fire danger is high. Also, they are used for detection when a towerman is off the tower fighting fires. The pilot of the airplane acts as observer; he uses a State highway map with a scale of one-half inch to the mile to report fires to a dispatcher by section, township, and range. Topographic maps are also used for this purpose.

Suppression.—The pilot scouts a fire and gives the fire crew leader such information as size, fuel, topography, rate of spread, critical areas, men or equipment already on fire, possible cause, and the best place to start fighting the fire. On large fires the fire boss relies on the pilot to keep him informed of breakovers, backfires, wind changes, potential danger areas, etc. (fig. 1). The district forester checks on a large fire by air as soon as possible after it is reported and quickly determines what steps should be taken to bring it under control and whether reserve manpower or equipment should be dispatched. Aircraft are often used to direct fire crews to fires in isolated spots. Large fires are patrolled and mapped from the air, and small fires are checked several times a day after they are suppressed if there is danger of breakovers.

Prevention.—Quick checking of fires materially reduces incendiary action during daylight hours. The point of origin of a fire can be rather accurately determined from the air. This is an important factor in law enforcement (fig. 2). During the past few years, aircraft and ground personnel working together have caught several men who set incendiary fires. Experimental work

FIGURE 1.—Aircraft provide the fire boss with information he needs on a fire like this one.

FIGURE 2.—Aircraft are effective in fire-law enforcement.

was done last year to determine whether the use of aircraft at night would be effective in reducing incendiary fires started under cover of darkness. The results were promising and the experiment will be continued this year.

Although airplanes have an undisputed place, helicopters are probably the coming thing in fire control work in Missouri. In areas where there are small clearings, they would be ideal for getting a small, initial attack crew on a fire. The helicopter could be used for both detection and suppression, and it would be very effective in fire-law enforcement. Helicopters are used for the latter purpose on a large military reservation in our forested area, Fort Leonard Wood. We have been able to use these on adjacent areas in order to get an idea of their value. Although the cost per hour seems excessive, there is no doubt that the helicopter is a very versatile fire control tool.

THE AIR TANKER AS AN INITIAL ATTACK TOOI

GEORGE E. LAFFERTY
Fire Control Officer, Boise National Forest

The use of air tankers as an aid in the control of wildfire ha been increasing year by year. Although much has been writte about their use in combating large, uncontrolled fires, little ha been written about their use as an initial attack tool.

During the 1957 fire season the Boise National Forest experi mented with air tankers and chemicals for initial attack. A con tract Ford Tri-motor airplane (fig. 1) rigged for aerial spray ing was converted to an air tanker by the addition of 19- by 20 inch free-swinging gates to the bottoms of the spray tanks. Th aircraft carried two 275-gallon tanks in tandem. Cable release permitted emptying one tank at a time or both at once. Fiv hundred gallons of water-suspended sodium calcium borate wa normally carried in the two tanks. This water and chemical slur ry weighed approximately 10 pounds per gallon, making the tota cargo exceed 5,000 pounds.

Calibration tests showed a drop pattern roughly 70 feet wid and 700 feet long when both tanks were emptied at an altitude o 50 feet. Concentrations as heavy as 6 gallons per 100 square fee were measured in the drop pattern. The entire load could be dis charged within 7 seconds.

FIGURE 1.—Ford Tri-motor air tanker.

In addition to 50 drops on large project fires, 24 "borate" drops were made on 13 small fires (table 1). The results were beyond expectations. We know that part of the success was due to the skill of operator-pilot Glenn Higby. His experience includes hundreds of hours of mountain flying in aerial spraying and paracargo operations. The aircraft itself seems to be especially adapted to the dropping of liquids in steep and rugged mountains. While it is relatively slow (airspeed 100 m. p. h.) compared to modern aircraft, this deficiency is offset by its maneuverability and accuracy.

TABLE 1.—*Use of air tankers, Boise National Forest, 1957*

Name of fire	Drops	Flying time	Cost[1]	Result		
				Assured control	Helped control	No value
	Number	*Hours*	*Dollars*			
Warm Spring Creek	4	5.3	1,250	X	. .	. .
Louse Creek	1	1.2	300	X	. .	. .
Lincoln Creek	2	1.4	500	X	. .	. .
Pine Creek	2	2.4	600	. .	X	. .
Golden Age	1	.8	260	. .	. .	X
Profile Creek	2	4.5	820	X	. .	. .
Middle Fork	2	2.2	580	X	. .	. .
Sheep Corral	1	.7	250	X	. .	. .
Peace Rock	1	1.2	300	. .	. .	X
Blue Moon	1	1.7	350	. .	. .	X
Whitehawk	1	1.2	300	. .	. .	X
Fullmoon	5	5.6	1,220	X	. .	. .
Mineral Creek	1	1.1	290	. .	X	. .
Total	24	29.3	7,020	7	2	4

[1]Cost includes procurement, flying time, labor, and equipment purchase or rentals.

Part of the effectiveness of the tanker as an initial attack tool depends on both it and the pilot being in a constant standby status during daylight hours. Procedures were established that permitted takeoff 15 minutes following "scramble" orders.

The effectiveness of air-delivered chemicals is highly dependent upon the accuracy and location of the drop. A lack of trained personnel on a fire will usually necessitate making tactical decisions from the air. There are two solutions to this problem. One is to have a fire-behavior specialist in the air tanker or in a radio-equipped spotter airplane to direct operations. The second requires that the pilot of the air tanker be adequately trained in fire behavior and in suppression tactics so that he can make proper applications without guidance. The latter solution would minimize loss of time and eliminate the chance for complete failure in event of communication trouble.

The principal value of sodium calcium borate is in retarding the spread of a fire for a sufficient time to permit suppression forces to effect control. This is of the utmost importance during periods of extreme fire danger. Air tankers were used in conjunction with action by both ground forces and smokejumpers, and with notable success. The program can be credited with being directly responsible for the control of 7 threatening fires. These fires started during periods of high fire danger and the rapidity with which they spread indicated serious control problems.

Other reports testify to the air tanker's success as an initial attack tool. The Payette National Forest's fire staff officer had this to say after investigating a fire we first attacked with chemicals: "The Profile Creek fire was discovered at 1315 on August 17. Fuel moisture percent was 4. For the following 4 days the fuel moisture percent remained at 4. The fire originated in the bottom of a canyon and had 3 miles of heavy fuels on moderate to steep slopes ahead of the fire.

"As soon as the fire was reported, smokejumpers were dispatched from Idaho City and a Ford load of borate from Boise. When the jumpers arrived it was too windy to jump so they returned to Idaho City. The load of borate was dropped across the lead of the fire and the plane returned for another load. . . .50 men reached the fire by 1600. . . .Ranger Dahlgreen reported that if it hadn't been for the borate drop, the personnel on the fire could not have held it that day. The borate held the fire from spreading uphill until the ground personnel and jumpers arrived. Considering the burning conditions and fuel available for the fire to spread in, the borate undoubtedly prevented a large project fire."

Ranger Jim Butler of the Mountain Home District, Boise National Forest, reported, "The Lincoln Creek fire started on August 16, in medium slash and had burned an area between 2 and 3 acres in size. . . .the Ford came over as it was crowning and very effectively downed the fire. The first load cut the fire down to where direct close attack on the lead was possible."

Another experience was reported by Ranger Butler as follows: "The Ford was on this fire immediately and hit the head of the fire with a load of slurry that really flattened it. Without this help, considering the 30 m. p. h. wind which prevailed, we would have been unable to control it at the 2 or 3 acres it burned."

Ranger Jack Wilcock of the Bear Valley District, Boise National Forest, in reporting the Warm Spring Creek fire writes: "I conclude from observing the progress of the fire from the air and on the ground that the water and chemicals stopped the spread of the fire in the light fuels and kept the fire on the ground in heavy fuels. I believe this potentially dangerous fire was kept to an area of 2 acres by the use of this new tool."

Since protection dollars are normally fixed, initiating a new method or piece of equipment requires a shift in present organizations. The cost of adding a standby air tanker is reflected in reduced crews or other equipment. Realizing this, we still feel that the air tanker has proved itself. Our confidence in the use of "borate" in the initial attack is such that we plan to have a standby air tanker in 1958.

WATER DROPPING FROM SEAPLANES ON THE SUPERIOR NATIONAL FOREST

L. J. Mc Donald, *Superintendent, Ely Service Center,*
and W. J. Emerson, *Assistant Supervisor*

A new and unique type of water dropping on fires is being worked out on the Superior National Forest in the wilderness-lakes country of northern Minnesota. Seaplanes operating out of Ely, Minn., on fire control missions are now equipped to pick up water from lake surfaces while taxiing on the takeoff run, then take to the air and cascade the water onto forest fires.

The 3-million-acre Superior Forest, with its many lakes and inaccessible Boundary Waters Canoe Area, is ideally suited to this kind of fire fighting (fig. 1). Successfully directed water dropping

Figure 1.—Seaplane on fire control mission over Boundary Waters Canoe Area of Superior National Forest.

missions may serve as a holding action on remote forest fires and give ground forces the time they need to get to the fire and apply control measures. Although the project is still in an experimental stage, the mechanical problems of picking up and dropping the water are essentially solved, and the main problems remaining are those of skillful application. Because the development of these procedures was completed late in the 1957 fire season, they have not been tried on actual fires.

Water dropping from seaplanes on the Superior Forest was an outgrowth of the fish-dropping technique that was successfully developed several years ago. Fish-stocking operations are carried on by flying over remote, inaccessible lakes and cascading a load of water and fingerlings, or fry, into the lake from a fish-dropping hopper installed in the cargo-dropping hatch. The 40-gallon fish hopper provided the means of experimenting with water dropping on fires, but the volume of water was too small for an effective fire-suppression operation.

A 125-gallon water tank with baffles was constructed of aluminum, with a round opening in the bottom (fig. 2). It fits into the 17-inch circular hatch of the plane and can be installed quickly and easily through the side door of the plane when requests for water dropping are received. A quick-opening, gate-type release permits cascading the full volume of water from the plane in a very few seconds. The water-cascading release mechanism is operated by one man sitting in the co-pilot's position. Advice on the accuracy of each drop can be received by the pilot and bombardier from radio-equipped groundmen.

The airplane used in the initial experimental and development work was a Noorduyn-Norseman. This was replaced recently with a DeHavilland Beaver. Pickup and dropping equipment have been modified to fit the latter airplane.

Test drops during the past season indicated that the water pattern, when it hits the ground, is about 300 feet long and 50 feet wide, averaging about .01 inch of "rainfall." Since these tests were in the open, others are planned to determine the influence of trees and vegetation on the effectiveness of the operation. Also planned for this season are dropping experiments with

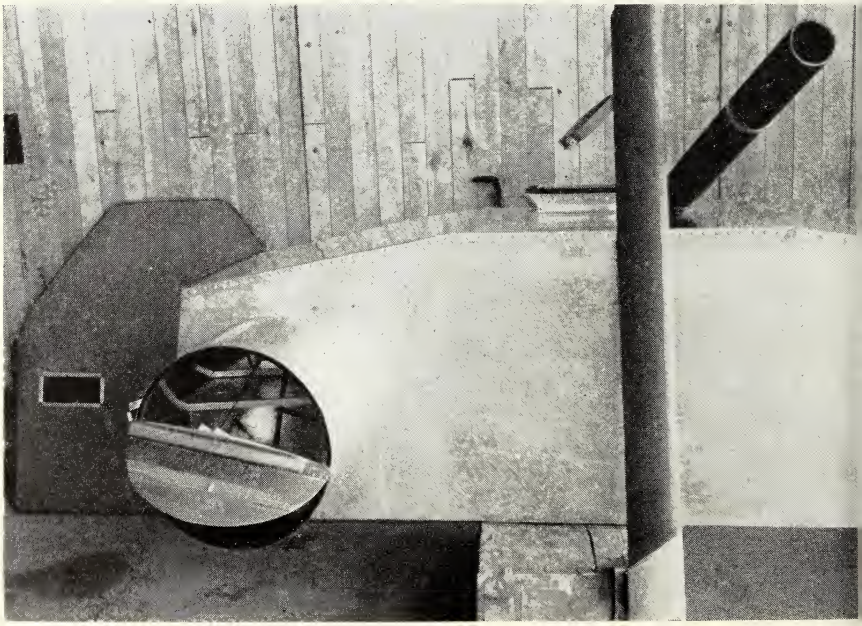


FIGURE 2.—View of bottom of 125-gallon water tank showing outlet and release gate at left and water pickup tube at right.

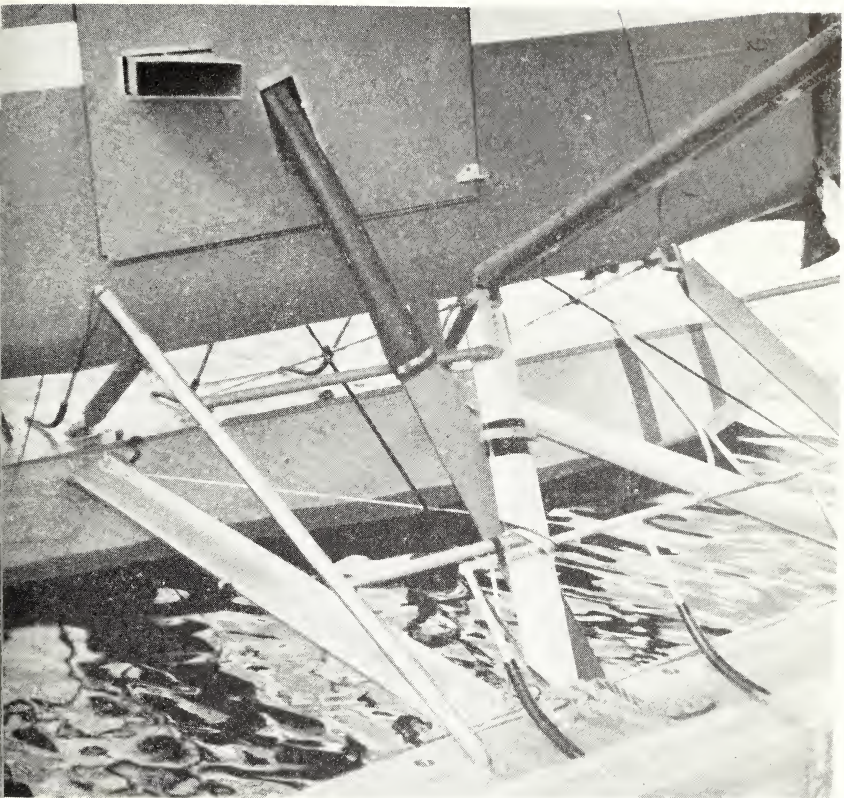


FIGURE 3.—Side view of DeHavilland Beaver Seaplane showing water pickup tube extending from tank inside plane through hole in false door. Square hole just left of tube is tank overflow tube.

he addition of detergents of various types and borates. These lrops will be applied to slash-burning projects and other test ires.

While a single drop of 125 gallons of water on most fires is ıot expected to have a very marked effect, repeated drops in a elatively short time should have. Such drops are possible because f the water pickup device. The pickup consists of a piece of irplane strut that is connected to the water tank through an pening in the fuselage (fig. 3). The lower end of the tube rests ust above the surface of the lake when the seaplane is stopped.

As the plane makes its takeoff run, the pontoons assume a osition parallel with the lake surface. This brings the end of the vater pickup tube down into the water and the tank is filled in bout 15 seconds (fig. 4). An overflow vent from the tank throws xcess water out the side of the plane as soon as the tank is filled. he seaplane then lifts from the lake and proceeds to the fire.

The large number of lakes scattered throughout the Superior Iational Forest make it possible for a seaplane to pick up water vithin relatively close range of any fire that may occur. With

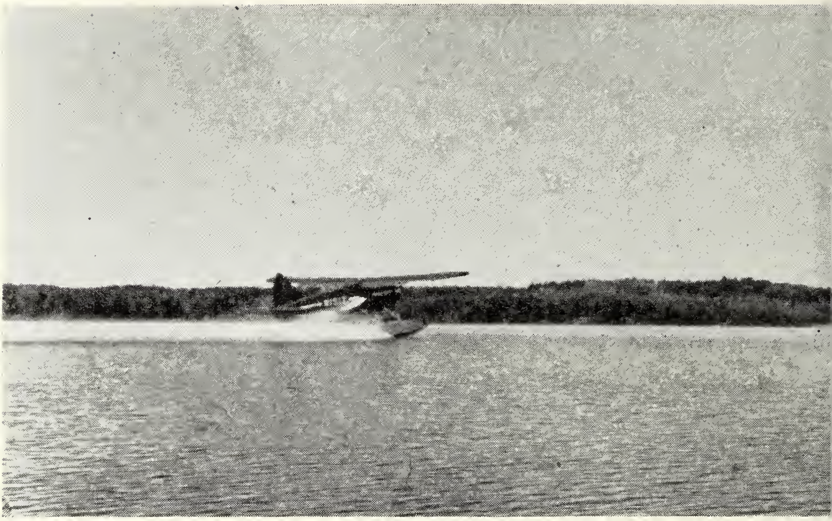


FIGURE 4.—Seaplane picking up water for a fire drop.

only a few minutes flying time involved between pickup and dro in most areas, it is estimated that by repeated drops sufficie moisture can be cascaded onto a fire in the early stages to ho it and keep it from "taking off" into inaccessible areas unt ground forces arrive. Even when a suppression force is workir on a fire, repeated water drops on spot fires and hot spots shou help to take some of the pressure off the fire fighters and insure that the fire does not crown and get out of control.

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Nozzle Guard For Jack Pumps

The common jack pump used on the 5-gallon back-pack can or water b will usually break where the spray attachment joins the handle whenev it is dropped. This can easily be prevented by installing an inexpensive gua made of a one-half inch washer, a 2-inch steel ring of one-eighth in material, and 9 inches of one-eighth inch steel rod. The steel rod is cut in 3-inch struts which are spaced equidistant and welded in place between t

ring and the washer. The guard is readily installed by removing the pun spray nozzle and inserting the one-half inch washer over the threaded e of the pump handle. Spray adjustment of the nozzle can be made by usi the index finger between any two struts on the guard.—GEOFFREY E. GREEN *District Ranger, Helena National Forest.*

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.


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BREAK MATCHES
CRUSH SMOKES
BE SURE ALL
FIRES ARE OUT!
Remember–
Only you can
PREVENT
FOREST FIRES!
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VOL. 19 OCTOBER 1958 No. 4

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 19 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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Forest Service, Washington, D. C.

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CONTENTS

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NOTE: The April 1959 Fire Control Notes will emphasiz Fire Control Training. Special assignments of certain article have been made but the editor would welcome additional items o this general subject. These must reach the Washington office b January 15.

EQUIPMENT DEVELOPMENT AND FIRE RESEARCH[1]

MERLE S. LOWDEN
Director, Division of Fire Control, U. S. Forest Service

People look at equipment development in a variety of ways. Some think of it as a mechanic with a monkey wrench tinkering with a machine that never works when you most want it. Others think of it as scientific research with complicated chemicals, formulas, and machines. Somewhere between these two extremes lies equipment development as we are trying to approach it in the Forest Service and as I see it in relation to the fire control job. Surely it has a very close tie to research, but there is a difference. Working as a team we must depend upon research to find the fundamental facts and to determine relationships between cause and effect.

Equipment development takes the results of research and tries to find a way to do it with machines. Let me take an example to illustrate this point. We are hearing a lot these days about aerial attack on fires with fire retardants. Research, development, and trial use were combined in the Operation Firestop project several years ago in California. One of the basic research studies at that time was to try many chemicals and compounds to test their value as wildfire suppressants and retardants. The most successful found by those tests was sodium calcium borate which is now becoming widely used. Also a part of the Firestop operation was the study of cascading water from an airplane from various heights to determine distribution and effectiveness on the ground. It was a logical step to mix water with the successful retardant and to apply the mixture from the air.

Actually doing the job, of course, is much more complicated than thinking about it. This took a great deal of analytical calculation and study, adventuresome imagination on the part of the field men in testing, good engineering in figuring the types of gates and openings to use for tanks, and the combining of many skills. The operation, while successful, is still in its infancy. However, this year there are 70 planes in this country available and equipped to attack fires from the air. Progress from an idea to a successful operation required a continuously working team of research, equipment development, and the actual users (or fire fighting organizations).

Most of our equipment development requires this same type of teamwork. Somebody must take an idea or research result and build or adapt a machine to it that is successful in field operation.

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[1]Taken from a paper presented at the Region 9 Fire Committee Meeting, Grand Rapids, Minn., June 12, 1958.

In its application to the field there is another highly importan task for research. This is in setting up procedures and method for evaluation and in giving technical advice on the evaluation an analysis of results as they come from the tests.

There are many supplemental features or accompanyin steps in equipment development. Often times we can get result by having industry do the job without any immediate cost to th Government. This we try to do as often as we can. In many case after an article shows wide application with sufficient opportunit for profit in its manufacture, the development will be carried for ward by some manufacturer. Field radios are a good example o this. The Forest Service did the early development work and mad the first sets. They continued for a time to develop and mak pilot models. Later manufacture of these models was contracted As this business expanded to many agencies and small radios ha widespread use, leading manufacturers began their own develop ment program. At present the Forest Service mainly carries it needs to the manufacturers, checks and works with them in de velopment, and tests results. Practically the entire job is done b private industry.

Another supplement to development is to take a product use for one purpose and adapt it to another. Through such trial us we may discover an article that fits our fire needs. A good ex ample of this is the use of the railroad fusee for backfiring.

Equipment development frequently leads to standardizatio and ties in with specifications for manufacture. It is hard t separate these parts of the total job.

Another task that goes with development is getting people t use the new article. Regardless of how good a "mousetrap" w develop, it doesn't amount to much if nobody uses it. We hav some glaring examples where we have spent much money and de veloped a fairly good product but have done a poor job of sellin it for field use. Our fireline trenchers are somewhat in this status.

We have many methods of selling ideas. Written material, such as technical bulletins, progress reports, magazine articles, and handbooks, has its value. Demonstrations are a tested metho and have been used a great deal by your group. "Chautauqua" tours are not as common but have been used with good success. Those developing trail-building equipment in the West have ha outstanding success with demonstration tours. In the Forest Serv ice we often use the free sample method; that is, we fully or par tially finance from the Washington Office an early model. Regions or forests may be reluctant to spend their money on a new item, but once they try it and it is successful they are very willing t use their funds to buy more. It is always possible, of course, t issue orders to use new equipment but if this is necessary we hav failed somewhere in the selling job.

I might say something about the Technical Equipment Boar system in use in the Forest Service. We have a rather large boar in the Washington Office appointed by the Chief and drawn from various units which have an interest in equipment development. Many of the regions have smaller but similar groups. Field units make proposals through the regional boards in a prescribed manner. Field folks at all levels are encouraged to suggest projects to be included in the equipment development program.

Proposals are reviewed within each region and those which find favor are recommended to the Chief's office for further consideration. There they are reviewed by the functional division that has the greatest interest in the project. For fire equipment this would be in the Division of Fire Control. The functional division reviews and recommends projects for coordination by the equipment board. This board prevents overlapping or duplication and arranges joint financing where several functions are interested. It brings together many interests and often a new machine or idea is found to have many applications in different forestry functions. Some modification may make a machine useful for many jobs. Each functional division thus can plan its program, and carry through on the introduction to field units. The equipment development program for the Forest Service is coordinated by the Technical Equipment Board and the action plan issued for each fiscal year.

Actual development work is done in many locations throughout the country but our main efforts have been concentrated in a few equipment centers. At Arcadia, Calif., we are concentrating on pumps and tankers, small mechanized handtools, helicopter accessories, aerial tankers, spark arrestors, and machines for testing other machines and apparatus. At Missoula, Mont., work connected with smokejumping and air cargo transportation is underway. This includes new and different parachutes, cargo packaging, protective clothing, letdown equipment, and other aerial items. We have also done most of the fireline trencher work there. A development center somewhere east of the Mississippi River has been under consideration for some time.

Radio and electronic work is now concentrated at the Beltsville Radio Laboratory outside of Washington and we have recently strengthened and broadened the work there.

Some projects are done at the experiment stations and in the regions. Methods of air cargo delivery and water transportation by plane have been worked on for several years by the Superior Forest at Ely. The Forest Service for many years carried on joint work with the State of Michigan at Roscommon. After a lapse of a few years we again have an agreement and are working with them on development of a sandthrowing machine.

Equipment development work in fire control may be classed in various ways. I like to think of it as falling into two main groups. The first is that in which known and tried items are improved or further developed. Many of these are continuing jobs such as those in our smokejumper project where we are continually improving parachutes, rigging, protective clothes, and similar items. The second is the pioneer type in which we explore new fields and new ideas, such as large-tire carriers and fire suppression rockets.

FIRELINE TRENCHER ATTACHMENT FOR POWER SAWS

RAYMOND M. WEST, *Anaconda Forest Protection Service,* an
ROBERT W. STEELE, *School of Forestry, Montana State Universit*

The power saw trencher is a lightweight combination trenchin and cutting machine for fireline construction. It consists of tw spiral augers mounted on a shaft at the end of a standard chai saw blade (fig. 1). The teeth of the cutting chain turn the auger by means of a sprocket in the center of the shaft.

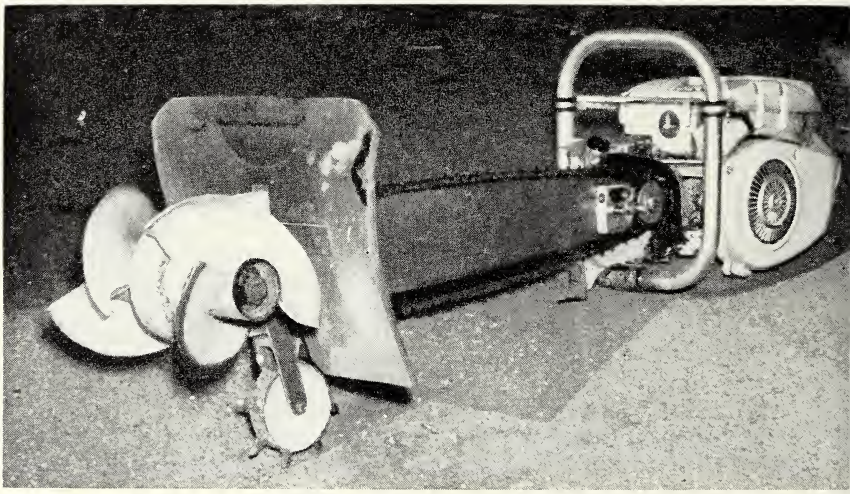

FIGURE 1.—Powered lightweight trencher. Note two-way spiral augers an the small support wheel.

The two-way spiral augers are 7 inches in diameter. Each i 6 inches wide so that a trench a foot wide can be constructe (fig. 2). The augers are made of abrasion resistant steel and ar keyed to a shaft which is mounted in bearings on the sides of th blade.

Power from the saw motor is supplied to turn the auger through the cutting chain as the chain moves along the blad and engages the sprocket. The rotating augers throw dirt to bot sides, making a clean trench.

In operation, the machine is held at a steep angle while restin on a small support wheel (fig. 1) mounted directly below th blade. The depth of trench can be varied by raising or lowerin the handle of the power saw motor to engage the rotating auger in the soil. A guard protects the operator from flying dirt an stones. The suggested method of use is with a 3-man crew, on with the trencher, one with a pulaski for heavy cutting and dig ging, and one with a shovel for line cleanup.

FIGURE 2.—A foot-wide trench can be cut.

The machine digs readily through sod and duff to mineral soil. It throws needles and other forest litter out of the trench, and is easily moved along the fireline. It can be operated both forward and backward on slopes or level ground. When necessary to cut a windfall or snag during the construction of a fireline, the machine is used as a conventional power saw, there being sufficient length of cutting blade back of the protective guard (fig. 3).

The advantages of this combination cutting and digging power tool are—

It is small and light, and can be transported anywhere about a fire.

It can be packaged for aerial delivery.

The unit complete with blade, chain, and augers weighs approximately 10 pounds.

FIGURE 3.—Machine used as a conventional power saw on a windfall.

It can be used on most standard chain saw motors and i easily attached by simply removing the original blade an chain.

No special training is needed to operate it.

It can produce an effective fire trench rapidly by mechan ical means.

TRACTOR HEADLIGHTS

A. B. Everts
*Equipment Engineer, Division of Fire Control, Region 6,
U. S. Forest Service*

Region 6 was asked to develop a lighting outfit for tractors. This outfit was to fit on any tractor rented for fireline construction. Field sampling of opinion indicated that there should be three lights, two forward and one backup, and that the direction of each beam be adjustable.

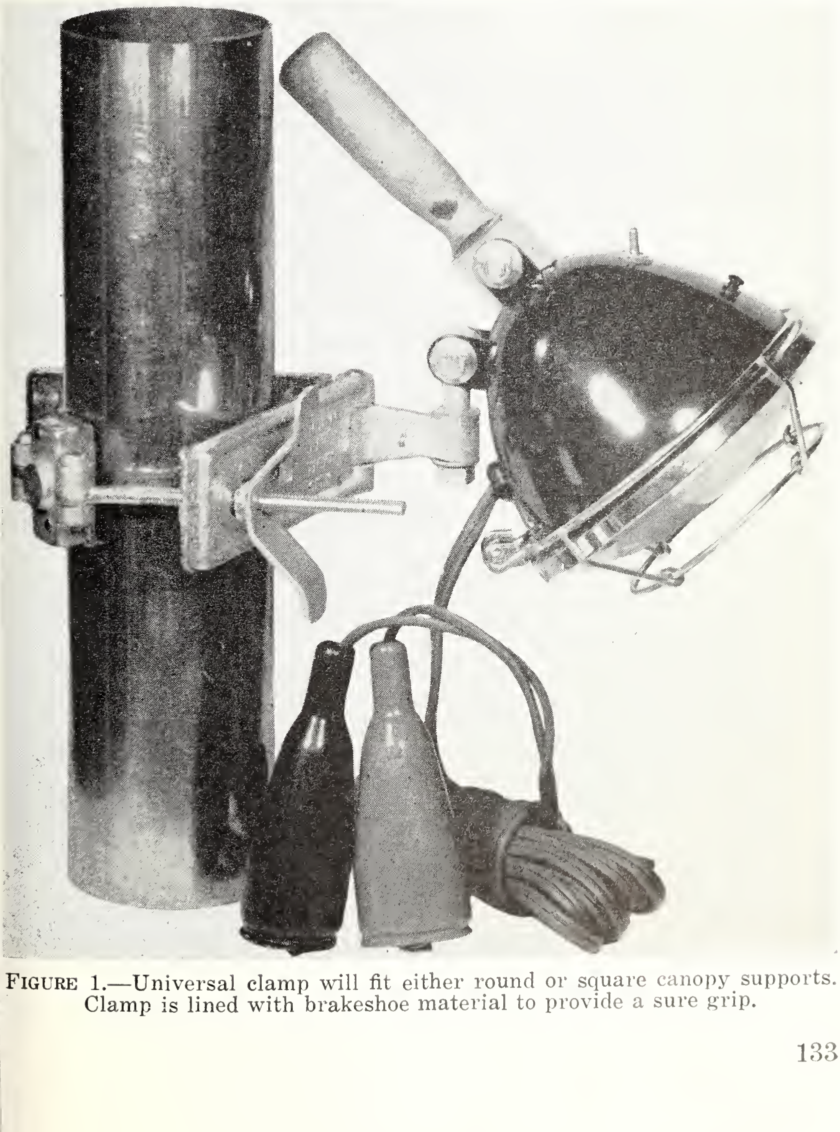

Figure 1.—Universal clamp will fit either round or square canopy supports. Clamp is lined with brakeshoe material to provide a sure grip.

The first problem to solve was how and where the lights shoul be attached to the tractor. Most logging tractors are equippe with canopies. In many States the law requires that they be s equipped. These canopies, however, are not all of the same design Some of the supports are round, and some of them are square The clamp designed will fit either type (fig. 1).

Some tractors are equipped with batteries. These may be eithe 6 or 12 volt. The kit, therefore, contains both 6- and 12-volt ligh bulbs. Alligator clip quick connectors provide a means of clamp ing the headlight wires to the wet battery. If the rented tracto has no battery, then 12 No. 2 dry cells can be used. These are con nected in groups of 4 each.

FIGURE 2.—Complete tractor-lighting outfit.

The complete kit, developed to meet forest fire fighting needs (fig. 2), is now available commercially. The lights and clamps can be purchased separately where it is known that the tractor on which they will be used is battery equipped.

The standard contents for the kit are as follows:

3 Tractor lights with 15-foot twin wire cords equipped with positive and negative insulated quick clamps and 6-volt lamps.
3 Wire lens guards for lights.
3 Universal adjustable clamps for canopy stanchions.
2 Battery boxes with terminals, each to accommodate 12 No. 6 dry cell 1½-volt batteries.
6 Dry cell connector plates.
24 No. 6 1½-volt dry cell batteries.
3 Lamps, 6-volt G.E. No. 1021.
6 Lamps, 12-volt G.E. No. 1327.
20 feet of twin wire cord.
2 Rolls 4-inch insulated tape.
1 8-inch crescent wrench.
1 6-inch pliers.
1 6-inch screwdriver.
2 Spare wingnuts for clamps.
6 Spare washers for clamps.
6 Spare hex nuts for lamps.
6 Spare lockwashers for lamps.
3 Spare battery box wires.

The kit, complete without batteries, weighs 85 pounds. Its dimensions are 15 by 16 inches, 28 inches long. Further information can be obtained from the Division of Fire Control, U. S. Forest Service, 729 N. E. Oregon St., Portland 8, Oregon.

FAN PSYCHROMETER

ROBERT M. LOOMIS, *Forester, Columbia Forest Research Center, Central States Forest Experiment Station,* and
VIRGIL STEPHENS, *Fire Control Officer, Missouri National Forests*

Battery-operated fan psychrometers have been widely used to measure relative humidity at fire-danger stations. With electricity now available at many stations, a unit using this current is practical. A fan psychrometer suitable for locations where 110- to 120-volt, 60-cycle alternating current is available was assembled

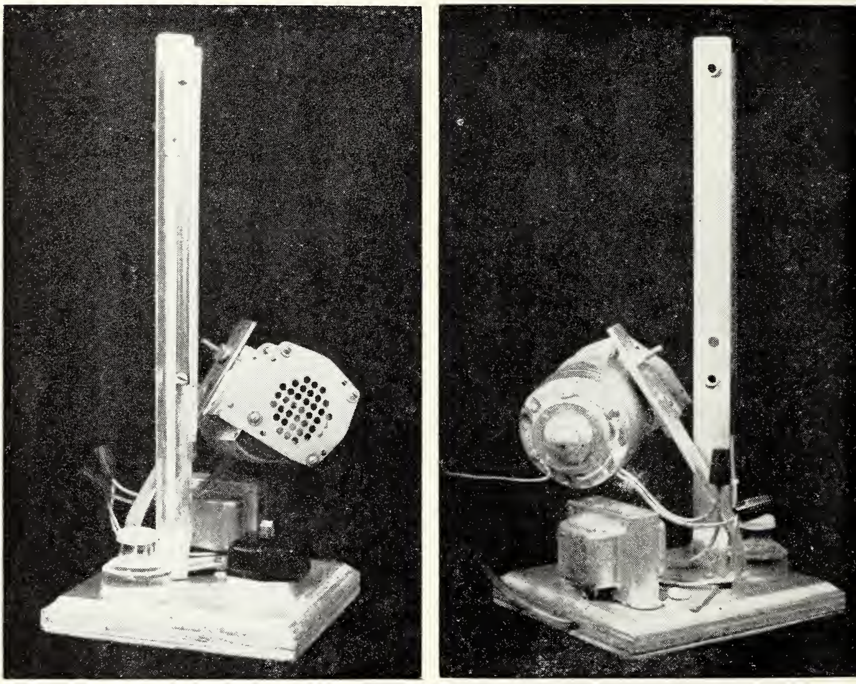

FIGURE 1.—Fan psychrometer: *Left,* Front view showing arrangement of wet and dry bulb thermometers, motor and fan, transformer, switch, and water container; *Right,* rear view showing assembly of motor and psychrometer, electrical wire connecting to 110-v. outlet entering base, cover for bottom of base, and ground wire from motor.

by Central States fire research personnel.[1] The 6,000-r. p. m. blower, 24-volt d. c. motor, and transformer were obtained as a unit through a radio-TV supplier for $4.00.

This instrument is efficient and compact, and simple to operate. The high-speed blower draws air from the side away from the motor, eliminating the possibility of motor heat influencing the reading.

[1]J. Allen Jackson, R-9 Training Officer, formerly Assistant Supervisor, Missouri National Forests, suggested this instrument.

The assembly shown in figure 1 is an example of a workable arrangement of the wood base, motor, transformer, blower-type fan, two strap-iron supports, switch, water bottle, and psychrometer. The wood base is ¾ by 7 by 7 inches, and is grooved on the bottom to carry the electrical wires. Holes are drilled to carry the wires through the base to the switch and transformer. Enclosing the electrical wires in the base is a piece of ⅛-inch Masonite attached to the bottom with countersunk flathead screws. A circular hole, 1⅞ inches in diameter and ⅜ inch deep, is cut into the base to hold the water container, which is an India ink bottle with plastic cover.

Two supports, one for the motor and one for the psychrometer, are bent from ⅛-inch by 1-inch strap iron, 10½ and 17 inches long. Supports, transformer, and switch are held to the base with roundhead screws. The motor and psychrometer are attached to the supports with stove bolts. The psychrometer is kept from direct contact with the strap iron by tubular metal sleeves ½ inch long. Blower and thermometers are arranged so that the air blows across the dry bulb first. For safety the motor is grounded with the wire from the rear of the motor.

This type of instrument is now in use on the Missouri National Forests and is proving satisfactory.

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Inexpensive Scanning Stereoscope

In office stereoscopic delineation of types, photo measurements, or dot counts on aerial photographs, nothing is more aggravating than to be hampered by the legs of a pocket stereoscope.

Freedom of hand movement can be obtained by rigidly mounting a stereoscope to a bar from an upright at the proper focusing height. However, this method requires that the photos be moved beneath the stereoscope for complete stereoscopic coverage, which is rather unhandy.

Commercial scanning-type stereoscopes are excellent and eliminate both of these disadvantages. Most of them, however, are too expensive for the average person engaged in photointerpretation.

A practical yet inexpensive scanner can readily be made by attaching a common magnifying stereoscope to a storm sash friction-type adjuster. The adjuster is screw-fastened to a short length of 2″ x 2″. The 2″ x 2″, in turn, is attached with screws to the left edge of a plywood base on which the photographs are placed. This viewing surface can be tilted toward the photointerpreter by raising the back edge to the desired height with legs or a wooden strip.

The friction disks at the three hinge points of the adjuster eliminate wobble but allow free roving of the stereoscope in a horizontal plane to any desired stereoscopic position over the aerial photographs. Smoother movement of the arms is accomplished by lubricating each joint and adjusting the locknuts. A hacksaw is used to notch the end normally fastened to the sash before bolting the stereoscope to it. One stereoscope in use has the standard 2X lenses mounted with an interpupillary distance of 63 mm. in an eyepiece made of ¼″ hardboard.

Certainly a more refined unit can be made by variations of the above. However, the point is that a stereoscope can be successfully adapted for scanning for about $1.00—PAUL M. HAACK, JR., Technical Note 40, *Alaska Forest Research Center, U. S. Forest Service.*

Lightning-Strike Recorder Rings for Lookout Firefinder Maps

Since 1954 Region 1 has been experimenting with aluminum rings o different sizes placed over the map disks on firefinders. Lightning strike were recorded on the aluminum with pencil as they occurred. When th temporary record was no longer needed it was easily erased. These ex periments have led to a new method which appears to be very satisfactory All firefinder maps in Region 1 will be mounted as follows:

1. The maps are cut 1¼ inches in diameter smaller than the metal re quired, leaving a ⅝-inch margin of bare metal.

2. 3S aluminum sheets .018 grained on one side, are used. Grainec aluminum is ideal for pencil marking and the marks are easily removed.
3. The map is bonded to the grained side with dry-mounting tissue. A large electric dry-mounting press is heated to 230 degrees and ap proximately 10 pounds of pressure per square inch is applied. After 45 seconds the pressure is released and the map is turned 90 degrees Pressure is again applied for another 45 seconds.
4. The mounted maps are made water repellent by spraying with aircraft industrial lacquer.

On some makes of firefinders (old-style Bosworths) the metal azimuth circle covers the perimeter of the map. If this is the case, allowance must be made by cutting the map smaller before mounting and spraying.—A. R FINK, *Missoula Equipment Development Center, U. S. Forest Service.*

HOW EASTERN REGION FIRE TRAINING COMMITTEE FUNCTIONS

A. R. Cochran
Former Fire Chief, Section of Fire Control, Region 7, U. S. Forest Service

A public awakening to the strategic place of resources in national existence came out of the world war experience. Old standards of protection were recognized as inadequate. New higher standards were required. Protection agencies faced a changed situation. Disastrous fires over widely separated areas of the country gave a sense of urgency to the situation. Losses formerly tolerated were no longer acceptable. Resource managers needed answers to the problems of resource protection. They needed to be equipped and trained for a job always different, but which now required much more exacting standards.

Training seemed to offer one of the most promising opportunities for strengthening fire control rapidly. This Region sought to meet the urgent training requirements through a task force approach. A Regional Training Committee was activated to analyze training needs, develop a training program, and apply it in the Region. Membership of the five-man committee consisted of three qualified firemen from the forests, the regional fire specialist on fire studies, and the regional fire staff officer.

The first work of the committee consisted of assembling information on fire control subjects as complete and authoritative as possible. The findings of research, the well-established standards and techniques of fire control, and the experience of fire control people were brought together. Fire weather and fire behavior studies furnished an important part of the information assembled.

The committee decided that in preparing a program emphasis should be on principles. The reason for adopting such a guide was to equip the administrative officer with principles and natural laws as the tools required for solving the multiplicity of situations which he will face in resource protection. Fire control subjects treated in this way attained a scientific stature as against a system of dogma, rule of thumb, and special problem solving which at best could be applied rigidly and often crudely, never quite fitting the problem on the ground.

The first step in developing an overall training program was to prepare an outline of subjects important to fire control and related to training needs of the Region. These subjects were apportioned into yearly training programs representing priority of subject matter and limited to what could be covered reasonably in the time available during any one year.

After the subject matter for a year's program was selected, the committee made an exhaustive analysis of each subject and arranged material in logical sequence. They limited subjects to those bearing on principles. This assisted the committee in sorting the pertinent from the nonrelevant. This phase required about one week of committee work for each year's training program.

Each subject was defined, and assigned its proper place in the training outline.

Each major subject is broken down into instructional units which the following illustrates:

What: Define subject.

Why: State the specific function or place of the subject and the reason why it is included.

The subject is broken into teaching units:

Lesson plan No.	*Instructional units*	*Scope of instruction*
1	Name of instructional unit for each lesson plan.	Define the limits or bounds of instruction, giving specifically the area to be included in each lesson plan.
2		
3		
4		

This process of stating the what and the why of each subject requires clear thinking and is the means of separating principles from nonessentials.

Because this outline information provided insufficient guide for the actual training job, a text was prepared. This gave fluency to the subject matter and provided a flexibility that paid off well for the time and effort required to make the writeup.

Lesson plan development was in accordance with professional standards; used as a reference was "Techniques of Military Instruction," FM 21-6, Department of the Army Field Manual, May 1954. The committee's big responsibility in lesson plan development was to find training techniques that carried an impact for fire control subjects. This is a fertile field for attention. In addition the committee had to adapt training techniques to the resources available on a forest.

Lesson plans, however carefully prepared, should not be released for general use until they have been proved in a training session. The experience of the training committee has been that some very worthwhile and needed adjustments have been made through the regional test training session. The trainees in the regional training session are responsible for forest training in these subjects and are naturally keen and alert. They are quick to detect weaknesses and ready to make changes that show they are needed.

A considerable amount of time must be spent by the fire specialist and regional fire staff man in preliminary work on a training session. This includes time for consultation with fire research people.

The training committee has used 5 to 6 weeks in session to produce a training program for a given year. In addition to the time in consultation, members spend whatever time is required, individually, on the subjects for which they are assigned responsibility for teaching in the regional training session. Because they have individual responsibilities for producing results, each is inclined to take his "homework" very seriously. Although committee members had to devote a significant amount of time, their efforts were justified by the results obtained. Attention to the technical soundness of the training material developed and to training techniques has paid off in effective fire control training.

SLASH DISPOSAL BY BURNING ON THE KLAMATH

LEE MORFORD
Forest Dispatcher, Klamath National Forest

Beginning with the World War II years, the cost of slash disposal increased to such an extent that disposal and hazard reduction became less common on forest lands. Personnel on the national forests of California began searching for a cheaper method to accomplish the desired results from both a fire hazard and silvicultural standpoint. When the logging industry moved into the Douglas-fir area of northwestern California a new fire problem faced the protection agencies. In the Douglas-fir timber a cull volume ranging from 20 to 50 percent of the total volume was left on the ground following logging. This created a very heavy accumulation of both large and small fuels. Fires occurring in these fuels were extremely difficult to control, particularly when fire dangers were above the low range.

Late in 1952 a study was made of the fires occurring in the Douglas-fir type slash areas of northern California. This study indicated that, if protection goals were to be met, some method of slash disposal would have to be instituted in spite of the heavy costs.

The Klamath National Forest took the lead in attempting to devise ways of disposing of the heavy accumulation of fuel so that fires in the slash areas could be controlled. The Happy Camp District was designated as an experimental area. Fred Wilder, who has an excellent knowledge of fire behavior, was assigned to the project. He treated the areas in several different ways and kept cost records on the treatments. It soon became apparent that if slash burning was to be done safely and economically, all district managers would need established guidelines. The costs could be prohibitive if burning was tried when fuels were too wet; burning was unsafe when fuels were too dry.

The problem had been discussed with the California Forest and Range Experiment Station at Berkeley and the fire weather section of the Weather Bureau. It was decided to set up a series of weather observation stations to get a representative measure of weather conditions in the timbered belt. By correlating their observations with the burning being done under the supervision of Fred Wilder, and through trial and error in other slash burning projects, it was possible to establish a set of preliminary guidelines to slash burning for use by all districts on the forest.

During the fall of 1956 the new guidelines were put into full use forest-wide. Weather observations were taken at the Humbug Fireman Station and Scott Bar Mountain, Slater Butte, and Blue Ridge Lookouts. The lookout stations were at the upper edge of the timbered areas in which the slash was being burned and the Humbug Fireman Station at the lower edge.

These observations were correlated with the burning projects on the Happy Camp District, to serve as a basis for revising and improving the preliminary guidelines, for which burning indexes had been computed from our Fire Danger Rating System. The revised system was used again in 1957 and a record was kept of the intensity with which the slash burned. Using this record and correlating it with the observed weather conditions and the previously established indexes, we again broadened and improved the guidelines.

The procedure under the guidelines is as follows: Observations are taken from selected stations prior to the beginning of the slash burning. Weather forecasts are received twice daily during the month of October and once each day thereafter. From these weather forecasts and from the computed indexes of the day before, the burning index is predicted for the next day. This predicted index is then given to all districts engaged in or planning slash burning.

No burning is done prior to October 1, and then not until at least ½ inch of rain has fallen. The guidelines and the indexes are used to determine where and when the slash can be burned safely and where and when the slash can be burned without too great a cost. In other words, when the burning index is zero, it is a waste of manpower and money to try to burn the lighter fuels. Heavy fuels that have been piled with some type of protection from weather can be burned at any time when there is no danger of spread.

To take advantage of every day of good burning conditions, it is advisable that work crews have a staggered tour of duty. It is also best to have men available to check areas that have been previously burned under favorable conditions whenever the increasing burning indexes indicate that there is danger of spread.

This system does not entirely eliminate all risk in burning slash since weather predictions are not always dependable and very often the weather prediction is not representative of small isolated areas. Either one of two methods is recommended for overcoming these deficiences. (1) Place a person in charge of the burning operations who has a good understanding of fire behavior and a background of experience in slash burning, or (2) have a portable weather station available at a selected site near the burning project where observations may be taken during selected periods throughout the day. Either of these two methods work satisfactorily and prevent unpredicted severe burning conditions from trapping the burning crews or catching them with fires that they may be unable to contain and that may become costly.

TYPICAL SLASH BURNING GUIDELINES

1. Slash burning will not be permitted until after October 1, and then not until the following conditions are present and requirements met.
2. Trends of the fire danger for Area 8 must be available for at least 5 days prior to burning, except that burning may be started immediately after at least ½ inch of rain has fallen.

3. Slash may be burned in these situations after ½ inch of rain and the Area 8 index trends are as indicated.
   a. In shaded canyon bottom; index below 17.
   b. North exposure, about 6,000 feet elevation; index below 15.
   c. North exposure, fir type, 3,500 to 6,000 elevation; index below 12.
   d. North exposure, pine or mixed conifer type, 3,500 to 5,000 elevation; index below 10.
   e. Piled slash along lower side of roadbed, or slash piled and lined with firebreaks, fir and Douglas-fir types; index below 10.
   f. East, south, and west exposures, Douglas-fir slash, 2,500 to 6,000 elevation; index below 10.
   g. East, south, and west exposures, mixed conifer and pine, below 5,000 feet; index below 7.
   h. Ridgetops and exposed points, pine and mixed conifer, index 3; Douglas-fir and fir, index 5.

CONCLUSIONS

The hazard reduction done on the Klamath since 1950 has not been fully evaluated. However, in 1955 during one of the most severe fire seasons in the history of the forest, an incendiary fire was started in unburned slash. It spread to an area in which the slash had been burned. This fire was controlled during the first burning period after spreading over approximately 800 acres. The fire overhead stated that only because of the previously burned slash were they able to construct and hold firelines. This fire was one of 28 that started on the forest between September 1 and September 5. Several of these 28 fires were disastrous, and a total of approximately 64,000 acres of timberland were burned over in the first 10 days of September.

The Klamath is crossed by a very large lightning belt and no part of the entire forest is exempt from lightning storms. It is not uncommon for 30 to 70 fires to be started from a single thunderstorm. With the cutover area increasing at the rate of 5,000 to 10,000 acres a year, the risk of lightning fires and the potential disaster resulting from them is continually increasing. This situation alone makes it imperative that adequate hazard reduction be employed. We believe that, by using these guidelines for reduction of hazard, we will be able to meet the objective of both fire protection and silvicultural management of cutover areas.

SLASH DISPOSAL BY DOZER, NORTHERN ROCKY MOUNTAINS[1]

In 1952 the U. S. Forest Service started a project that included an analysis of dozer-piling methods for slash disposal in the clear-cut lodgepole pine type, with attention to effects on regeneration. Advantages and limitations of dozer piling were to be determined and a comparison of machine sizes (dozers), production, and cost made. In 1953 the larch-Douglas-fir and ponderosa pine types were included.

During 1954 and 1955, dozer bunching or piling of slash was used on approximately 33 percent of the acreage and 40 percent of the volume prepared for disposal in the Northern Region (Region 1) of the U. S. Forest Service. It is entirely possible that at least 50 percent of the volume will be handled by this means within the near future.

Specific cost data were particularly difficult to obtain because of many variables such as type of blade, volume, slope, ground condition, experience and skill of operators, and contract rate. It was also extremely difficult to measure results of slash disposal proper against incidental stand-improvement and other work. It was not possible to establish the necessary controls for absolute accuracy in cost and production analysis. This report, however, is prepared from such figures as we could get and have analyzed by the most experienced men available. Although it falls far short of the desirable, it should be helpful in planning machine operations.

MACHINE SIZE

In general, men experienced in machine slash disposal favor the larger machines, such as the crawler type D-7 or D-8 (fig. 1). Dozers comparable in size and power to the D-7 or D-8 have been most widely used; however, machines comparable to the D-6 have also been satisfactory from the cost and production standpoint. Many men who formerly considered only the larger machines have been swinging to the D-6 size class because of transportation, availability, and other advantages attributable perhaps to local considerations or conditions.

The production of a D-4 size machine was analyzed for only one job. Results were not considered favorable to general use of the smaller dozers. These small machines have trouble in handling slash where stumps are present in any quantity or where there is extensive windfall. Although the general use of dozers in the D-4 size class is not recommended, they have unexplored possibilities where cut per acre is light and other factors are ideal. On good ground they are highly maneuverable and may have a place when compared to the alternative of hand piling.

Contract dozers in the D-6 class have been available for $9.75 an hour; dozers in the D-7 class for $11.75; and dozers in the

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[1]A somewhat shortened version from *Mechanized Slash Disposal*, compiled by H. K. Harris. U. S. Forest Service Equip. Devlpmt. Rpt. No. 43, 27 pp., illus. 1956.

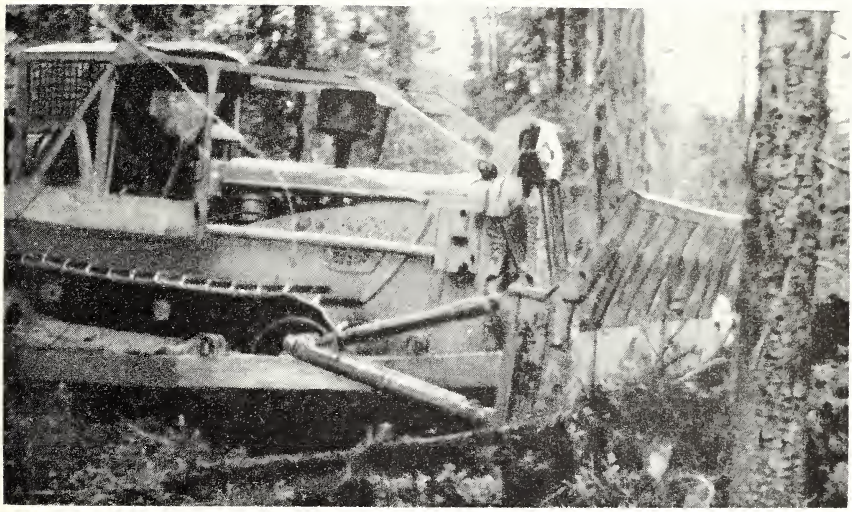

FIGURE 1.—Slash disposal dozer. Note heavy armor and cab protection.

D-8 class for $12.50. These rates include operators. They vary somewhat by areas and according to the availability of other work.

RATING AN AREA FOR DOZER WORK

Because cost and results vary according to the difficulty of a slash-disposal job, the relation between obstacles and ease of production are of importance in planning. Therefore, the following factors must be considered:

Slope.—Although dozers can operate on slopes steeper than 35 percent, production falls off so rapidly that costs become prohibitive.

Windfall.—Some areas contain sufficient windfall to definitely hinder the slash-piling effort, particularly if long and large stems are involved.

Snags.—Standing snags represent a considerable hazard to the operation; the number per acre is important in any attempt.

Rock outcrops.—Rock slows down tractor maneuverability and handling of the blade.

Reserve stand.—Reproduction and larger trees that must be saved influence rate of production. This factor is also a consideration in the selection of slash-disposal methods.

Boggy ground.—Soft ground not only limits tractive effort but can tie up a dozer team for long periods. It is often a consideration in selecting the time or season of operation.

Soil characteristics.—Light soil types, such as those common to true white pine types, provide poor traction even under ideal condition.

Slope should probably be the major consideration in rating an area for ease of production with dozers. In one study where slash was bunched on 69.8 acres by a TD-18 dozer equipped with an Isaacson brush blade and operated by a skilled operator, the time required per acre almost doubled when slope increased from 20 to 35 percent.

The following tabulation, based on observation of dozers at work and discussions with field men, can be used to rate an area in respect to the possibilities of dozer slash piling.

Factor	Unit	*Ease-of-production classification* — *Easy*	*Average*	*Difficult*
Slope	percent	Less than 15	15-30	More than 30
Windfalls per acre	number	0	1-10	More than 10
Reserve stand, stems per acre	do	Less than 5	5-10	More than 10
Snags[1] per acre	do	Less than 3	3-10	More than 10
Rock outcrops, area	percent	Less than 3	3-10	More than 10
Boggy ground, area	do	0	1-10	More than 10
Very loose soils, reduce slope factor	do	0	5-10	More than 10
Reproduction stocking[2]	do	Less than 15	15-50	More than 50

[1]General definition given by field men, "Any dead stem left standing, following logging, over 6 inches d.b.h. and 10 feet in height."

[2]Percent stocking based on 4-milacre units.

PRODUCTION AND COST

An analysis of production showed that dozers in the D-7 or D-8 size class, properly equipped, and operated by experienced men, can be expected to average 2 acres an hour in areas rated "easy"; 1.2 acres per hour in areas rated as "average"; and .67 acres per hour in areas rated as "difficult."

For each thousand board-feet of timber logged, cost of machine piling slash averaged less than a dollar on easy areas, $1.25 on average areas, and $2.35 on difficult areas.

The following factors in addition to those determining ease of production also influence cost:

Volume of slash handled.

Acreage or size of operation.

Transportation and nonproductive machines and labor.

Size, condition, and number of machines.

Skill of operators.

Field supervision.

Amount and kind of stand-improvement or other work done in conjunction with slash bunching.

Time and season.

Contract or Government-owned dozers.

The species handled in a dozer operation may also have some influence upon cost. Studies are under way to determine the volume of slash to be expected in various timber types and its relation to sawtimber volume. It is known that the volume of slash per thousand board-feet of timber logged is much greater in young stands than in mature stands. Six trees 12 inches d.b.h. produce approximately the same scale as one tree measuring 24 inches d.b.h., but the large tree produces only about half as much slash as the 6 smaller ones.

In the study reported here, slash accumulations were not measured for volume. However, the extent to which volume of slash influences cost is reflected in the cost of dozer operation, not including overhead, according to the volume of timber logged per acre as follows:

Volume logged per acre (M board-feet)	*Cost of dozer piling per acre (dollars)*
5	10
10	14
15	19
20	23
25	27
30	31

Note that an increase in volume of timber logged per acre will, in general, result in a reduced cost per thousand board-feet for the dozer operation. The reason for this is obvious. Noneffective dozer operations, such as backing and turning, are reduced as the volume logged per acre, and hence slash, increases.

Small, isolated areas with light volumes of slash may be more economically handled by hand-piling than by dozers, since contract rates or transportation costs for dozers raise cost considerably. On the other hand, relatively small areas with heavy volumes of slash may be more economically handled by dozers. The deciding factor may be site ease-of-production classification ("easy" or possibly "average"), the amount of stand improvement, or possibly benefits from dozer bunching such as scarification and seed distribution.

OPERATIONAL TECHNIQUES

Carefully planned and executed operational techniques may make the difference between an economical operation or one that is costly. For example, in the investigation reported here, time studies were made to establish a "pattern of operation" for dozer piling slash on a clear-cut lodgepole area which included considerable stand-improvement work. The time studies took into account (a) distance of drift slash, (b) effect of standing trees and stumps, (c) blade capacity and allowable loss of slash from blade, (d) pattern of dozer movement, and (e) windrowing of slash vs. bunching or piling.

As a result of the time studies, production for the particular situation considered was increased from approximately 1 acre per machine-hour to 2.25 acres. This was accomplished by—

Increasing distance of each swipe to approximately 2 chains Although some sloughing was experienced, it consisted principally of slick stubs and poles with only a few branches which are not a serious fire hazard when left on an area.

Reducing the noneffective time spent in maneuvering the tractor by backing through finished area and crowding new slash when moving forward.

Windrowing slash instead of piling. In this instance, the windrows required less nonproductive maneuvering of the tractor.

The pattern of operation may require considerable variation to fit conditions. The training of operators, particularly with respect to pattern of operation and degree of cleanup required, is essential to the success of every job. The following matters should also be considered by supervisors in planning slash disposal:

1. Avoid machine piling in areas too steep for economical operation. Weigh production against operating time as a check.

2. On some sites, machines are not practical because of the volume and spacing of reproduction or seed trees that must be left. The big machines, with wide blades, cannot operate without pushing many trees down and damaging considerable reproduction.

3. On sites where soils are easily eroded and steep slopes predominate, dozer operations may not be desirable. Use of dozers may contribute to the erosion problems created by the logging operation.

4. The amount and kind of stand-improvement work should be considered. Dozers can push over residual trees in many stands better, faster, and cheaper than hand labor can. When both stand improvement and slash disposal are done concurrently, the overall job is simplified.

5. Select the proper season for dozer operations. Some areas do not dry out until late summer and much trouble will be experienced if machine piling is started too early. Dozers cannot operate successfully on steep ground (20 to 35 percent) when it is frozen. Sometimes the difference between morning and afternoon frost conditions, particularly on north-facing slopes, is a factor.

6. Slash is more easily handled if it has had a month of drying weather. Where maximum seed distribution is desired, the cones from dried slash are easily shaken from the branches and scattered throughout the operating area. In some timber types, however, excessive scatter of cones and seed from dry slash may result in undesirable, overdense stands; it may be advantageous to bunch such slash as soon after cutting as possible.

7. Select the proper size dozers. In lodgepole clear cuttings for example, the stumps are too numerous to avoid and must often be pushed out by the blade for maximum production. Small dozers have not proved practical.

8. Whether contract or Government-owned dozers are used, give particular attention to service and repair. Fuel barrels are a poor substitute for a tank wagon because of lost handling and fueling time. If barrels are used, they must be kept clean and free of rust and scale. A 15-gallon drum should be available for oil changes. Each dozer should carry an extra hoist cable, and other cable should be kept on hand. There should be extra grouse plates (with bolts) for tracks. A supply of extra filters for oil changes should be available.

9. All dozers must be equipped with substantial cabs. All men must wear hard hats. Ground workers should be kept at least 200 feet from dozers at work. Special and detailed safety plans, instruction, and inspection are necessary.

10. Use dozers in pairs if the job is large enough. This will reduce lost time on soft ground or when the dozer gets "high-centered."

11. In heavy windfall or snag areas, use a helper with a power chain saw, especially with machines of the D-4 or D-6 size class.

12. It is important that the cleanup around the perimeter of each unit be better than average. This will provide a safety factor if burning operations are conducted during windy or dry weather, a condition that often occurs during the early fall. The pattern of cleanup may often be arranged to provide additional safety by means of separator strips, where the slash piling is given special attention.

13. Keep a qualified foreman on the job. It should be his responsibility to—

a. Do the current planning on an operation; i.e., where to use dozers or hand piling on an area; where slash should be left to prevent erosion; and other necessary details. Conduct time studies, as necessary, in order to reduce noneffective maneuvering of machines to a minimum in establishing a pattern of operation.

b. Direct operations when windrowing, piling, scarification, and stand-improvement work are done concurrently.

c. Keep dozers spaced for safety of operation but close enough that they can assist each other when necessary. Check work of operators frequently to prevent unnecessary "polish" as well as inadequate cleanup.

d. Avoid working dozers in smoke and under conditions of reduced visibility when burning is done in connection with piling.

e. Check operators on proper maintenance of Government-owned equipment. (Operators should follow manuals carefully regarding service periods; brush blades are heavier than regular blades and front idlers require extra attention. Fuel tanks should be filled each night to avoid condensation, and the last hour of a shift should be used to grease, fuel, and tighten bolts.)

f. Keep a daily record of running hours for each dozer. Settle with dozer operators (contract equipment) on actual running time each day. Prepare accurate progress maps and cost data necessary to report and analyze accomplishments.

EFFECTS OF BUNCHING ON REGENERATION

Prompt restocking to the right density and with the most desirable species is at least as important a management objective as harvesting the timber stand. The problems of regeneration differ with areas, timber types, and methods of logging and slash disposal. In discussing the effects of dozer bunching on regeneration, it must be recognized that the acceptance of a single method of slash disposal is not recommended. Each slash-disposal method possesses certain advantages and disadvantages that must be weighed carefully before selecting one to apply to a given stand or condition.

Lodgepole pine type.—Clear cutting in blocks of various sizes, depending upon conditions of topography, wind, and other factors, is the common practice in pulpwood cuttings in the lodgepole pine type of Montana. After pulpwood clear cuttings, only small or occasionally large defective trees remain. Therefore, trees that occupied the area before cutting and the trees in the surrounding uncut timber furnish the principle source of seed. Seed dispersed from surrounding timber is chiefly limited to the margins of the cutting area, and the small amount of seed dispersed beyond 3 chains is inadequate and undependable for reproducing a stand. Therefore, seed dispersed before cutting and seed on cones attached to slash and in individual cones scattered over the ground undoubtedly accounts for most of the supply for regeneration.

Since some slash disposal is usually necessary to reduce the danger of fires in logging debris, an understanding of the effects of disposal on natural regeneration is important for planning successful renewal. Most publications concerning lodgepole pine regeneration place considerable emphasis on slash-disposal methods; however, they differ widely in conclusions and recommendations.

The White Sulphur Springs area, where most of the information for this discussion was collected, contains pure, even-aged, overmature stands growing at elevations of 6,500 to 7,500 feet. Soils are generally clay and silt-clay loam composition. The results reported here should be applicable to similar stands in Montana and elsewhere.

Preliminary observations of broadcast-burned and unburned clear cuttings indicated that effects of slash disposal were closely associated with the available seed supply. Sparse reproduction was found on burned seedbeds created either by broadcast burning or burning of piled slash. Abundant reproduction was found on unburned seedbeds. Much of the seed and cones were destroyed by the fire which accounted for this difference. If the fire from broadcast burning covers the major part of an area, average reproduction will be exceedingly low.

The amount of regeneration observed in a stand of lodgepole pine, according to seedbed, is given in the tabulation that follows:

	Seedling distribution, stocked milacre quadrants			*Density of trees per acre,*
	1950 (percent)	*1951 (percent)*	*1954 (percent)*	*1954 (number)*
Seedbed:				
Burned, piled slash	15	15	28	860
Burned, windrows	24	18	28	720
Slash, windrows and concentrations	38	28	45	1,880
Forest floor	78	74	80	7,010
Skidroad	95	88	96	10,380
Scarified	83	81	88	10,730
Slash, lopped and scattered	83	76	82	9,910

Since the regeneration on undisturbed forest floor exceeds the present concept of optimum stocking and number of seedlings per acre, scarification or scattering of seed as a result of dozer piling cannot be considered an advantage (fig. 2). If fire-hazard reduction were not required, the best treatment would be to leave the slash in place. Future stocking in the stand will presumably level off or increase very slowly. Viable seed has been found in cones attached to 6-year-old slash.

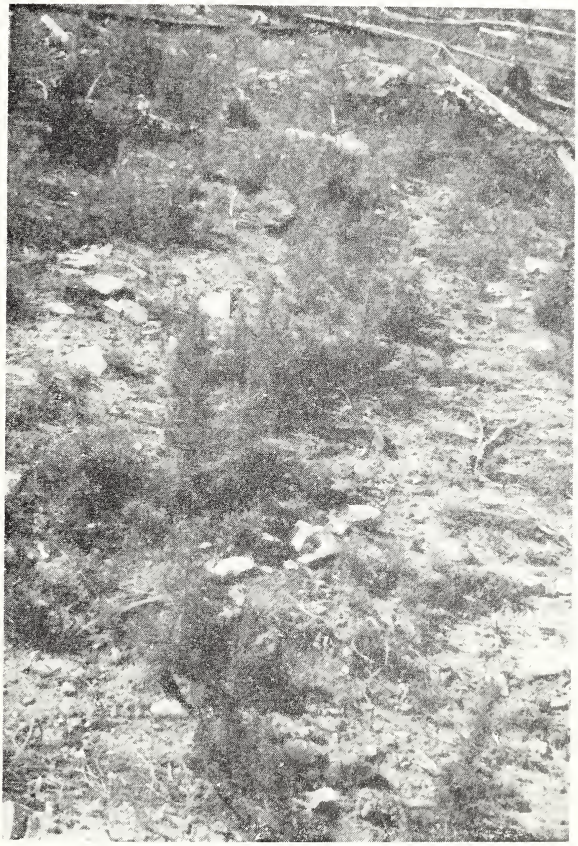

FIGURE 2.—Lodgepole reproduction in scarified ground 5 years after slash was piled.

Dozer piling in the lodgepole type is advantageous in that it permits controlled burning of slash, thus limiting the total burned area; it also permits the economical destruction of defective and diseased trees (fig. 3).

Research was begun in 1955 to determine the value of dozer bunching as a control of regeneration in areas where distribution and supply of seed are overabundant. It may be possible to bunch cone-bearing slash before it dries and the seed is easily shed. This would not only reduce the seed in scarified areas between

FIGURE 3.—*Top*, Machine-piled slash in lodgepole clear-cutting area. *Bottom*, Slash disposal and stand-improvement work combined on clear-cut lodgepole pulpwood sale.

windrows or piles, but more cones would be consumed by the burning operation. First results of the study have produced some leads as to when the slash might have to be removed in order for the control to be effective.

Also important to the slash problem, but not necessarily directly related to machine slash disposal, are observations regarding the fire hazard of undisposed slash in the lodgepole type. In areas where no slash-disposal treatment was undertaken, and in areas where lopping and scattering was done (fig. 4), the fire hazard remained at a level higher than was acceptable to fire control men 4 years after needle fall. Needle fall, which took place within two growing seasons after logging and one growing season after disposal, was assessed as having dropped the rate of spread one class.[2]

Larch-Douglas-fir type.—Dozer piling is generally regarded as conducive to good regeneration in the larch-Douglas-fir type in Montana. In the average logged-over larch-fir stand, only 10 to 20 percent of the area is disturbed sufficiently by logging to provide favorable seedbed conditions. Dozer bunching provides additional favorable seedbed where slopes are not too steep and dozers can be economically used.

One study of cutting practices in Montana larch-fir type revealed that stocking was generally adequate in the three cutting methods used where the slash was piled by bulldozer and brush blade and/or burned. The results are shown in the following tabulation:

Cutting method and slash-disposal treatment	*First-year seedlings per acre*	
	Western larch (number)	*Other species (number)*
Seed tree:		
Hand pile and burn	259	247
Dozer pile and burn	4,598	2,725
Spot burn	1,799	464
Shelterwood (economic selection):		
Hand pile and burn	545	545
Dozer pile and burn	5,692	331
Spot burn	6,228	703
Shelterwood (vigor selection):		
Hand pile and burn	1,144	1,468
Dozer pile and burn	9,509	2,204
Spot burn	10,592	1,941

As a result of slash-disposal treatment, favorable seedbed area ranged from 35 to as much as 80 percent. The hand-pile and burn treatment, for the three methods of cutting, resulted in the lowest stocking because of the lack of favorable seedbed.

In some areas the use of bulldozers on slopes of 30 to 35 percent, and even on gentler slopes in some soils, may induce soil erosion and hasten runoff to an undesirable extent. Because of the importance of soil scarification and removal of intermediate and low vegetation, this aspect of the problem needs more study.

Prescribed burning is the only known method for preparing seedbeds on slopes greater than 35 percent. It is risky and difficult. All indications point, however, to the superiority of mineral soil as produced by scarification and burned forest floor for germination and establishment of larch reproduction.

[2]Fuel classification currently in use in Region 1 divides fuels into 5 rate-of-spread classes known as low, medium, high, extreme, and flash.

FIGURE 4.—Lodgepole clear-cut area 5 years after slash was lopped and scattered.

Ponderosa pine type.—Studies show that mineral soil will produce approximately eight times as many seedlings per acre as natural duff under similar conditions. A mineral-soil seedbed can be obtained either through burning or scarification. Where rodents are a problem, the scarification produced by logging and supplemental machine slash piling, and the exposed soil resulting from burning, may make the difference between satisfactory and unsatisfactory restocking. In one instance, rodents destroyed 92 percent of the seed.

INDEX, 1958

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.


Smokey's Commandments
BREAK MATCHES
CRUSH SMOKES
BE SURE ALL
FIRES ARE OUT!
SMOKEY
Remember-
Only you can
PREVENT FOREST FIRES!

VOL. 20 JANUARY 1959 No. 1

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 1

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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Forest Service, Washington, D. C.

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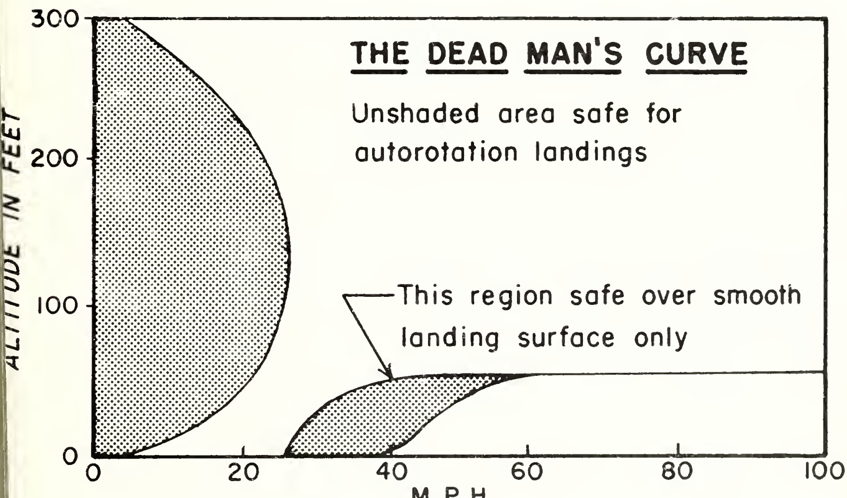
CONTENTS

THE HELICOPTER AND THE DEAD MAN'S CURVE

James L. Murphy
Research Forester, California Forest and Range Experiment Station[1]

"Straight up! That's how a helicopter takes off. Just get him a hole in that timber big enough to clear his rotor blades—that's all he needs."

Man—you are so wrong. If you're asking your pilot to fly in and out of that kind of helispot, you'd better read on. Why? Because you're asking him to flirt with the DEAD MAN'S CURVE.



From Bell Helicopter Flight Manual for Bell Model 47 G2

Let's suppose that a helicopter is operating at low elevations and *does* have the power to lift straight out of a hole in the timber. What happens if the engine should fail? "Well," you say, "that's why a helicopter's so safe. The pilot just autorotates to the ground—that is, those overhead rotor blades act like a wing and he just glides on in."

Now, wait a minute. Let's see what a helicopter manufacturer has to say about it. Take a look at the graph.

What does the graph say? Here are the most important points:

1. The helicopter must lift vertically at least 300 feet before the pilot can safely autorotate. If his engine fails before reaching 300 feet, the ship will drop like a rock.

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

2. If the helicopter is flying at an altitude of *less* than 200 feet and the engine fails, the ship must have a forward speed of *at least* 28 miles per hour to autorotate safely to the ground—or again it drops like a rock.

So when the pilot asks you to get him a helispot with a drop-off into the prevailing wind, or a hole in the timber at least 300 feet square, do it. It's the only way to keep our helicopters out of the DEAD MAN'S CURVE.

☆ ☆ ☆

Mobile Bridge For Crossing Canals

The problem of crossing canals with heavy equipment, particularly tractors and fireline plows, is general in eastern North Carolina. In many areas, standing timber for the construction of emergency bridges is not available, and it is often necessary to walk the equipment long distances to cross canals. The ever increasing number of canals has made the dependence upon permanent access bridges impracticable. The need for a mobile bridge for this purpose has been recognized for several years.

The North Carolina woodlands personnel of the West Virginia Pulp & Paper Company have developed a mobile, heavy duty, steel bridge, capable of spanning the largest canals in the area and of supporting the heaviest tractor and plow equipment currently in use. This bridge is towed as a trailer behind a conventional 2-ton truck. Large, balloon-tired dual wheels support the bridge on the highway and serve to position it in the canal. When the bridge arrives at the canal bank, it is detached from the truck and a crawler tractor is coupled to a hitch mounted on the rear of the bridge. The tractor positions the bridge, and by lowering the wheels into the canal, seats it on the two opposing banks. Hinged ramps are provided at the front of the bridge to prevent cave-in of the bank. The bridge is removed by simply pulling it back to the roadbed. The entire process takes less than 20 minutes.

A special hitch, also developed by one of the company supervisors, allows use of the tractor winch, rather than direct drawbar attachment, to position the bridge. This adds flexibility to the operation and saves considerable time.

This bridge was developed from bridge spans designed by the United States Army Engineers. Smaller bridges of the same general design would have more widespread application in other parts of the Coastal Plain. Assistance through the Operational Development Project would be available to any agency interested in developing a smaller or lighter mobile bridge of this type.—*Division of Forestry, North Carolina Department of Conservation and Development.*

SLIPON TANKER-FLAMETHROWER

A. B. Everts
Equipment Engineer, Division of Fire Control, Region 6, U. S. Forest Service

There are many management jobs where an economical, *really hot* flamethrower can be used to good advantage. Liquid gas, either propane or butane, produces a hot flame, but it does not have the body to consume wet or heavy fuels. Once the torch is removed the fire goes out. The addition of diesel oil provides the body necessary to sustain heat. Excess oil can be applied in such a way as to make otherwise difficult fuels ignite and continue to burn after the torch is removed.

Flamethrowers using diesel oil and butane or propane have been described in Fire Control Notes in the past. The flame produced by the torch described in this article is much the same as those previously reported. What is new is the method of producing it.

Figure 1.—Slipon tanker-flamethrower. Gage pressure on the vaporizing cylinder registered 40 pounds at about 30° F.

Previously reported flamethrowers were of two types. (1) One used a battery of small butane tanks hooked together by copper tubes. The diesel oil was contained in a pressure tank which was pressurized by an air compressor. (2) The other flamethrower used propane pressure to expel the diesel oil. It required the transfer of propane from commercial containers to the propane tank on the flamethrower unit. There are hazards in connection with this transfer process.

Butane has a higher heat value than propane. One gallon of liquid butane will give off 103,500 B.T.U.'s at 60° F. The figure for propane is 91,690 B.T.U.'s. Gage pressure in pounds for the two gases is as follows:

	Propane	*Butane*
60° F.	92	12
100° F.	172	38

From the above, it is obvious that butane is essentially a warm-weather gas. It can be used in flamethrowers for backfiring or burning out in normal summer weather. However, for flamethrowers designed for use in freezing or below freezing weather, such as the winter burning of slash, propane is required.

The parts of the new unit are as follows (fig. 1):

(*A*) A 110-gallon steel tank which has been hot-dipped galvanized.

(*B*) Standard 91-pound commercial propane tank.

FIGURE 2.—The torch can be regulated as needed to obtain sufficient heat to ignite the piles.

FIGURE 3.—Stripping a juniper tree with the flamethrower. This photograph was taken in April. Humidity about 80 percent.

(*C*) Vaporizing cylinder made of 6-inch steel pipe, one-fourth inch thick. This cylinder serves two purposes:

(1) It permits carrying the propane tank on its side. Normally these tanks are used in an upright position, with liquid in the bottom and gas in the top of the tank. As the gas is withdrawn, the liquid is converted to gas. When the tank is placed on its side, liquid is withdrawn, at least until the tank is half empty, making it necessary to convert the liquid back to gas. This is done by means of the vaporizing cylinder C. The liquid is withdrawn from tank B and enters the bottom of the vaporizing cylinder. The gas is withdrawn from the top of the cylinder.

(2) The freezing of liquid gases is in an inverse relation to the surface area of the liquid. Since both the commercial cylinder and the vaporizing cylinder lie on their sides, the surface area of the liquid is increased. No freezing occurred.

(*D*) Tool box.

The pump used to pump the diesel oil is the little ECO, 8-10 g.p.m. Top diesel oil requirement at full torch blast is about 2 g.p.m.; however, if the unit is to be used as a tank truck, a pump of at least 8-10 g.p.m. capacity is required. Neoprene rotors tend to swell when used to pump diesel oil. Flamethrower pumps should use the carbon rotors. All hose and hook-up lines are oil resistant.

When the flamethrower is converted to a tank truck, the carrier rack for the propane tank and vaporizing cylinder is removed and the water hose replaces the dual oil and gas hose.

The torch is 6 feet long with twin-control valves so that the propane and diesel oil can be regulated as desired. In use, a 6- to 8-inch gas flame is carried as a pilot light. The head of the torch is inserted into the piled slash, and the oil is turned on. In slash which is difficult to ignite, the torch can be turned on full blast (fig. 2).

On piled roadside slash, one barrel of diesel oil and one-half tank of propane appear to be sufficient for a day's operation when the piles are somewhat difficult to start; for example, piles covered with 6 inches of snow.

In addition to using the unit for slash disposal, the flamethrower has been used for stripping juniper trees encroaching on the range (fig. 3) and for winter burning sage and rabbitbrush. The area was then seeded with crested wheatgrass.

Further experimentation is planned this winter. The torch will be tried out as a means of thinning "dog-haired" ponderosa pine. It is believed that the flame is selective enough to strip the trees of needles. This will not only dispose of the hazard, but may prove to be cheaper than cutting the stems.

Further sagebrush burning is also planned. This will be done with the aid of a mist sprayer that can create wind velocities up to a hundred miles an hour.

TOTALIZING WIND COUNTER FOR CONTACTING-TYPE ANEMOMETERS

Division of Forest Fire Research, Intermountain Forest and Range Experiment Station

About 95 percent of the wind observations taken at fire-weather stations are recorded manually. The 1/60 mile contacting-type anemometers are used with a buzzer or a flashing light and a watch to count the number of contacts (fig. 1). Generally, this is done for a 2-minute interval three times a day, the results are averaged, and the afternoon wind is calculated. The other 5 percent of the wind observations are taken on Weather Bureau dial-type anemometers which mechanically sum the passage of wind during the afternoon period. This equipment is expensive, however, and could not be used at all fire-weather stations.

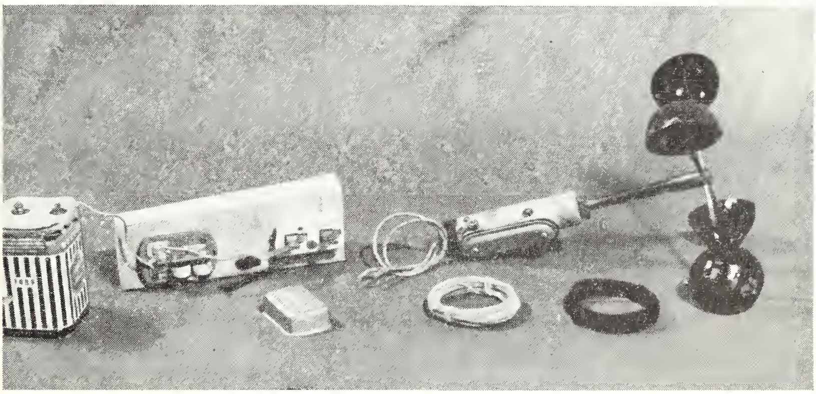


FIGURE 1.—Buzzer-type anemometer.

An equipment development project to modernize the wind measuring system at fire-weather stations was established. Incorporated in its objective was the desire to make the new system as automatic as possible, thus reducing the risk of human error. Also, the old buzzer or flashing light method is awkward to use and time consuming, which increases the chance of getting pseudo wind observations.

To meet all the objectives, an electrical system seemed the most practical. Mechanical methods must be used at the exact location of the anemometer, while an electrical circuit can be a remote operation.

Development History

The market did not have available suitable electric wind counters that were economical and could be used with the 1/60 mile contacting-type anemometers at fire-weather stations. The counting circuit needed to include certain features to be acceptable for lookout operations. The unit had to be operated by a dry cell, and it had to incorporate a means of saving current discharge when the anemometer was becalmed and the contact closed. Furthermore, the counter had to respond to wind speeds of at least 60 m. p. h., and it could not record the chatter found in all pressure-contact anemometers. The unit needed to be durable enough to withstand the climatic conditions at lookouts and fire-weather stations. Lastly, the components of the counter had to be readily available on the open market and inexpensive enough to make the replacement of the buzzer systems feasible.

Advice from electronic labs and private research firms was sought, but none of the suggestions proved acceptable. A cooperator proposed a counter that seemed usable. The circuit diagram and related information was passed on to the Forest Service Radio Laboratory at Beltsville, Md. They investigated the circuit and found it satisfactory, and they found several local manufacturers who could produce the counter for approximately $15. With this confirmation and the price low enough, the next step was to get the counters field tested.

During the summer of 1956, the California Forest and Range Experiment Station conducted a wind survey. The circuit diagram was sent to them, and they had 12 units constructed. The counters worked satisfactorily as long as an input voltage of 4.5 to 6 volts was maintained. Later the station built several units and placed them at fire-weather stations.

Several prototypes were built and tested for chatter reaction and endurance (fig. 2). The housing was a simple aluminum box 5 inches long, 3 inches wide, and 2⅝ inches deep. One unit was used by Montana State University's Wildlife Division on an elk survey, and the counter worked perfectly all winter, even at tem-

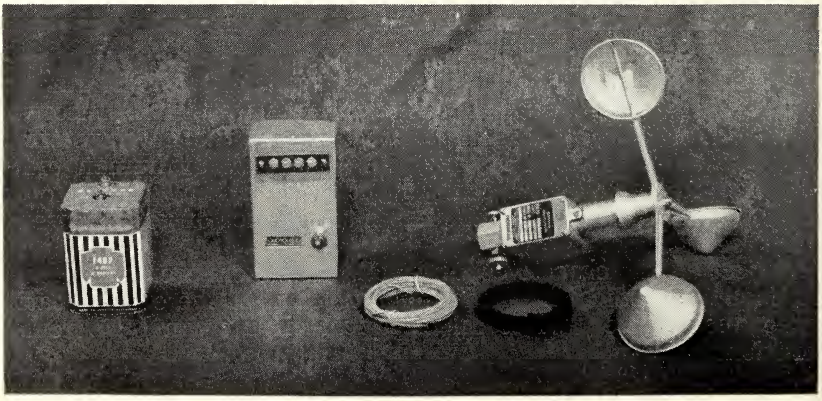


FIGURE 2.—Early model wind counter.

peratures as low as —38° F. During the summer, the prototypes functioned properly at maximum temperatures of about 95° F. Two counters were tested at the Priest River Experimental Forest against a single register recorder using the same anemometer. They were found to check perfectly. Laboratory tests proved the electrical circuit eliminated the danger of chatter or multiple counts. A variable resistor was used to compensate for line loss; however, later findings proved a booster battery worked better when the operating voltage dropped below 4½ volts.

During the summer of 1957, 12 units were built and tested. There were no failures. Twenty-two more were built and included in the instrumentation of the portable fire-weather station (fig. 3).

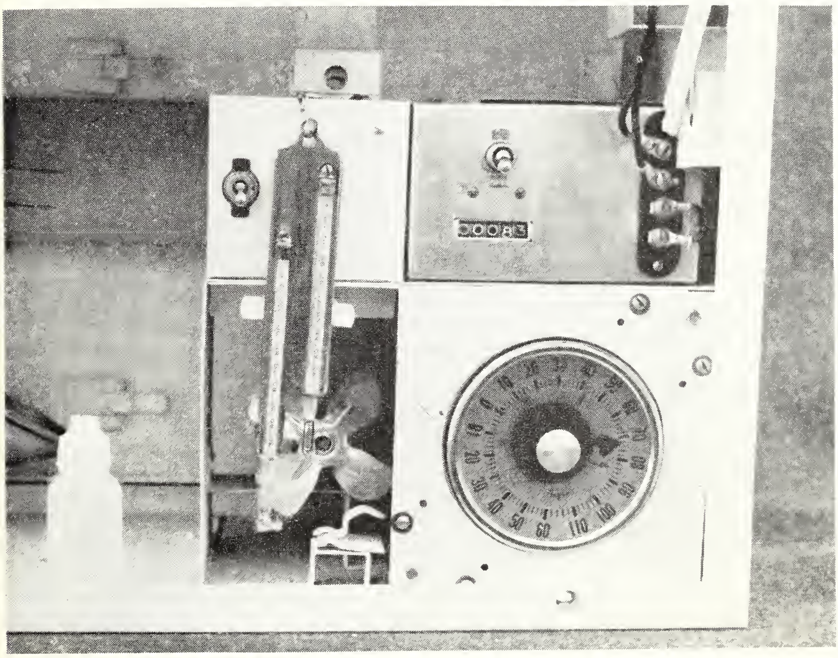


FIGURE 3.—Totalizing wind counter in upper right of portable fire-weather station.

Method of Observation

The totalizing wind counter does meet all the objectives stated earlier. The unit makes use of a simple electrical circuit which is dependable and inexpensive (estimated total cost about $15). Use of an automatic counter eliminates some of the human error involved in observations. These steps are followed when the wind counter is read:

1. Record the count and the time.
2. Turn the toggle switch to the *ON* position.

3. Let the counter run the desired length of time. The longer it runs, the more accurate will be the calculated afternoon wind.
4. Turn the toggle switch to the *OFF* position.
5. Record the count and the time.
6. Calculate the wind speed by dividing the elapsed count by the elapsed time in minutes. This will give the average wind velocity in miles per hour.

The total wind time used by the buzzer system is only 6 minutes. The totalizing wind counter can be run for several hours while the observer does his other field duties. A simple form would make the recording of wind velocity an easy matter with little chance of error.

Recommendation

We recommend that the totalizing wind counter be used at fire-weather stations instead of the buzzer or flashing light system.

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Intercommunications Equipment—An Aid in Fire Control

One solution to interstation communications problems is a modern, inexpensive two-way "intercomm" outfit. These systems of two or more units cost from about $12 on up and are simple to install and operate.

Where radio and telephone communications are frequently tied up with fire traffic, the intercomm units make ideal local substitutes. Units between offices, dispatchers, and work areas permit fire control personnel to be readily informed while going about their duties, thus freeing them to some extent to do other work during the critical fire periods. At other times, the units may be used for administrative purposes, increasing the efficiency of the organization the year round.—FRANKLIN O. CARROLL, *District Ranger, Apache National Forest.*

UNDERGROUND SOURCES OF WATER FOR FIRE SUPPRESSION

D. D. DEVET, *Assistant Supervisor,* and L. T. FENDLEY, *Assistant Engineer, South Carolina National Forests*

The Francis Marion National Forest, located on the Coastal Plain of South Carolina, has many bays and swamps. During drought periods, fires in the peatlike fuels of the forest require large volumes of water to control, mopup, and extinguish them. In the past, large sums had been spent hauling water to these fires. Yet, an abundant supply of water lies underneath the ground in the immediate vicinity of any fire.

To study the possibility of utilizing the underground water for fire suppression, the geology of the forest and local wells were studied and mapped. Tests were conducted by the Forest Service and by a commercial well-drilling outfit under contract.

FIGURE 1.—A 4-inch casing ready to be lowered by hydraulic method. The derrick is positioned and the well casing and washing nozzle are in place ready to start pumping operation.

The Forest Service used its own hydraulic equipment and employed methods similar to those developed in the Lake States for establishing shallow wells (less than 30 feet deep). Six test holes, from 12 to 26 feet deep, were made on the Francis Marion National Forest.

A trained crew can set up the hydraulic rig in 12 to 15 minutes (fig. 1). When the pump is started, the casing is rotated by two men with large pipe wrenches. This reduces soil friction on the outside of the casing and allows the casing to help cut its way into the ground. A fourth man, not shown in figure 1, raises and lowers the cutting bit and washing nozzle inside the casing while the casing is being lowered.

While the well casing is in the ground, the screen and suction pipe are lowered inside the casing until the tip of the screen reaches the bottom of the well. The casing is then pulled leaving the screen and suction pipe in the well (fig. 2). If water-bearing stratum has been penetrated, water will flow into the screen and rise in the suction pipe. The elevation to which the water will rise is governed by the hydrostatic head on the gravitational water in the water-bearing stratum, and the yield of the well is governed by the perviousness and depth of the water-bearing stratum.

Successful penetration of the deep layer of heavy clay underlying the sands required considerable time and large quantities of water. The equipment could not reach the hard, porous, and permeable marls and limestones—the water-bearing stratum. The yield of any single well was less than 10 gallons per minute and consisted primarily of surface seepage.

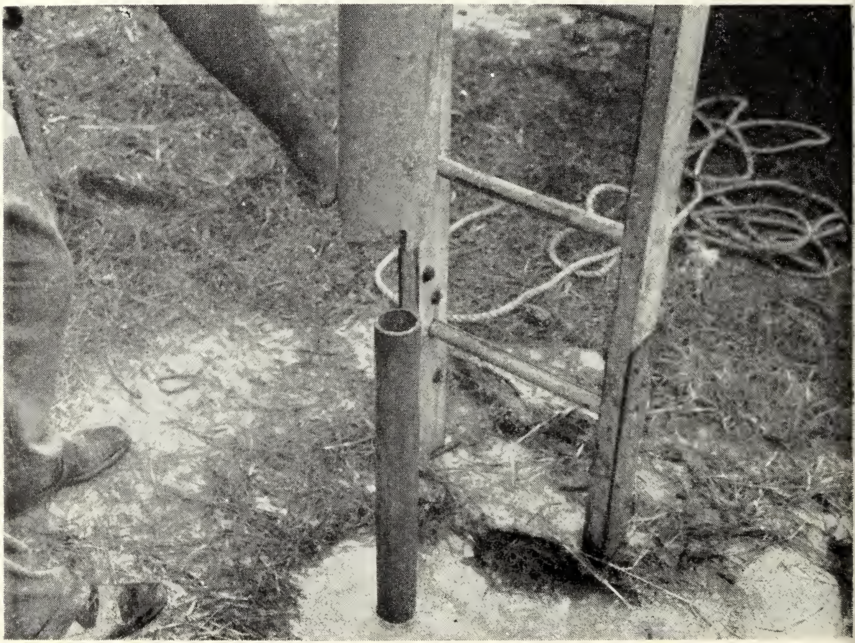

FIGURE 2.—Suction pipe and well screen placed in well ready for pumping.

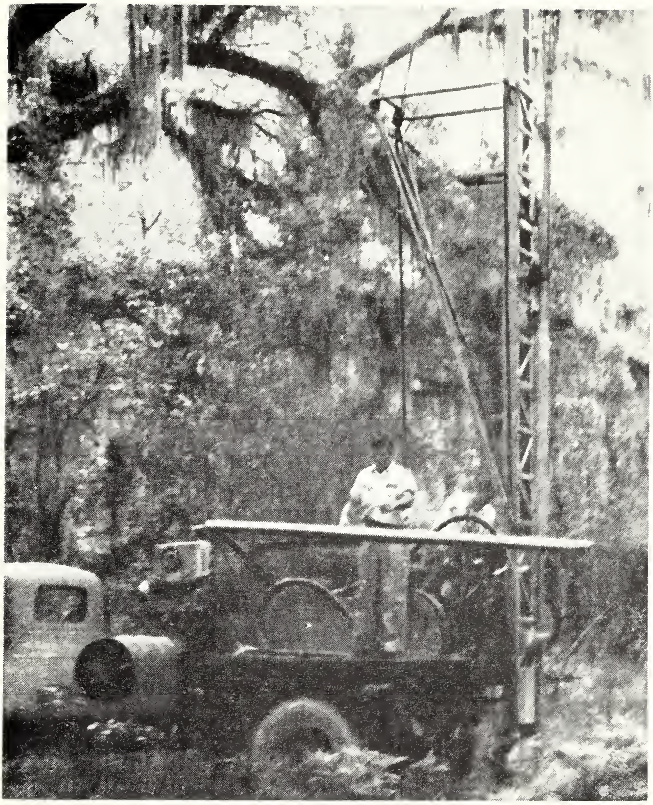

FIGURE 3.—Commercial drilling equipment in place.

A log of all wells drilled revealed that no formation above the hard rock would yield a sufficient flow of water for fire-control purposes. The average elevation of hard-rock formations on the Francis Marion (except for the extreme northwest corner) is about 40 feet below ground level. The average depth of water for fire-suppression use, 30 g.p.m. or more, is less than 10 feet in the hard rock.

A good well-drilling machine can drill through sand and clay formations and install 4-inch casing at a rate of approximately 35 feet per hour. The same machine can drill through hard rock at the rate of about 3 feet per hour. Once the stratum is reached, the hydrostatic pressure is sufficient to raise the water to a level within operating range of the suction pump. (The pump used for this experiment was a rotary type, positive displacement, rubber-gear pump, capacity—50 g.p.m. at free flow; approximately 30 g.p.m. at 200 p.s.i.).

The well-drilling equipment of the contract outfit gave better results in the tests. A mobile drilling machine was driven from Columbia, S. C., to the Francis Marion National Forest (a distance of 130 miles) in 2 hours and 50 minutes. It was set up ready for drilling, with cable tool, in 13 minutes (fig. 3). Excluding time spent for testing flow and soil stratum samples, this rig drilled a 4-inch well 39 feet deep in 2 hours. At this depth, a yield of 55 g.p.m. was measured without causing any draw-down in water level. One hour and 48 minutes were required to drill from a depth of 39 feet to a depth of 44.5 feet through hard rock. At this depth, a yield of 82.5 g.p.m. was measured without causing any draw-down in water level.

In addition to its effectiveness, commercial equipment could be moved from Columbia, S. C., to practically any well site on the Francis Marion National Forest within 3 hours, and set up and ready for operation approximately 15 minutes after reaching the well site. The average cost of the two wells drilled with contracted equipment was $240.

The results of the tests showed that the use of fast-drilling contract outfits for establishing wells needed for fire control has definite possibilities on the Francis Marion National Forest.

This preliminary work is part of a long-range plan to control all fires through an in-place system of wells and devices to suppress fires by water alone.

CANTEEN TEMPERATURES VARY WITH COVERING MATERIALS AND EXPOSURE

Arcadia Equipment Development Center, U. S. Forest Service

Opinion varies on the effectiveness of the present canteen covering. The attention a fireman gives his water container probably influences its temperature more than the type of either the covering or the insulation. When a canteen is checked out of fire camp in the morning and is carried with a dry cover exposed to the sun all day, the present type of cover and insulation, as such, serves little purpose. In fact looking at the problem from a cost standpoint alone, around 45 cents could be saved on each canteen by eliminating the covering. To improve Forest Service specifications for canteens, we have studied the effect of various covers on water temperature.

The 1-gallon canteen commonly used by the U. S. Forest Service is insulated by an inner blanket and a khaki duck covering. The general description of the current specification [1] requires "insulation to the extent practical so that . . . water will remain reasonably cool." The regulation cover also offers some advantages as a pad; however, this was not considered as a part of the study.

Three basic methods were used in studies to alter canteen temperatures: (1) insulation; (2) evaporation; and (3) reflection. Various combinations of the above means were also employed and observed.

Tests were conducted with 19 standard canteens, some having altered covers and insulation (table 1). Each canteen was classed into one of four groups: Sun (exposed to direct rays of sun broadside), and canteen either wet or dry; and shade (maintained in full shade entire test period), with canteen either wet or dry.

All canteens were rinsed and filled with water at 60°.[2] A 50-gallon can provided a source of water for the "wet" canteen groups, which were wet hourly. This water was allowed to warm by exposure to air temperature from 59° at the start to 89° by 1330. By 1630 hours the air temperature had lowered to 87°. The water temperature of each canteen was observed at 1-hour intervals beginning at 1030 and concluding at 1630 Pacific Standard Time, July 24, 1956. Air temperatures and relative humidity were also recorded (table 1). Wind direction was variable and ranged from 1 to 5 m. p. h.

For this test it was also agreed that an actual temperature was needed to serve as a breaking point between "cool" and "tepid" water. It was conceded that this value would vary widely with personal opinion but could serve for comparative purposes. After considerable discussion and actual sampling, 76° was selected as a reasonable figure for the purposes of this study.

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[1]Amendment No. 2 to U. S. D. A.—Forest Service—Specification No. 83, amended 3/18/58, on the one-gallon canteen: "The sides . . . shall be covered with a blanket material which has a minimum weight of 16 ounces . . . and recovered with an 8 ounce double filled khaki canvas . . . The material may be secured by a . . . steel retaining band, or by completely covering the body and sewing."

[2]All temperatures expressed in this article are in Fahrenheit.

TABLE 1.—*Temperature of water in individual canteens,*[1] *by exposure, type of covering and evaporative cooling, and time of day, July 24, 1956*

SUN

Hour (Pacific Standard Time)	Air temperature[2]	Relative humidity[2]	Standard canvas and blanket		Bare, dry	Foil and blanket, dry	Foil, perforated, wet	Foil and flock, wet
			Wet	Dry				
	°F.	*Percent*	°F.	°F.	°F.	°F.	°F.	°F.
1030	82	46	60	60	60	60	60	60
1100	82	46	64	61	62	62	62	62
1130	85	43	69	66	68	64	66	64
1200	86	41	72	70	74	68	70	68
1230	87	38	74	75	80	72	74	70
1300	88	38	76	81	82	77	76	72
1330	89	38	78	83	85	79	78	74
1400	88	38	79	87	89	82	81	77
1430	89	38	80	90	91	85	82	78
1500	89	38	81	94	93	87	84	80
1530	88	38	81	96	96	88	84	80
1600	89	38	81	96	96	90	84	81
1630	87	41	81	98	97	90	84	81
Difference from standard canteen at 1630					−1	−8	+3	0

SHADE

Hour (Pacific Standard Time)	Standard canvas and blanket		Bare, dry	Foil and blanket, dry	Canvas only, dry	Plastic sides, dry	Flock only, wet
	Wet	Dry					
	°F.	°F.	°F.	°F.	°F.	°F.	°F.
1030	60	60	60	60	60	60	60
1100	64	63	64	62	64	63	64
1130	65	64	67	64	65	66	66
1200	67	67	69	67	69	68	68
1230	69	70	71	69	72	71	70
1300	71	71	74	71	74	74	71
1330	71	74	75	72	76	75	72
1400	73	76	77	73	78	78	73
1430	73	77	78	74	79	79	73
1500	74	80	79	75	81	80	74
1530	74	80	81	77	82	82	74
1600	74	81	82	78	84	84	74
1630	74	82	82	78	84	84	74
Difference from standard canteen at 1630			0	—4	+2	+2	0

[1]"Tepid" canteen temperatures are those higher than 76° F.

[2]Standard weather observation, applies to both sun and shade exposures.

Canvas and blanket (a standard canteen, blanket lined and covered with canvas, meeting specification No. 83, 3/18/58).—The canteen that was wet hourly and maintained in the shade reached a maximum temperature of 74° at 1500 hours; it never exceeded 76°. The canteen kept dry and in the shade reached the "tepid" state by 1430 hours. The canteen kept dry and in the sun reached the "tepid" category between 1230 and 1300 hours and continued to rise to 98° by the time of the last observation, while the wet canteen in the sun reached a maximum of 81°.

If we then consider the effect on these four canteens as more or less typical and standard, all subsequent tests can be related to it as canteen coverings are removed or altered for the study. These differences are included in table 1.

Bare.—Both the canvas cover and the blanket liner were removed from standard canteens and the bare metal of the containers was exposed to sun or shade.

Foil and blanket.—The canvas cover was removed from these two canteens and replaced with aluminum foil held in place by the customary spun metal rim (fig. 1). No change was made in the blanket underneath. The results were more favorable than those of any other covering.

Foil perforated.—The canvas cover on this canteen was replaced by perforated aluminum foil held over the blanket insulation by a metal rim (fig. 1), and the canteen kept wet.

Foil and flock.—The canvas and blanket on this canteen were replaced by aluminum foil over a flock covering, and the canteen kept wet.

Canvas only.—The blanket insulation was removed in this test and only the standard canvas cover was retained over the metal. The container was kept dry.

Plastic.—The regular side covering was removed and replaced by green plastic sheet material cut to fit out of $\frac{1}{16}$-inch stock. These new sides were held in place by the spun metal band, and the canteen kept dry.

Flock only.—A green flock coating was substituted for the usual blanket and canvas cover, and the canteen kept wet.

Other tests were also run but these were not included in table 1. The canvas was removed from 3 canteens and they were ex-

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FIGURE 1.—*Left*, Foil and blanket cover. *Right*, Perforated foil cover.

posed with the blanket insulation only. Their temperatures ran from 1 to 3 degrees higher than those of the standard canteens. One experimental[3] fiberglas canteen which did not meet the construction specifications was also included as part of this study. It not only shattered on the first drop but reached the "tepid" category an hour before the standard dry canteen under shade and was 3 degrees warmer at 1630.

Conclusions

1. Drinking water can be kept at an acceptable temperature in the present standard canteen by the use of shade and evaporative cooling. Water temperatures actually increased for 4 hours to 74° and then leveled off.

2. If both shade and evaporative cooling are impossible, dry storage in the shade is more effective than wet storage in the sun since the water reaches the warm state an hour or so later. After 6 hours one dry exposed canteen approached 100° on a day with moderately high temperatures.

3. The value of evaporative cooling is greatly reduced in humid weather.

4. Bare canteens lacking any covering, influenced water temperatures in a manner similar to standard canteens when left dry and in the sun. The water in bare canteens, however, warmed faster and exceeded 76° generally in about 2 hours.

5. Canteens with dark, heat-absorbing covers reached the highest recordings and one canteen ran as high as 102° (data not included in table 1).

6. Aluminum foil, with its highly reflective characteristics, was used in various ways as a covering material. A "foil over flock" canteen maintained "wet" and in full sunlight had little advantage over the present canteen. A "perforated foil" container ran warmer and contrariwise "foil over dry blanket" ran 4 to 8 degrees cooler. "Canvas only," "plastic," and "flock only" appeared to hold little advantage.

7. Slight to significant advantages were gained by varying the type of insulation and/or cover materials. Some of these changes are minor, by themselves, but it may be possible to combine several modifications into worthwhile results. For example, hand-sewn covers appeared to encourage thorough "wetting" and better evaporation than those with metal bands or rims. Rubber cement, which is sometimes used in fabrication, tends to waterproof the material and reduce evaporation. Even the use the container has been put to seems to influence the porosity of the cover and changes the results slightly.

8. Tests indicate that the care and use of a canteen on a fireline or project influences the water temperature more than any particular kind of cover as may be required by specification.

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[3]Temperature is only one part of the canteen specification study under way. Burlap is being used as covers on certain commercial brands. The present metal galvanizing process may cause gastric disorders and its use with acid liquids, fruit juices, or coffee is impractical. Aluminum, stainless steel, plastic, and polyethylene have all been proposed. The use of a synthetic would probably lick the leaky cap "bugaboo."

BATTERY-OPERATED FAN PSYCHROMETER

Division of Forest Fire Research,
Intermountain Forest and Range Experiment Station

One of the three most important weather measurements taken at forest fire-weather stations is relative humidity. This information is obtained from a psychrometer, which consists of a wet- and a dry-bulb thermometer. Moving air past the moistened wicking of the wet-bulb thermometer causes evaporation; this in turn lowers the temperature reading of the thermometer. The difference between the wet-bulb and dry-bulb temperatures indicates the relative humidity, which is read from a table.

Most fire-weather stations measure humidity with either a hand-crank psychrometer or a sling psychrometer. Both types are manually operated. The hand-crank unit creates wind by using a hand-driven fan. The sling psychrometer uses a whirling motion to create the effect of wind. Both devices are satisfactory when used correctly, but they are susceptible to human error and may result in erroneous relative-humidity readings.

Hand-crank fans were designed more than 20 years ago. Since then, each renewal order has required special tooling by a contractor, for none of the components is available on the open market. Many tubes in the two sizes of sling psychrometers are broken by inexperienced field personnel, resulting in unnecessary cost and lost humidity information.

To modernize humidity-measuring instruments became a necessary task. A unit had to be set up, using easily obtainable components, that would (a) give long service at low cost, (b) supply consistent and reliable data by reducing the chance of human error, and (c) increase the ease of handling for the observer. A study of commercially produced psychrometers had shown that they were either too elaborate, too costly, or impracticable for servicewide use. It was then decided that working with the instruments available at the fire-weather stations would be the simplest and least expensive procedure.

The problem was to find a suitable substitute for the hand-crank fan. When using manual psychrometers, inexperienced field personnel often did not create enough wind for a long enough period to depress the wet-bulb temperature to its proper point. In order to have the maximum depression of the wet-bulb thermometer, a minimum air displacement of 12 feet per second must flow past the moist wicking. Any amount of wind less than that is likely not to lower the wet-bulb temperature to its correct value. This, of course, would give an erroneous relative humidity. To avoid this error, an electrical fan aspirator was needed.

In the spring of 1955, several types of small electric motors were bought and tested along with different makes of fan blades. The combination blade and motor, in addition to its ability to displace a minimum of 12 feet per second air movement past the wicking of the wet-bulb thermometer, had to be powered by a 6-volt dry cell, have a low current drain, and have long life under severe field conditions.

During the first tests, electric timers were used to run the motors for 2-minute periods; however, timers were later abandoned as impractical for field purposes. Some motors were rejected because they used more than 1.5 amperes; the dry cell drained too fast. Others were eliminated because they did not operate efficiently in a voltage range of 4 to 6 volts; this stipulation was necessary to ensure proper air flow even when the battery was old and weak.

Further testing proved that the motor bushings had to be metal or nylon; they wore quickly otherwise. Motors with cardboard or fiber bushings were rejected. Several motors functioned well but were not completely encased, thus making them susceptible to weathering. Others had spring-metal brushes, which appeared less desirable than carbon or silver-graphite brush tips.

Several types of fan blades were tested. A 4-bladed fan, clockwise rotating, plain finish, with an overall diameter of 3 inches, proved to be the most suitable. The hub of the fan blade did not fit the motor shaft; however, a special bushing corrected the situation. Other blades that fitted the motor shaft could be purchased, but the one chosen was the most economical.

By the winter of 1955, a motor and fan blade combination was decided upon as a result of the tests. Since the electric aspirator fan was to replace the hand-crank fan on standard psychrometers currently used, a "Fan Psychrometer Conversion Kit" was developed. This kit consisted of an installation template, an electric motor, a fan blade and bushing, an aluminum mounting, a toggle switch, screws, and appropriate wiring. After removing the hand-crank fan from the wood base, field personnel could mount the new unit with the aid of the installation template. A 6-volt dry cell was the power source. In the spring of 1956, the Forest Service warehouse in Spokane, Wash., made 25 conversion kits for Regions 1 and 4. These units were tested that summer; all worked satisfactorily.

A method was described for converting a sling psychrometer into a modified standard USFS fan psychrometer unit. In addition to the kit and psychrometer, only a wood baseboard, a piece of ½-inch strap iron, and a water bottle were needed. The installation template gave the proper relationship of the fan unit, the water bottle, and the psychrometer tubes. After preparing the wood base, the procedure was to mount the sling psychrometer on the metal strap, then screw the psychrometer unit and the fan unit to the wood base. Complete directions were included in the installation kits.

A second order of Fan Psychrometer Conversion Kits was made in the spring of 1957. More than 250 units were field tested that summer. During this time, sling psychrometers or hand-crank psychrometers were converted to battery-operated fan psychrometers; no completely new fan psychrometer units were purchased. The only failure occurred in the cracking of one plastic motor housing.

The battery-operated fan psychrometer has proved successful in field tests for two fire seasons. Laboratory tests showed that the fan blew more than the required amount of air displacement even when the operating voltage dropped to 4 volts. Endurance tests were made with the unit running continuously for 8 hours. Then the motor was tested by running it from an OFF position to maximum speed 1,500 times. The results of the endurance tests proved that the electric fan unit is sturdy and can have long life with proper care. A very small drop of oil on the bearings assures proper maintenance.

The battery-operated fan costs less than the hand-crank fan. All the components, except for the aluminum mounting, are avail-able on the open market. An entire setup, including a modified sling psychrometer, can be assembled for approximately $10. The Fan Psychrometer Conversion Kit costs about $4.50. Successful field use points to the advisability of replacing all hand-crank fans with electric fans, and converting sling psychrometers to battery-operated fan psychrometers.

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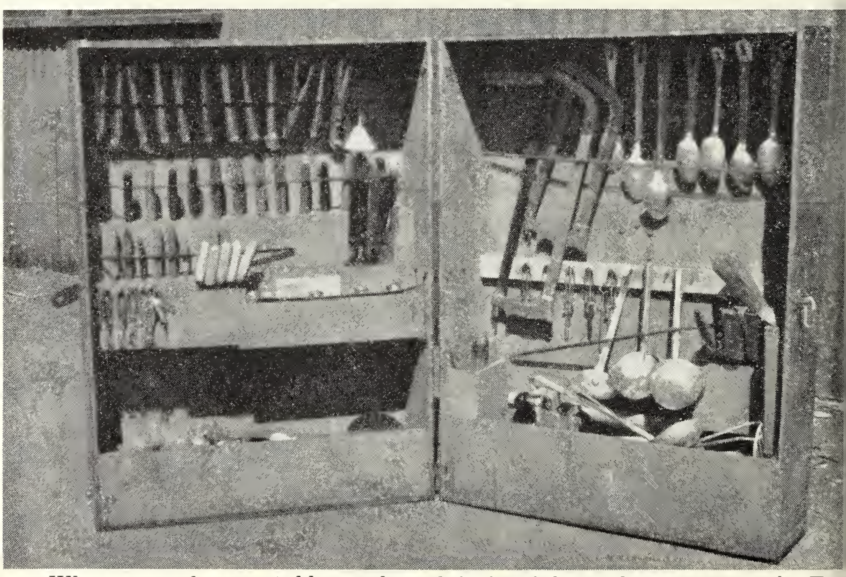
Box for Kitchen Tools Used in 300-Man Fire Camp

This box is made of ½-inch exterior plywood, and uses glue and # 1¼-inch flatheaded screws on all joints. These joints are covered with meta edgings. The box is 31 inches long, 17 inches wide, and 43 inches high. Cut in the center and hinged in back, it provides two 8½-inch compartments (outside measurements). A 6-inch hasp in front and handles on each side make for easy loading. Hinges, handles, and hasp are put on with flatheaded stove bolts.



When opened on a table, each tool is in sight and easy to reach. Tw bottom compartments hold such tools as potato masher, large can opener and skimmer. Slotted compartments are for butcher knives, paring an vegetable knives, spatulas, ice picks, meat forks, and cleavers. Cup hook on cleats at top and in center are used to hang pot lifters, soup ladles, cookin and serving spoons, peelers, meat saws, etc. There is room also for salt an pepper shakers and sugar dispensers.

Screen door springs stretched over hanging tools hold them in plac while in transit. The exterior should be painted red; the interior given natural finish and oiled.—DAVID M. EDWARDS, *C & M Craftsman, Sa Bernardino National Forest.*

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.


Smokey's
Commandment
THOU SHALT
NOT DESTROY
THY FORESTS
Remember–
Only you can
PREVENT
FOREST FIRES!

OL. 20 APRIL 1959 NO. 2

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 2

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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INDIVIDUAL DEVELOPMENT: POWERHOUSE FOR SUCCESSFUL FIRE CONTROL

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Saving and protecting human lives, natural resources, and private properties of great value—these are the Nation's continuing objectives in fire control. Each of us is bound to these objectives—through our work, beliefs, and respect for the people in the fire-fighting organizations.

A hard-hitting, successful fire combat team is made up of highly trained and developed individuals. Training gives the basic experiences in instruction, learning, and doing to meet basic job requirements. Development includes continuous training but goes far beyond it—

To help an individual reach his maximum capacity for service on a job.

To prepare him for greater responsibilities through widened perspective and experiences that broaden understanding.

To change attitudes.

To deepen the sense of responsibility for aiding the development of others—through good supervision.

To inspire self-development—from which all of the above actions must start.

One of our greatest sources for increased fire manpower—without employing more people—is to increase the competence, the understanding, and the skills of those now in our respective organizations. And actually this increase in power can be quite a simple and effective process—if we want it to be:

It starts with setting a personal *individual goal*—to be the best lookout, a highly competent fire dispatcher, the best "fire general" in the unit, a highly skilled research scientist or staff specialist in fire control.

It progresses by following a considered trail, which charts how the man and his employing service can work toward that goal through self-improvement and good supervision.

These steps require joint action between the man and his supervisor—leading to increased competence and satisfying careers. The results will provide added manpower—critically needed in the complex years ahead.

Devising an individual development plan takes analysis, which is hard work. But a firm start can be made with purposeful friendly discussions between the supervisor and the individual. Such talks give the supervisor a chance to gage the individual's strong points based on performance—the opportunities for improved performance—experiences gained or needed—skills in need of sharpening—additional knowledge required for a new assignment—encouragement for study in a new subject. To be most useful these discussions should lead to a simply written individual training or development plan. Here are some of the points to consider in preparing this plan:

1. What are the training or development objectives (instruction in crew leadership, aerial operations, line construction, fire boss responsibilities)?
2. Who can best help—instructor (crew foremen, dispatcher, staff fire specialist)?
3. How to best do it—method (field demonstration, technical study, seminars)?
4. When—sequence and timing (during fire season or nonfield season)?
5. Where—place of training (on-the-job, training school, university)?
6. Provision for followup (field inspections, discussions on progress, encouragement in further reading and special studies).

These individual plans form a basis for preparing a broad development program for each work unit—because they reflect individual needs.

With a copy of the plan in hand, the man has set down, through joint analysis with his supervisor, some personal goals for self-development. These goals become shared values. His organization establishes the scheduled opportunities and facilities to help reach them. These are acts of good supervision—for which there is no substitute. But the will of the man to learn, to grow, to improve by inspired leadership—this is the core of personnel development.

Here then is the dynamo. The individual, generating self-created power, gains momentum with job counsel, coaching, and systematic planning of broadening experiences. For example, older and more skilled personnel can be assigned to take instructor courses or to plan and lead fire schools—or join the Toastmaster's Club to improve speaking skills—or be appointed to serve on inter-unit work committees or inspection teams.

In the Forest Service, with the personal leadership of our Chief and our Director of Fire Control and with strong field support, a substantial start in this process is underway. Our results to date show promise. In essence, we believe that skillfully *planned* investment of time with our people in training and development is needed now—to insure an effective operation in the future. We will welcome the ideas, the questions, and the thinking of others in working toward a mutual goal—achieving the best possible administration of the fire services with competent and inspired people who can travel along highly productive and satisfying careers.

THE NATIONAL FIRE TRAINING FILM PROGRAM

E. M. BACON
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Training is essential to insure the availability of competent personnel for fire control work. Since stepped-up prevention efforts reduce the number of fires, and more adequate manning and effective suppression reduce the size of fires and acreage burned, training must increasingly supplement extensive experience.

One phase of the accelerated training effort in fire control has been the development of a national fire training film program. Many diverse fire control subjects are suitable for training films. Establishment of a training film program and determination of subject priorities has been made difficult for that reason. A factor bearing on this is the level of fund allocation for such a program, which competes with other fire control needs and fire training approaches. The final decision on subject coverage in the film program was made following review and comment by Forest Service regions and stations. Priority was assigned to fire behavior training and the tactical use of aircraft in fire suppression.

The Fire Behavior I Series is designed for fire crewmen and foremen in initial attack. Series II includes more advanced instruction dealing with fire behavior factors in large fire suppression. In addition to the national program, regional film production of subjects having local application will continue.

This plan for fire control training films will insure orderly development designed to meet existing needs on a priority basis within the limits of funds allocated to this work. Development is not yet complete. The more complex fire behavior relationships will require research not only to obtain a more clearcut understanding of these relationships, but also to determine the best techniques for film presentation. As these progress and as changes in needs and priorities occur, adjustments will naturally follow. Still, in this program we have a longer look ahead; a charted course that will constitute both a mandate for action and a specific plan to meet objectives in fire training.

Film Title	*To be completed in fiscal year—*
1. Prescribed Burning in the South	1959
2. Fire Equipment—Plows	1959
Fire Behavior I Series	
3. Introduction	1959
4. Current Weather	1961
5. Fire Behavior Principles	1961
Fire Behavior II Series	
6. Fire Weather	1962
7. Advanced Fire Behavior	1962
8. Safe Practices in Fire Suppression	1960
9. Slash Disposal	1960
Air Attack Series	
10. Helicopter	1960
11. Air Tankers	1960
12. Fire Prevention Methods	1961
13. Snags Can Kill	1962
14. Suppression Tactics	1962
15. Fire Danger Measurement	1963
16. Fire Danger Rating Application	1963
17. Air Traffic Control, Management and Operation	1963

THE FIRE CONTROL TRAINING PROGRAM OF THE NORTHEASTERN FOREST FIRE PROTECTION COMMISSION

Arthur S. Hopkins
Executive Secretary

The Northeastern Forest Fire Protection Commission was created by an interstate Compact approved by the Congress and ratified by the six New England States and New York in 1949. Its purpose was to promote effective prevention and control of forest fires on a mutual aid basis in the 43,000,000 acres of forest land within the seven Compact States.

At its first annual meeting, the most significant action taken was the establishment of a technical committee composed of the seven State Foresters to supervise its training program. The program was to be designed to make it possible for the Commission, on short notice, to assemble from the several States uniformly trained overhead personnel capable of functioning as well-coordinated, smoothly operating teams to handle large fires anywhere in the region. Small or normal size fires were deemed to be the responsibility of the States.

This objective differed widely from that of the training programs of the several States in that it was to be confined to the training of overhead personnel in fire control organization, methods, and techniques. State administrative paper work, law enforcement, fiscal regulations, etc., were not considered to be a responsibility of the Commission but that of the particular State in which a mutual aid team might be called to operate.

It was out of the question for the Commission to hold training meetings in all the States. Some method of training on an interstate basis had to be developed, through which the training could be carried back to each separate State.

Interstate training sessions lasting 3½ days are held annually in February. The subject matter is prepared in lesson plan and narrative form and presented by the Compact training team to about 40 trainees. These men are State fire control officers of the district chief or ranger grade. The trainees are trained to act as training officers in their own States. It was early recognized that the States that were most aggressive in in-state training would benefit most from membership in the Commission.

In developing its training program, the training team has worked out a unique and practical procedure of assembling and presenting its material in complete and noncontroversial form. At the start it was thought possible to rotate the training team members from year to year. However, as the project proceeded, it was evident that a background in previous lessons was essential and that the trainers greatly improved the quality of their subject matter and the manner of presentation as they became more experienced. The training team now consists of one or two representatives of six of the States, two or three from the Forest Service, and the Executive Secretary who, with one of the Forest Service members and a State Deputy Commissioner, act as Advisors. The procedure is as follows:

1. Subjects are determined and assigned in late spring or early summer at a preliminary meeting of the team. This gives each member time to do some work on his assignment before the final preparatory meeting.
2. The team and advisors meet in the offices of Region 7 of the U. S. Forest Service in Upper Darby, Pa., about December 1 of each year for a period of a week or more.

   At this meeting the lesson plans and narratives are prepared. The team members work at a large table and when one member has completed the first draft of his subject, he reads it to the others who discuss it in detail and may offer suggestions for changes.

   The member then redrafts his material to make it conform to the consensus of his teammates. The draft is then read and rediscussed. A third draft is sometimes necessary. When agreement among all the members is reached, the draft is submitted to the advisors and discussed with them. If substantial changes are then indicated, the whole process is repeated, i.e., from team members to team advisors.

   When fully approved by everyone, the material is processed for mimeographing and inclusion in the lesson material for the next winter meeting to be held the following February.

   This procedure results in resolving differences of opinion and produces material which can be applied throughout the region or wherever similar conditions are found.

This "Teacher Training College" approach has worked out exceedingly well and the combined in-state programs of the various States now reach over 1,000 individuals and groups annually. In these in-state sessions the material presented by the trainee teachers is tailored to the capabilities of the particular group attending.

For example, in one State woods industry employees, such as foresters, camp superintendents, and woods foremen, are trained in the line overhead jobs only. In another, where the National Guard is under orders to provide food and quarters for fire fighters, its officers have been trained in the appropriate jobs in the service section. State personnel, both fire control and others, are also similarly segregated for training purposes in accordance with their experience and ability.

In order to make its lesson material more available, the Commission published in 1954 a "Manual for Fire Control Organization" for reference use. This has had wide distribution in the

United States, Canada, and overseas. A second manual, "Forest Fire Fighting Methods and Techniques," is now on the press.

The standardization of fire control organization and methods brought about by the Commission's training programs and manuals has enabled the fire control personnel of the Compact States, when confronted by similar conditions of fuel, topography, wind, and weather, to think alike, plan alike, and act alike on the fireline.

SUMMARY

1. The Commission has established for its area uniform procedures for the suppression of both large and small fires.

2. By cooperative training, it has built up an interstate organization of high esprit de corps available to handle forest fire emergencies in any of the Compact States.

3. By in-state training, it has brought about a progressive improvement in the efficiency of the fire control job generally.

4. The Commission has proved beyond a doubt that interstate cooperation in forest fire control, and especially in training, is possible and very much worthwhile.

COMPACT FIRE TRAINING COMES TO THE SOUTH

S. D. BEICHLER
Chief, Forest Protection Section, Southern Region, U. S. Forest Service

The Interstate Compact idea is not new. Interstate Compacts have covered many activities for many years. However, Compacts in the field of forest fire prevention and control are comparatively new. The first such, the Northeastern Forest Fire Protection Compact, was authorized by Act of Congress in 1949 and has been active ever since. This embraces the States of Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont.

An act of Congress in 1954 authorized establishment of the Southeastern Interstate Forest Fire Protection Compact. This embraces the States of Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia. It was subsequently ratified by the legislatures of all the concerned States and has been active ever since.

This 1954 act also authorized establishment of the South Central Interstate Forest Fire Protection Compact embracing the States of Arkansas, Louisiana, Mississippi, Oklahoma, and Texas. This too has been ratified by the State legislatures and has been active.

The purpose of these Compacts is to promote more effective forest fire prevention and control through integrated fire planning and to facilitate mutual aid among the compacting States. Provision is made in each case for an annual Compact meeting.

In addition to adopting a Compact fire plan, the Southeastern Compact voted to prepare and adopt a Compact fire organization manual. A manual committee was appointed and, working with representatives of the Division of State and Private Forestry, Region 8, U. S. Forest Service, prepared and published a forest fire manual. This was intended to be an organizational manual covering organization buildup from the small one-or-two-crew fire to the large campaign-type fire. Its purpose was to foster mutual understanding and agreement as to organization, responsibilities, duties, etc. Much use was made of material from a number of sources, including a similar manual prepared by the Northeastern Compact and material of several of the Compact States. The manual was published in February 1957. At the 1957 annual meeting of the Compact it was voted to hold a Compact-wide training session on the manual itself.

Borrowing from the experience of the Northeastern Compact, a training team was set up composed of one member from each Compact State, along with representatives of the Region 8 Division of State and Private Forestry. An agenda was worked up for a 3-day session covering all sections of the manual. Topic assignments were made to members of the training team, along with suggested format for lesson plans, and time allotted for presentation. Each member then wrote up his material and prepared training aids. A "dry run" of the program was held in May in the regional office at which time final changes and polishing put the material in the form in which the team agreed it should be. An effort was made to use as many different types of training aids as were adaptable. All lesson plan material was reproduced and assembled in individual binders to be given to each trainee at the beginning of the session.

The training session was staged in August with a total of 58 registered, including training team, trainees, and observers. These people represented nine States, two national forests, the Northeastern Compact, U. S. Weather Bureau, Forest Fire Research, the Chief's office, and two regional offices. The consensus was that the session was well worthwhile and did much to promote understanding of big fire organization and to effect standardization among different organizations.

Subsequent to the session, similar in-state training sessions have been held by a number of States. It is hoped that these are forerunners of a series of profitable Compact-wide training sessions.

FIRE CONTROL TRAINING IN GEORGIA

James C. Turner, Jr.
Chief, Forest Fire Control, Georgia Forestry Commission

Disastrous project-sized forest fires raged through drought-stricken north Georgia in 1952 and south Georgia in 1954 and 1955. Thousands of acres of timberland were consumed by the raging flames before willing but uncoordinated government, industrial, and other fire fighters finally contained the fires.

These destructive fires vividly emphasized the need for prearranged, coordinated plans for use against fires that are severe enough to require the combined efforts of State, federal, and private forces to contain them. The men and equipment had proved themselves willing, competent, and adequate, but unified direction was needed to utilize them quickly and efficiently.

Plans were made after the 1955 fires to start classroom work on fire fighting organization. Field drills to apply the classroom work were also set up; practice in the field, without the stress of a going fire, was an urgent need. Fire fighting manuals of the Northeastern Forest Fire Protection Commission, the U. S. Forest Service, and others were studied to obtain a southern organizational plan. Georgia observers also journeyed to other southern States to watch their fire fighters conduct field exercises.

The first classroom instruction began in 1955 at the Forestry Commission's state-wide training school at Rock Eagle 4-H Center. District foresters and State headquarters personnel taught classes on the fundamentals of fire organization. In 1956 an actual fire camp using the organization outlined in the Southeastern Interstate Forest Fire Protection Compact commission manual was set up at Rock Eagle. Commission personnel were conducted through the camp and the duties of each fire organization position were explained to them.

The Forestry Commission followed up that summer session with an actual field exercise in November 1956. A complete fire camp and suppression organization utilizing key plans, service, and line positions was set up in Jones County on pulp company property. The exercise was conducted from start to finish with the same sense of urgency that an actual fire calls forth.

One hundred twenty selected county forest rangers, district office fire control personnel, fire investigators, and State fire control headquarters personnel participated in the problem, which lasted 2 nights and parts of 3 days.

"Operation Dead Out," as it was called, required that a crew comprised of Commission personnel relieve at dawn a theoretical crew that was already battling the fire. Camp was established the first afternoon and a "fire" line, following the boundary of the pulp company land, was marked so that fire fighters would have a definite fireline the next day. All personnel met to hear the problem, which was then given to the fire boss. He met with the plans, service, and line bosses to organize the men into their various key jobs in each section of the fire organization. The service and plans sections then began to print maps of the "fire" and assign tractors and vehicles so that the problem could become quickly operational the following morning. They operated from the mobile communications trailer (fig. 1).

FIGURE 1.—Headquarters trailer was nerve center of "Operation Dead Out."

The men rose early the following morning and replaced the theoretical crew on the "fire" line at 6:00 a. m. Each major position of the line, plans, and service sections was assigned an umpire, who not only made notes for the post-exercise critique, but also submitted various operational problems during the exercise to the bosses assigned to him. These problems were typical situations which arise in the course of an actual fire, such as vehicles running out of fuel, breakovers, equipment breakdowns, injuries to personnel, or requests for maps. Personnel involved went through all the steps necessary for their problems' solution. The problems were submitted to the crews on the fireline so that the chain of command upwards could be exercised in requests for help, in giving orders, and in shifting personnel and equipment. This method provided more training for all involved and insured the complete functioning of the organization.

Following a simulated large breakover which required a major realignment of both reserve personnel and those on the fireline, the problem was declared over. Smoke bombs had been set off during the day to mark smaller breakovers and add to the realism. Law enforcement personnel assisted in traffic control and apprehension of simulated arsonists. Air patrol was flown by Commission pilots, who used blocked-off highways for landing strips (fig. 2).

The men were fed from a field kitchen (fig. 3). Lunch was delivered to the crews in the field. All hands slept in tents provided by the Commission from its emergency warehouse at Macon. Camp was dismantled the second morning and the men returned to the Georgia Forestry Center at Macon for a detailed critique. Each umpire reported. The bosses of the segments of the organization who had an umpire were allowed to make rebuttals. The men all agreed that the field training was invaluable, so plans were begun for five bi-district field problems in 1957.

In November 1956, State foresters and fire control chiefs from throughout the South approved the manual of the Southeastern Interstate Forest Fire Protection Compact commission. "Dead Out" had already followed the manual closely in its setup and execution. Subsequent Forestry Commission field problems would do likewise.

FIGURE 2.—Commission pilots landed on blocked-off highway during "Operation Dead Out."

The 1957 series of field exercises lasted a day and a half each. They opened with afternoon camp erection and briefing. Actual field work took place the next morning and critique and camp breakup followed in the afternoon. Approximately 110 men participated in each problem. They came from all agencies represented in the district fire committees, including the Georgia Forestry Commission, U. S. Forest Service, U. S. Corps of Engineers,

FIGURE 3.—County rangers served as cooks on "Operation Dead Out," November 1956. Range is located in kitchen trailer.

U. S. Army, U. S. Fish and Wildlife Service, National Park Service, Lockheed Aircraft, pulp mills, sawmills, land companies, and individual landowners. The district fire committees are the heart of the fire fighting organizational system, for they are composed of representatives of government agencies, industry, and individuals who possess forest fire fighting equipment and the desire to join forces with the Commission should the need arise.

Positions of authority were divided on each exercise among the participating groups, except for the fire boss, who was always a Forestry Commission district forester. In most cases, personnel from the organization on whose land the "fire" was being fought were assigned to the fire boss as staff advisors. Umpires checked personnel as before and submitted individual problems to them for solution (fig. 4). The umpires were experienced fire fighters who were more familiar with the organization than were the men they worked with. Thus, they were able to furnish sound constructive criticism, or praise when it was merited. Critiques again followed each exercise (fig. 5).

Camp facilities, including mobile headquarters and field kitchen trailers, portable radio antenna, water and lighting systems, service and fuel trucks, supply trailer, tents, cots and sleeping bags, were furnished by the Commission from their emergency stores at Macon. The kitchen had a daily capacity of 1,000 meals.

FIGURE 4.—Simulated repairs were made on fireline in Treutlen County, August 1957.

Air patrol planes and pilots were provided by the Commission. Ten to twelve fire suppression tractors furnished by state and orest industry were used by the line sections at each exercise. The exercises were organized on the basis of three sectors, each f which was manned by three tractor units. Specialist crews perated bulldozers and chain saws. Service, plans, and supply ersonnel operated out of the camp headquarters.

The exercises functioned smoothly and without injury to the ien despite rain, dust, fog, and temperatures that ranged from elow freezing to almost 100°F. Camp sites were located in Wayross State Forest, on private property in Treutlen County, on J. S. Forest Service and pulp company property in Dawson ounty, and on pulp company land in Jones and Worth Counties.

Morale was high and all hands agreed that invaluable insight nd experience were gained in the problems of directing large umbers of men and equipment against a big fire. Flaws in equipient operations and the execution of problems were revealed. hese could be remedied at later study sessions.

In 1958, key Forestry Commission personnel were selected to ach classes on the Southeastern Compact commission manual in very forestry district. Beforehand, the instructors attended a

FIGURE 5.—Commission Fire Chief J. C. Turner, Jr., presided over Treutlen post-exercise critique.

training school taught by Commission and U. S. Forest Service personnel who had attended an earlier regional Southeastern Compact commission training session. The 1958 schools also included critiques and analyses of the 1957 field problems. Plans are now being drawn by Forestry Commission fire control chiefs for another series of field exercises which will give further training in the operation of the fire fighting organization prescribed by the Southeastern Interstate Forest Fire Protection Compact commission manual.

OPERATIONAL AND SAFETY TRAINING FOR SMOKEJUMPERS

DIVISION OF FIRE CONTROL
Region 1, U. S. Forest Service

Smokejumping has become recognized as a very essential part of our fire fighting organization, as indicated by the expansion of some of our present units and the development of a new station by the Bureau of Land Management in Fairbanks, Alaska. The Bureau of Land Management has requested Region 1 to recruit and give refresher training to a 16-man crew to be transferred to them in time for the 1959 fire season. The plan is to recruit experienced jumpers from Regions 1, 4, 5, and 6 to fill this crew. The Bureau of Land Management will, in the future, establish a training base of its own in Fairbanks.

The Missoula unit also recruits and trains a 24-man crew for basing at Silver City, N. Mex., from early May to July 15 during the peak of Region 3's fire season. This crew is normally composed of jumpers from the combined regions and headed up by a smokejumper foreman from Region 3. The Region 3 season is such that these jumpers can report back to their respective home regions for the peak fire season there.

Region 1 has maintained its Missoula unit at 150 jumpers. Thirty-three States, Canada, and the Hawaiian Islands were represented among the trainees in 1958. A majority of the recruits are college students representing numerous fields of study; forestry students are most numerous.

The type of individual desired for the smokejumper job is a self-reliant one, accustomed to rugged outdoor life with at least one season of forest fire fighting experience and a good recommendation from his former supervisor. There are strict physical requirements, and the recruit must pass a physical examination. Even then, some of the recruits lack the coordination and physical ability to make the grade as jumpers and are washed out in training.

PARACHUTE TRAINING

New smokejumpers receive intensive physical and mental conditioning during their 4 weeks of training. Prior to the first jump, the training is directed toward two major objectives. The first of these is to have the individual in top physical condition. This is accomplished by regular calisthenics and running before breakfast. The second major objective is mental conditioning, instilling confidence and know-how in the individual.

After completing the classroom and orientation phases of training, the new jumpers spend 32 hours on the parachute training units. They spend 4 hours a day learning the techniques they will be using while making actual jumps.

The parachute training consists of four phases; namely, the mockup, letdown, tower, and Canadian swing landing trainer. Training received at the mockup includes practice exits from replicas of aircraft, learning to steer and handle the parachute, ground-to-air signaling, and suiting up within the aircraft. At the letdown, the trainees learn how to get down out of trees safely via a 100-foot nylon rope which is carried in a pocket attached to the right pant leg. The emphasis is on speed, correct procedure, and safety. At the tower, from a height of about 30 feet, the men learn how to maintain proper body position when dropping from aircraft. The Canadian swing landing trainer has recently been employed to teach men how to hit the ground when landing. Physical conditioning is also stressed in the teaching of landings.

The parachute training is carried on in an individualized manner. Each trainee is helped and guided in accordance with his own particular needs and ability. Individuals are warned if they show weaknesses and additional time is often spent correcting them. Daily grades are kept for each phase. At the end of the training the weak trainee is placed at a job for which he is better fitted.

The instructors are all foremen and squad leaders with years of experience. The materials and methods taught have been standardized over the years and represent the most safe and efficient way of parachute jumping.

After the men have progressed from the parachute training units, they make seven practice jumps. The first is made in a large field. The jump spots get progressively smaller and more skill is required if the trainee is to land in them. The fifth jump consists of a timber jump where each jumper hangs up in a tree. After landing, they learn how to retrieve their parachutes from the trees. The seventh, or graduation jump is made under conditions much like those experienced in an actual fire jump.

The training is much shorter for smokejumpers with previous experience in this field. They receive 1 week of refresher training that includes 8 hours on the parachute training units; they make two parachute jumps during this week. These men are required to report for work in good physical condition.

The equipment that is used for jumping is continually being improved. Two parachutes are used at all times. One of these is a standard 24-foot-diameter chest-type parachute which is used only in case of emergency and is manually opened. The other is the 28-foot-diameter back-pack parachute which is opened by means of a static line attached to a cable within the aircraft. This parachute opens within 2 to 3 seconds after the jumper leaves the plane. A 32-foot-diameter parachute has been brought into use recently. This parachute decreases the rate of descent but in strong winds has a tendency to be harder to handle. However, it has good possibilities.

The smokejumper suit consists of a pair of trousers and a jacket constructed of heavy canvas duck. This suit is well padded in the critical areas. A heavy webb strap has been incorporated into the trousers. This strap fits under the instep of the boot and forms a loop up into the crotch area.

A regular football helmet with a wire mesh mask attached is used for headgear. The nylon letdown rope is carried in a pocket attached to the trouser leg. The parachute harness is constructed of heavy nylon webbing.

FIRE TRAINING

Smokejumper fire training is accomplished simultaneously with the parachute training to break up the monotony of just one phase of training. The time each day is divided equally between the two phases.

New jumpers are subjected to 84 hours of fire training (lecture and field time inclusive) basically designed to fully train even an entirely green individual to the minimum standards of a skilled smokechaser. The variety of previous experience of men from different parts of the country makes it necessary to so plan the fire training phase. Additional time up to 16 hours is devoted to bringing the slower individual to the desired level of performance. If he fails to meet this standard he is released from the project.

Individual fire training classes consist of the following:

Safety, 4 hours
Smokejumper behavior, 4 hours
Tool instruction and demonstration, 8 hours
Orientation lecture, 4 hours
First aid, 8 hours
Fireline building instruction, 4 hours
Snagging, 4 hours
Spur instruction and cargo retrieving, 8 hours
Maps, 4 hours
Area compensation and pacing, 4 hours
Compass, 4 hours
Woodsmanship, 4 hours
Radio training, 4 hours
Fire suppression lecture, fire behavior and escape, 8 hours
Rescue and litter training, 4 hours
Practice fire suppression, 8 hours, with additional time if needed.

The 4-hour safety lecture is followed up throughout the training and jumping season. A yearlong project officer is designated as the Project Safety Officer and heads up a very aggressive safety program. For training purposes this Safety Officer position is rotated annually among the yearlong project employees.

HELICOPTER TRAINING

In addition to the training given in use of specialized fire equipment such as chain saws and powered trenchers, smokejumpers are familiarized with helicopter usage to facilitate correlation with the jumper program. In 1958, all Region 1 jumpers were checked out in helicopter safety rules and in requirements for helicopter landing spots. In addition, 89 men with previous smokejumping experience were trained in helijumping techniques and made 3 training jumps. These are free-fall jumps from a helicopter flying at low elevation to permit delivery of men to locations where the machine cannot land.

FIRST-AID TRAINING AND RESCUE TRAINING

Smokejumpers receive 8 hours of first-aid instruction during their initial training. An equal amount of time is devoted to lecture and to practical application. This training is extremely important because of the time element and the difficulties involved in transporting an injured person from an inaccessible area. Experienced jumpers receive 4 hours of refresher first-aid training. Foremen and squad leaders who are employed throughout the year are required to hold advanced first-aid cards. A pain-relieving drug, demerol, is available for emergencies. Human albumin is also available and can be administered by trained personnel.

The parachute project maintains a rescue unit and a one-wheeled stretcher. A ten-man crew is normally dropped with this stretcher. Smokejumpers receive 4 hours of training in stretcher bearing and related rescue training. In recent years the helicopter has been used predominantly for evacuation of the injured. An arctic toboggan, or pulka, and snowshoes are available for winter rescues. The regular crew of smokejumper personnel, supplemented by a number of experienced smokejumper students attending Montana State University and local smokejumpers on leave for the winter, make up the rescue teams for off-season missions.

SPOTTER TRAINING

Due to the turnover in qualified personnel, the job of training spotters is constant and will probably go on as long as there are smokejumpers. The spotter, a fully qualified smokejumper with special training, finds the fire by using maps and then directs the plane and the assigned jumpers in the dropping operation.

Selection of jump spots involves dropping drift streamers (strips of crepe paper 10 inches wide, 9 feet long, and usually pink), which fall at approximately 1,000 feet per minute. This is done to determine wind drift and velocity. Final selection of the target spot is affected materially by the amount of wind, type of terrain, and hazards involved. The decision to jump is the responsibility of the spotter.

The spotter candidate usually undergoes a training period covering an entire summer's operation before he is dispatched to spot without supervision. The spotter trainees, numbering from four to ten, are given 4 hours of ground training involving map reading, safe flight techniques, radio procedures, checking jump gear, jump spot selection, and spotter to pilot signals, both hand and light.

During the jump training of new smokejumper candidates, the spotter trainees are given every opportunity to acquaint themselves with spotting. Most training jumps are made in early morning to predetermined locations, so that the spotter trainee has opportunity to work out other problems that will confront him without contending with spot selection or wind correction.

All spotters start their training in the Ford and Travelaire aircraft, principally because their slow speed gives the man better opportunity to learn map reading and also gives him more time when spotting to make any necessary corrections.

Aircraft on fire missions are required to give periodic position reports. The spotter does not necessarily make this report himself but works closely with the pilot who usually has control of the radio. A fully qualified spotter of several years' experience accompanies the new man on the first three fire missions and on the first flight in a new aircraft.

Cargo dropping is another job in which spotters are given training. Close cooperation between pilot and dropper is necessary for a safe and satisfactory performance. The pilot is in full control of this operation and signals the dropper or droppers by bell or voice when to release a bundle. Putting the cargo in the right place and readily accessible to the men on the ground is an essential operation in aerial fire control.

Pilot training usually follows the same pattern as spotter training; that is, an experienced pilot rides with the trainee through several jumper runs until the trainee has the procedures, such as signals, cutting the engines, slow flying, and cargo dropping, sufficiently in hand so that he can operate by himself. A pilot, just as a spotter, is continually learning for the first few years and does not attain full proficiency until he has dropped jumpers and cargo under varied conditions.

Pilots and jumpers must be trained to take immediate action on all fire calls with no unnecessary delays. We are constantly striving for better methods and new ideas to improve our getaway time in the safest manner.

There is constant effort to improve equipment and techniques in all phases of smokejumping. For example, it is hoped that we can eventually come up with a jump gear and fire pack arrangement so condensed that jumpers will be able to economically pack their own gear out of the woods for distances of 5 or 6 miles at least. Work is being done now on a bicycle-wheeled carrier for retrieving smokejumper equipment by the jumpers on their return from the fires.

AIR TANKER ATTACK—TRAINING IS THE KEY

NOLAN O'NEAL

Assistant Chief of Fire Control, Region 5, U. S. Forest Service

The chemical-dropping air tanker has established itself as one of the most effective and promising of all fire tools. More than any previous type of equipment, it is the result of desire and effort by fire fighters, research personnel, equipment development technicians, and private industry. In 1954 a few rather ineffective trial drops were made on a fire in Southern California's Cleveland National Forest. In the summer of 1958, over a million gallons of chemicals were dropped on 135 fires in California's national forests (fig. 1). With enthusiastic help from the California Division of Forestry, 50 airfields have been approved and equipped with mixing and storage facilities. Veteran Forest Service pilots have led the way with converted surplus Navy torpedo bombers. Four such ships have been used to set standards, develop techniques, and provide leadership. Dozens of private aircraft and pilots have been carefully checked to establish a fleet of air tankers ranging from the versatile little Stearman with 120 gallon tanks through TBM's, PBY's, F7F's, a B-25, and a PB4Y-2, the latter capable of laying down a 2,000-gallon retardant band in a single pass.

The fire boss who orders air tankers has at his command a fire fighting weapon of great speed, flexibility, and effectiveness. He must realize that he is using a costly and potentially dangerous technique—a technique that demands planning, organization, coordination, and control to a degree beyond any fire suppression

FIGURE 1.—TBM air tanker in action on the Monrovia Fire, Angeles National Forest, Calif., October 1958. (Los Angeles County Fire Department photo.)

method he has previously employed. With this realization, follows the obvious need for continuous, intensive training. Just as the handtool fire fighter needs training to work with his new ally, so people in the air attack team must be taught the skills of mixing, loading, communicating, directing, dropping, and gaging terrain, fuels, and air movements.

The following limited agenda is for all air attack personnel but is aimed specifically at the air attack pilot. Use only pilots and fire fighters who are thoroughly experienced and good instructors to do the training. Use all possible aids, such as recent air tanker movies and slides. Handbooks, illustrations, rules, and regulations are now available to help presentation. Most important of all, accept only seasoned mountain pilots as trainees, select men who temper confident aggressiveness with calm, mature judgment. Beware of "hams" or "hot pilots." Take carefully picked air attack men and school them in these essential subjects:

Fire behavior.—Emphasize atmospheric factors, local winds, fuels, and topography.

Fire organization.—Chart organization of personnel and equipment from small through large fire situations. Stress coordination and the place of air attack in the overall effort.

Air attack organization.—Detail duties and responsibilities of air tanker pilots, lead plane pilots, air officer, air attack boss, air service manager, air traffic officer, fire and line boss. Show how each of these positions functions on a large fire or how they are combined on smaller ones.

Airbase procedures.—Credentials and checking in; landing; taxiing; spotting; loading; communications; takeoff procedures; precautions associated with load weight; airfield surface and length; altitude; temperature; visibility; traffic; turbulence; rules regarding passengers, photographers, news interviews, and local field procedures.

Communications.—Radio—Forest net, air net, unicom, other agencies. Visual communications—air to air, ground to air. Communication is the indispensable key to proper use of air tankers. Air tanker attacks should never be used until contact and control are established.

Strategy and dropping techniques.—Initial attack without lead plane—a job for experienced fire pilots only. Variations in dropping to fit the fire situation considering: intensity; spread; fuel types; ground obstructions; visibility; terrain; values; local winds; turbulence; and coordination with ground crews and equipment.

Safety.—The rules, regulations, knowledge, skills, and attitudes that must be observed to fly without accidents. A review of tragic accidents, and near misses, while using aircraft will make it evident that training to the point of perfection is imperative. Many air attack pioneers have given their lives in the past 30 years, including ten men lost in 1958, six of whom were fighting fire with air tankers. These men believed in the program and we owe it to them to see that its successful development continues. At the same time, we must resolve to expand air tanker use only as fast as intensified training can assure effectiveness with safety.

CALIFORNIA DIVISION OF FORESTRY TRAINING CENTERS

W. G. Francis, *State Forest Ranger,* and D. L. Russell, *Associate State Forest Ranger, California Division of Forestry, Southern California Training Center*

In its 1956 fire plan revision, the California Division of Forestry concluded that "With increasingly complex equipment and increasing resource values to protect, it is apparent that our fire-going personnel must be given more formal and comprehensive training in order to be competent in all phases of their job."

The initial stride toward accomplishing this objective was made in July 1957 with the establishment of two training centers; one at Ramona in San Diego County for personnel in the southern part of the State, and one at Sutter Hill in Amador County for northern personnel.

Established primarily for the teaching of basic skills and techniques to classes of new fire control and administrative employees, each training center is staffed with a ranger and an associate ranger. Qualified personnel from the districts in which the two centers are located assist with the instruction.

The initial training year began November 4, 1957, and terminated June 12, 1958. This included five 20-man classes of 5 weeks duration for forest fire truck drivers. The 1958–59 program, scheduled October 13, 1958, through June 12, 1959, will have five classes for truck drivers and one 5-week course for forest fire fighter foremen. This will be a pilot course for the following year.

In the forest fire truck driver program, each class extends for 5 weeks, Monday through Friday, the only interruptions being major fire calls (there have been some). Each day (8 a.m. to 5 p.m.) is devoted to scheduled subjects, while the evening hours (7 to 9 p.m.) are devoted to review and study, as needed.

The trainees perform all station, equipment, and kitchen upkeep between the hours of 6 and 8 a.m., during the noon break, and between 5 and 6:30 p.m.

The driver curriculum includes 52 different subjects dealing with the job of the forest fire truck driver. The bulk of the instructional time, however, is devoted to fire control and forest fire truck operation. Safety training is part of the curriculum.

The training center field area covers approximately 140 acres. Most of the training hours are spent in specially designated parts of this area that have been developed to give practical field training in basic driving, fire practice (fig. 1), fire road and truck trail driving, precision driving, hand fireline construction, hose lays, acreage estimation, heavy equipment operations, physical training, and pump operation and drafting. Classroom work includes theory, principles, and demonstration.

FIGURE 1.—Single truck fire fighting instruction. Five-man crew making a moving attack on a running fire in light brush and grass. (Simulated, by using oil in a trench.)

The two training centers are the first organized units with the specific job of training for the Division of Forestry. Their future appears assured; field reaction indicates that the graduated trainees are well equipped with the basic knowledges required of their jobs.

As the training centers continue in operation and gain additional experience, develop new training aids, work up lesson plans, and new courses and techniques, their benefits will be demonstrated throughout the organization by the increased efficiency of better trained employees.

DEVELOPING AND TRAINING A FIRE WARDEN

Carl Burgtorf
Ranger, Cumberland National Forest

In areas where forest fires endanger timberland values, a program is necessary whereby fire-suppression crews can be trained, equipped, and alerted so that fire can be attacked at a moment's notice. Again and again over a period of many years the National Forest Warden organization has proved its worth in fire control. These dependable volunteer fire fighters perform yeoman service each fire season. The work by fire wardens and crews in Region 7 has been estimated to be worth at least $75,000 each year, based on fire prevention and on savings resulting from early attack on going fires.

When national forests were established in the East shortly after passage of the Weeks Law in 1911, well-known responsible residents of forested areas were appointed as rangers. An outstanding example was the late Arthur A. Wood, who was made an assistant ranger on March 1, 1914, and rose to the position of Supervisor of the Monongahela National Forest in West Virginia.

Arthur Wood's early years on a farm in the Lost River Valley of West Virginia served him and the Forest Service well in the task of preventing and controlling wildfire on newly acquired national-forest land. For many years, he and his Lost River neighbors had collaborated to keep forest fires from their lands and buildings. Working together they used every means at their disposal to divert wildfires from their timber, rail fences, and farm structures. Pitchforks, forked sticks, branches, and brooms were used to rake firelines and beat out flames. At times they backfired from roads, trails, or fields; on several occasions, small communities were saved when backfires were set at strategic points.

As a ranger, Arthur Wood enlisted the leadership and cooperation of these local fire fighters. With obvious respect, a hearty handshake, and a friendly smile he appointed them as wardens and left them a bundle of tools (fig. 1). He always made personal contacts and displayed a sincere interest in the wardens and their families. Arthur Wood often said: "Local wardens are dependent on the land for their living. They, like us, are personally interested in its protection. We are natural cooperators." His policy and philosophy of cooperation have been preserved and they have continued to yield fine results.

Today, our fire wardens run the gamut of vocations from railroad president to marginal-land farmer with a $600 annual income. All are dependent on the land. Many wardens develop keen loyalty and independence. When asked the whereabouts of the local ranger, one elderly warden replied: "I haven't seen the ranger for quite a spell as I haven't had any fires. I'm taking care of my end of the district and he's taking care of his." This kind

FIGURE 1.—National-forest warden sign and tool box. Sign with name is erected at roadside in front of residence. Here District Assistant Ledford Perry and Warden Harrison Bryant discuss tool maintenance. Wardens also issue campfire permits to hunters and hikers.

of personal responsibility is impossible to buy, but it is often found in wardens and it usually extends to timber trespass and forest protection other than fire.

When forest fires occur, the wardens begin control action according to a plan that mobilizes manpower and equipment. The warden and his men usually are familiar with every acre in their assigned district; in fact, they may know the ground so well that it is difficult to get them to use a map. Most fire wardens can be reached by telephone. In some cases a telephone-messenger arrangement is necessary. Few causes of fires escape the attention of these alert wardens. They know the folks who are clearing land, cutting timber, and operating sawmills. They know how to "reach" these people.

In presuppression planning, it is recognized that fire wardens have regular day-to-day work to perform, and therefore cannot be expected to stand by without compensation. The usual procedure is for a lookout or dispatcher to inquire where individual wardens plan to work during the day and to arrange for a relay of messages to them. Cooperation of the wardens is remarkable. However, experience has proved that the fire organization must be strengthened as the fire danger increases. One time-proved plan is to alert a warden when the fire danger reaches High (80 on the Man-Hour to Control Curve of the Cumberland National Forest) and to place this warden on standby in pay status. If the fire danger mounts to 90 on the curve, the warden's crew of six men may be placed on standby in pay status. This system provides a flexible organization adjusted to actual burning conditions and to the risk factor. Standby man-hours are doubled under high-risk situations such as the opening day of hunting season. This plan of operation insures that almost daily contact will be made with wardens during fire weather. They become familiar with district personnel and feel that they are a valuable part of the Service organization.

In return for his services a fire warden receives wages while on duty. But the average warden is not entirely motivated by pay; he takes pride in his job as warden. This feeling is further developed when wardens gather at training meetings. There they review experiences and see training movies and new equipment. This fellowship is an important part of the warden's reward, especially when meetings are planned in advance so that the men realize that the interesting and educational break in their normal routine is being arranged especially for them. At one meeting a national-forest warden, a Dartmouth graduate, became most articulate as he described his action on a particularly severe fire. Undoubtedly, he lost considerable income by being away from his business; however, the fire had occurred on a national-forest area where he liked to hunt and he was anxious to help.

It is most desirable for a ranger to consider forest fire wardens for positions as towerman, game manager, smokechaser, and patrolman or to offer them temporary jobs on tree planting or other crews. This provides incentives for younger men on the warden crews, strengthens the organization, and provides many other less tangible benefits. The ranger should strive to implant in the mind of each resident of the forest community the idea that ". . . the forest is a part of my environment, my community. When the forest benefits, I benefit. What is good for the forest is good for me."

For a forest fire warden organization to achieve and maintain top efficiency, it must have top leadership. Rangers should take advantage of every opportunity to improve efficiency through training and actual fire experience. The "4-step" training method has withstood the test of time: "Tell them why," "Show them how," "Have them do the job," and "Check them out." Use of this method can prevent accidents and lower suppression costs.

A lack of means for quick communication is a great handicap for a warden. This can be overcome by backing up the warden crew with regular Service personnel and their radio equipment.

Many wardens reveal an inability to direct others. Even where choice men have been selected, it has been observed that bright and energetic fire fighters who are willing and anxious to get results, do not know how to do so efficiently and safely. However, many aids are available to instructors and rangers. The new film BUILDING THE FIRELINE is tops in the field of visual aid. Such aids, together with leadership and practical demonstrations, will build proficiency.

Development of a warden organization is dependent upon the resident population, landowners, and permanent forest users. Many areas of remote forest land can be protected efficiently only by professional fire fighters. However, Region 7 fire planning is based on a volunteer warden organization. These volunteer firemen who assume responsibilities in protecting our natural resources should have the benefit of modern training methods. It is axiomatic that they must know fire behavior and suppression techniques in order to operate efficiently and safely.

Wardens should be given all necessary training when they are appointed. A minimum of one day a year refresher training should be planned. We have used the following check list in determining training needs and guiding the warden-training plan:

Job Elements	*Proficiency Expected*
Fire Prevention:	
a. Personal contacts	Explain the reasons for fire protection. Make courteous, friendly contacts with neighbors. Be well informed on fire laws.
b. Investigation	Determine fire cause, find and preserve clues. Identify witnesses and suspects.
c. Forest fire hazards	Recognize hazards, "what" and "why," and report to ranger.
d. Risks	Recognize risks. Instruct neighbors and others in the dangers of the use of fire.
Suppression and Presuppression:	
a. Map reading	Read a map sufficiently well to know one's own position and to locate other points.
b. Locate and report on fires	Tell where fire is located, fuel type that is burning, and expected fire behavior.
c. Operate & maintain a telephone	Change batteries, check fuses, identify symptoms of trouble, and report trouble.
d. Ground patrol	Serve as patrolman; make fire prevention contacts; use maps and fire tools, telephones, and radios.
e. Fire behavior	Know: (1) how a fire burns; (2) heat transfer; (3) moisture content of fuels; (4) size and arrangement of fuels; (5) weather; (6) topography; (7) how to recognize "blow-up" or unsafe situations.
f. Fire organization	Use tools, organize crews, and construct safe firelines.
g. Fire suppression	Control "one-crew" fire (point of attack; line location; mopup; fireline patrol).
h. Maintenance of tool caches	Maintain equipment to a satisfactory standard.
i. Calculate probabilities of fire spread and manpower needs	Compute initial fire-spread probability and relate it to manpower needs.
j. Personnel safety	Training in first aid.
k. Timekeeping	Keep time records.

TRAINING FIRELINE PLOW-UNIT FOREMEN

FRED G. AMES
Mississippi National Forests

As with other national forests, World War II left Mississippi without its trained manpower to control an annual average of 1,100 forest fires. By early 1945 though, the Regional program for mechanization of fire control forces had developed a reliable tractor-plow unit. Forest officers soon recognized the possibility of making initial attack on all fires with such tractor-plow unit equipment, provided that proficient operators could be developed.

The original team consisted of 5 men: a foreman, tractor-plow operator, and three fire fighters. To synchronize their efforts toward perfection and speed in the operation of tractor-plow units became a job of top fire priority for the rangers. It was recognized at once that strong foremanship was needed to guide and lead these mechanized fire suppression teams.

Initial guides and standards were prepared by the rangers for the training of a foreman and members of his team. Training progress was hastened by immediate analysis of performance on actual fires. Over a period of 12 months critiques were held on several hundred fires immediately following suppression action. At

FIGURE 1.—The foreman gives clear instructions and exercises positive control in guiding his plow unit.

these critiques, members of the fire crew discussed frankly all phases of the suppression operation. Ideas about the training of each member of the team were cataloged under three headings: responsibility, qualifications, and duties. The end result was a simple but effective set of standards for training these mechanized teams. In this training, initiative and alertness by every member of the team were stressed. The importance of clear instructions and positive control was never overlooked (fig. 1).

Parallel to the development of training standards was the discovery and improvement of special devices, such as tie-down locks for tractor and plow, unloading facilities, mud tongs, and other special items that made plow operation faster and safer. Modern transports, developed for hauling tractor-plow units, plus an improved network of roads, made forest fires more accessible to initial attack by mechanized teams. The average size of a fire during 1939–41 when manpower was plentiful and handtools were used, was 36 acres. During 1946–49, when mechanized teams were learning the tricks of the trade, the average fire was reduced to 15 acres. Now, with better equipment and better trained teams, the average fire size for the past 3 years has been 5 acres.

The development of proficiency by unit crew foremen has been made possible because: (1) detailed job-tested standards for every phase of the operation are documented in lesson plans, (2) all members of the crew are trained with the foreman and work together on a full-time, yearlong basis as a resource crew as well as a fire crew, and (3) suggested improvements in equipment or crew operation are recognized and adopted with majority approval.

PLANNING AND ORGANIZING A FIREMAN SCHOOL

Jack Heintzelman
Fire Staff Officer, Mt. Hood National Forest

For years, Region 6 of the U. S. Forest Service has used a standardized 3-day spring training camp program for new and relatively inexperienced firemen. Similar programs are conducted on each of the 18 national forest units just prior to the fire season.

While it is recognized that experienced firemen cannot be created in 3 days, the training program is aimed at three objectives: first, provide the trainee enough basic training to get him started on his new job; second, instill in him the importance of his part in the overall protection program; and third, develop group spirit, teamwork, and interest in the job.

Experience has indicated that fireman training camps should be limited to not over 70 trainees. If there are more than 70 eligibles, 2 training camps should be held. Depending on local conditions, particularly travel time, 2 consecutive camps may be held in 1 location or 2 separate camps may be advisable.

The following points should be considered when selecting a campsite. Low elevation sites are preferred because of accessibility and more favorable weather conditions. A lookout station or a point which overlooks typical forest topography should be located within 4 miles by road. Areas suitable for instruction in small fire suppression and field problems in smokechasing should be readily available. The training camp should be located on one side of a well-drained, clear, level area of 5 acres or larger in size to provide space for parking, initial instruction in compass and pacing, and recreation. The camp should be located adjacent to a surfaced road. Electric power is desirable for lights and operation of projectors.

Region 6 was fortunate in having many such campsites in old C.C.C. camps; however, many of the structures in these camps have long since fallen into decay. The trend now is to construct project work centers which can be made available for firemen training sessions as well as for other uses.

Camps are run on a fire camp basis with a camp boss to arrange for the providing of messing facilities, bunk space, classrooms, transportation, supply and maintenance of fire tools, recreation facilities, first aid, and communications. In addition to the kitchen help and the camp boss, one or two assistants are needed. It is important that one of the assistants be expert at restoring fire tools after each use.

A typical division of training programs for the 3-day training session is as follows:

Primary lookouts	*Hours*	*Lookout fireman*	*Hours*	*Fireman*	*Hours*
Map reading & use	2	Map reading & use	2	Use of fire tools	2
Detection	6	Detection	4	Small fire supp.	6
Use of fire tools	2	Use of fire tools	2	Map reading & use	2
Small fire suppression	6	Small fire supp.	6	Smokechasing	6
Detection review	4	Smokechasing	6	Small crew fires	4
General guard duties	2	Gen. guard duties	2	Gen. guard duties	2
Forest test	2	Forest test	2	Forest test	2

As many of these subjects as possible are taught in the field under actual conditions. "Detection" courses include training at a fire lookout station. "Use of fire tools" is an outside course taught by people with competence in their use. In "Small fire suppression" actual fires are built, allowed to get a good start, suppressed, and mopped up. "Small crew fires" involves the construction of firelines under varying conditions. "Smokechasing" classes culminate in actual smokechasing by individuals over typical terrain for a mile or so.

Classes should be limited to 8 or 10 trainees. In a school of 70 trainees there may be 7 classes running at the same time. In view of the number and different lengths of the classes, it proves to be quite a problem to have all the trainees occupied all the time, classrooms available for all, transportation ready, and instructors available.

Instructors usually consist of district rangers and their principal fire assistants. Each instructor ordinarily has a competent fireman assistant instructor to aid in arranging of teaching aids and individual coaching. These folks may become future instructors. Instructors use regional training plans for each subject. The plans are comprehensive and designed to give the best coverage possible in the time available. Experience has shown that the best level of instruction is achieved when the plans are followed explicitly. Instructors report to the training camp the day before classes start. This allows them time to arrange their training materials and establish their field problems on the ground.

Trainees arrive at camp in time for the evening meal the day prior to the first day of instruction. Following supper a well-planned orientation meeting is held. At this time a safety court is appointed with a judge and assistants. This court is designed to uphold a good-humored safety program. On subsequent evenings violators are brought before the court and fined. Normally, trainees receive small fines, instructors larger ones. The training camp athletic equipment fund is the beneficiary of these fines.

The orientation program ordinarily consists of an introduction by the Forest Supervisor, followed by a program presented by forest staffmen and rangers on the broad objectives of the Forest Service, how and why it functions, the role of fire control, and the place and contribution of the trainee within the fire organization. The mechanics of the training camp are explained in the concluding remarks and the meeting ends on a note of "Ready to go." Evening programs are ordinarily limited to an hour and a half.

Another evening is handled as visitors' night. On this evening, following supper, contests such as softball games, packing, dirt throwing, bucking, and compass and pacing are held. Guests are introduced, awards are made. The safety court collects its toll.

The windup of the training camp is a written quiz on the subjects covered in the school. Following grading, the fire staffman retains the papers to analyze the results of the camp. The quizzes are then returned to the district ranger to use as an aid in followup training of the individual firemen.

Many forests award a plaque to the district whose trainees achieve the highest score in the combined games, contests, and forest test. It is considered an honor to win the plaque.

The training camp is just the beginning. Followup training is a must as soon as the trainee gets on his job; the training camp, however, has given him a good start.

FIRE CONTROL TRAINING AND EXPERIENCE RECORDS USED IN REGION 3

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One of the finest guarantees of success for a fire department is to have leadership in the hands of highly trained people with sound experience gained through doing the job and constant training in fire behavior, specialized skills, and the "know-how" of fire suppression. This is no less true in the field of forest fire fighting than in a city fire department. In the wild land fire fighting business, personnel are not full-time fire fighters; they wear "many hats." As a result, key fire positions are often filled with people who are only part-time fire fighters. This is unavoidable but it places strong emphasis on the need for a system of selection that can generally assure placement of the most highly skilled people in key positions.

This selection system has not been too refined and has led many times to difficulties in fire management. Personnel are presumably selected to fill fire positions on the basis of training and experience; actually, selections are often made on the basis of years in service. Often the written record of a selectee's training and experience on fires is either incomplete or entirely lacking. Actual fire experience may be negligible.

The Southwestern Region of the Forest Service recognized this several years ago. Forest fire staff officers had agreed in 1954 that there was a need to record the training and experience of all who had an active part in fire control work. It was at this time that Gordon Bade, Kaibab National Forest fire staffman (now retired), prepared an outline for regional use.

In 1956 and 1957 the region had far more fires than any other Forest Service region. Resource losses were high. During this period, especially in 1956, the region was at times hard-pressed for manpower to handle peak fire loads. Many employees were filling fire positions for which they were not fully qualified by experience or training. A recognized need for records was delayed because of heavy work loads and changes of personnel. Actually, it wasn't until 1958 that the records were started on all the forests.

It had been the custom in the past to issue fire experience cards (Red Cards) showing the individuals' qualifications as fire fighters. The qualifications were based quite often on personal opinion or years of service rather than on actual fire experience. Many individuals carried cards showing fire boss qualifications with inadequate experience to be so qualified. Forest supervisors and fire staff people became more fully aware of this when they started to pick project fire teams for their respective zones.

There were no records on qualifying experience and a great deal of assuming entered into the selection of persons for many positions. There was a tendency, for example, to assume that a man who is a ranger must have had much fire experience. Many such assumptions lacked foundations in fact.

An analysis was made of the larger fires. Some became large because of human failure. Some failures were due to lack of knowledge of basic fire fundamentals. The region began to use the expression "assuming assumptions" to point up the mistaken judgments and to emphasize the need for better training and better experience records.

Changeover moves slowly and time is needed to develop a smooth fire organization. A ranger lacking in fire training and experience is in no position to adequately train those working under him. In fire control there is no substitute for experience and training. Many of our people have been trained through experience with only a little formal pre-fire training. Learning by experience is expensive. It often becomes learning through mistakes, and mistakes in fire control can be costly in funds, resources, and lives. Formal training should always be a prerequisite to on-the-fire experience; both are important. The individual training and experience records are equally important.

Evaluation of training and experience is somewhat complex. Fires vary in size and complexity. The degree of training and experience needed to handle the fire job also varies, depending on whether the job involves the smaller fires that make up over 90 percent of the total, or the large project fires that make up less than 1 percent. Both require a knowledge of fire fundamentals. The first type of situation demands training and experience in rapidly controlling fires when small, and in preventing escape after control. The other requires the highest degree of training and experience in fire behavior under the worst of fire weather conditions plus the ability to quickly organize and manage a large fire organization.

Region 3 realized that training and experience records must be kept. The approach has been as follows:

1. Adoption of the previously mentioned Bade Training Outline which gives a record of (a) the individual's training and experience both on and off the forest; (b) the items in which the individual has been trained, the items in which he needs training, and the progress of the training; and (c) interviews on training and experience between trainee and supervisor.

2. Background material is furnished by the individual where no previous record has been maintained for him.

While the region attempts to set up training guides and regional training meetings, it is still a forest responsibility to train its personnel. Once the basic information on training and experience is recorded for all forest personnel it becomes the forest's job to earmark the individuals who have shown ability to handle certain phases of the fire job. The forest dare not "assume" too much in a person's ability without accepting the risk of inadequate performance.

While these evaluations are being developed the region has been working on three programs:

1. Carrying out a program of training or retraining all personnel in the fundamentals of fire behavior and fire control.

2. Establishing project fire teams in the three regional zones to be available on forest call to handle the more difficult fires. The project teams are chosen by forest supervisors and fire staffmen from those individuals who have proved their ability. The list of available names will be larger once the records are available for review. An attempt is made to fill top positions with known qualified people. At present, an inadequate reservoir of the "proven" class makes some "assuming" in picking people for other positions unavoidable. A regional office project fire team is also established. All physically able "field goers" are put into fire team positions that they can fill. Those in need of training also attend regional training meetings.

3. Providing training sessions for new specialities such as aerial tanker and helicopter operation, air cargoing, and safety.

By 1960 we plan to have a complete up-to-date record of each individual's training and experience. His Red Card will show the jobs for which he is definitely qualified. We hope then to gear fire training courses to fit the major needs. There will be beginners' courses in fire behavior and fundamentals of fire control, a more advanced course on the same subjects, and a plan to assign individuals to fires for both training and experience. We fully recognize that it will take a few years to establish the full program but a sound plan is now under way. We cannot afford to continue "assuming assumptions" in fire leadership qualifications.

A fair and current record of fire training and fire experience seems to be a sound foundation on which to start building competent fire leadership. It is basically more fair to a man if he is put into a job for which he is qualified. The record helps lay a base for each man's training needs. It should result in better fire management and a reduction in fire losses due to human judgment.

TRAINING IN THE TEN STANDARD FIRE FIGHTING ORDERS

William R. Moore
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During April 1957 a task force was appointed by the Chief of the Forest Service to study ways the Service could strengthen its efforts to prevent fire fighting fatalities. One of the recommendations of the task force was that the ten standard fire fighting orders be adopted for servicewide use and committed to memory by all personnel with fire control responsibilities (fig. 1). These orders are now in general use by the Forest Service, and are being used by some State and private fire protection agencies and by other federal agencies having fire suppression responsibilities.

STANDARD FIRE FIGHTING ORDERS

1. Keep informed on FIRE WEATHER conditions and forecasts.
2. Know what your FIRE is DOING at all times—observe personally, use scouts.
3. Base all actions on current and expected BEHAVIOR of FIRE.
4. Have ESCAPE ROUTES for everyone and make them known.
5. Post a LOOKOUT when there is possible danger.
6. Be ALERT, keep CALM, THINK clearly, ACT decisively.
7. Maintain prompt COMMUNICATION with your men, your boss, and adjoining forces.
8. Give clear INSTRUCTIONS and be sure they are understood.
9. Maintain CONTROL of your men at all times.
10. Fight fire aggressively but provide for SAFETY first.

Every Forest Service employee who will have fire fighting duties will learn these orders and follow each order when it applies to his assignment.

R. E. McArdle

RICHARD E. McARDLE Chief, Forest Service

Figure 1.

Training, both initial and followup, is essential in order to apply these orders consistently on the fireline. Training efforts, to be effective, must probe deeply enough into the elements of each fire fighting order so that the trainee can understand *Why* the application of each order is necessary and *How* he can activate it.

The training program is logically divided into three steps:

Background: Why it is important to learn and apply the ten standard fire fighting orders.

Application: How these orders can be applied effectively on the fireline.

Followup: Further training on the job and a check on how well the orders are being applied.

Let us study each of these steps and develop some material to help instructors put across the important points.

Background.—The fire task force made a detailed study of 16 fires in which 79 men lost their lives from burning. This study revealed 11 factors which were significant in the burning of fire fighters and which were common to many of these fires. The ten standard fire fighting orders were developed to be used as a constant reminder for fire suppression people to strengthen their action in the areas where these critical factors were present. Large charts were developed at the 1958 Missoula Fire Behavior School which show these factors and the ten standard fire fighting orders. With the use of these charts an instructor can clearly show how application of the ten standard orders will strengthen performance in the critical factor areas. He can further enlarge on this subject with a brief review of fire case histories.

Application.—A series of cards large enough for small group instruction, and showing fire case histories which dramatized success or failure of each of the ten standard fire fighting orders, was developed at the Missoula Fire Behavior School; 35-mm. slides were made from these cards for use in instructing large groups (fig. 2). The application of the ten standard orders can be effectively illustrated by using these training aids.

Followup.—This is the payoff step in training and in the application of the ten standard fire fighting orders. You will recognize the orders as being a statement of fundamentals which should be second nature to every man with fire suppression responsibilities. Enthusiastic application of these fundamentals is necessary if we are to fight fires effectively and safely. It is on the fireline that the line officer can observe the results of the training program. He can conduct on-the-job training in the application of the ten standard orders. And perhaps most important of all he can detect weaknesses that will point the way to future training programs. For example, frequent failures in the application of standard orders 8 and 9 might indicate a need for intensive foremanship training; failures in applying orders 1 and 3 could indicate a need for more fire behavior training; inadequate equipment to meet the requirements of order No. 7 could be a warning that the fire equipment cache needs a change.

Strong emphasis should be placed on standard fire fighting order No. 10 at training sessions and during followup training in order to prevent the trainee from developing fear or hesitancy when he has the job of controlling difficult fires. Training is not complete until the trainee is convinced that the safest, most effective way to fight forest fires is to understand the enemy and to attack it aggressively, applying sound suppression tactics until it is beaten.

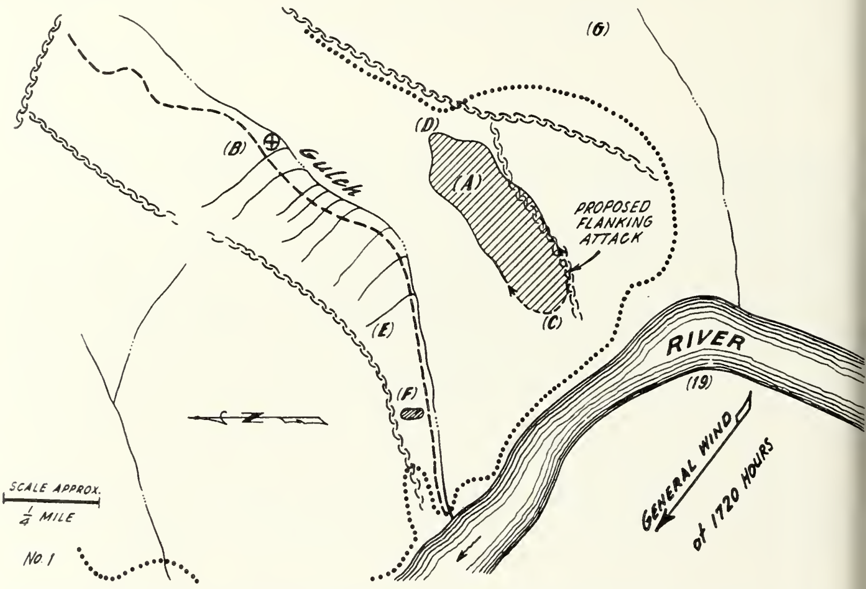

FIGURE 2.—Case history designed to emphasize standard fire fighting order No. 1. "Keep informed on *Fire Weather* conditions and forecasts."

The Situation

Fuels in this area were very dry. The afternoon burning index was about 70 and the temperature was in the 90's. The fire (*A*) was burning on a ridgetop in combined Douglas-fir, ponderosa pine, and grass fuels and was about 60 acres in size. The side of the gulch opposite the fire had light, fast fuels of dense cured grass and scattered grass and timber. A 16-man crew was positioned near the head of the gulch (*B*) and prepared to attack the fire. Scattered cumulonimbus clouds were present and moving in a northwesterly direction over area at (*G*). Rain evaporated before it reached the ground.

Proposed Action

1. Because of the size of the fire, the crew would proceed from point (*B*) around the slope opposite the fire and approach the fire from below.
2. Anchor a central line at bottom of fire (*C*) and construct line uphill both ways in a flanking action.
3. Continue flanking action until the fire is pinched off at the head (*D*).

The Results

1. The plan was activated and the crew moved down the slope opposite the fire to (*E*).
2. The fire across the canyon had begun spotting and moving downhill. From (*E*) the crew could see that a spot fire (*F*) had crossed the canyon and was spreading rapidly toward them in fast fuels.
3. Downdrafts from the cumulo-nimbus clouds present probably caused this reversal of expected fire behavior.
4. The crew, having found themselves trapped in front of a fast moving fire, retreated toward the ridgetop. Two men outran the fire to safety. One man set an escape fire and was saved. Thirteen men were overtaken by the fire and burned to death.

TRAINING LARGE FIRE ORGANIZATION

LYLE BEYERS
Protection Assistant, Oregon State Board of Forestry

The Oregon State Forestry Department has found that special emphasis must be placed on training in fire organization, using a combination of the lecture, written material, and on-the-job training. No single method of instruction is wholly adapted to training in large fire organization. Because of the nature and complexity of the organization, the particular advantages of each method of instruction that can be applied in presenting the subject should be used.

The lecture method with visual aids is the best approach for presenting the subject. The fire organization can be shown by the use of a large scale map of a fire, around which the complete suppression force is developed and portrayed by symbols. There should be one chart for each level of overhead as it is added to the fire picture. The first step shows the fire boss in complete charge and having the responsibility of directing all activities pertaining to control of the fire. His channel of command is represented by a circle completely around the fire area.

The second is a breakdown of the fire boss job into the primary functions showing the plans chief, the service of supply chief, the assistant fire boss, and the line function (fig. 1). The fire is divided into divisions, each under a division boss. Each chief and division boss is connected by a line to the circle representing the command of the fire boss. The next chart repeats the second and adds to it the breakdown of divisions into sectors with a sector boss in charge of each sector. On the fourth chart the foremen are added, each one connected by a line to his sector boss.

The final chart of the series is the map of the fire showing the distribution of men and machines about the fire (fig. 2). Every man and major machine should be represented on the fire line by a separate symbol. This helps to portray the large number of men and machines that are required on a large fire, and to point out how important it is to have an organization to coordinate this force. These symbols should be distributed about the fire so that they represent a realistic situation. Crews and sectors should vary in size and several kinds of machines should be shown.

The overhead is represented by a symbol for each level of command. Every man is connected to his boss by a line representing the channel of command. These lines also represent the lines of responsibility.

Throughout the presentation of the structure of the large fire organization, the principle of the four "definites" should be emphasized. These are definite channels of command, definite distribution of duties, definite understanding of duties, and definite responsibility. The lines which connect one position to another

FIGURE 1.—Second break: fire boss and top staff.

represent the channel of command and lines of responsibility. There is only one line from a man to his boss with only one channel of command to that man. This principle must be learned and followed before the command function can operate without confusion.

A definite distribution of duties and understanding of these duties are essential to a competent organization. Finally, every man in the organization must understand that he has a definite responsibility to do his job.

At each level of command, these principles are pointed out, particularly as they apply to the particular job. Several examples of failure to follow these four definite principles should be given to point out the confusion or chaos which may result.

The complete organization should be presented to all potential overhead, as it is outlined above. They should then be divided into

FIGURE 2.—Final chart.

levels of command or jobs to which they may be assigned. Each man in the group is then instructed specifically on the duties of his job and responsibilities. This department has selected qualified men from its personnel throughout the State and assigned them to five overhead teams to fill the top 10 jobs in a large fire organization. These men are trained specifically for these jobs and to work as a team.

The sector boss level of command is filled by experienced men from the district and headquarters. This group receives concentrated instruction at the district fire schools.

The foremen used in our large fire organization are mostly from the lumber industry; they are foremen of the organized crews which make up most of the labor forces. In several of the districts, special training schools designed for foremen from industry have been held in cooperation with the U. S. Forest Service. At these schools, the large fire organization is presented as outlined, followed by special instruction on the definite duties and responsibilities of the foreman.

The use of written material as a method of instruction is used principally in listing the distribution of duties assigned to the various overhead. These are particularly valuable for further study and as a reminder list on the job.

On-the-job training should be given to further train an organization for use on a large fire. The occasional large fire is a training ground that should not be overlooked.

The medium-sized fire also offers a chance for very good on-the-job training. This can easily be done by overstaffing the organization with the personnel who would normally be assigned to a large fire. The particular jobload may not be great, but the duties of each job are usually present. The channels of command can be followed, and the lines of responsibility adhered to.

We have, on several medium-sized fires, overstaffed for training purposes by putting not only one but two overhead teams on the fire, one for day shift and one for night. In every case, one or two instructors in fire organization are present on the fire to serve as an advisor, observer, and critic.

Following each fire, which is staffed to train overhead in large fire organization, a critique is held immediately afterwards where not only fire control is discussed but also the functioning of the fire organization is reviewed. Notes should be taken of this discussion and presented at the fire schools the following spring.

To summarize: Training fire organization should be presented as realistically as possible with visual-training aids. Written material should be available to give out for further study and to keep as a reminder list. Every opportunity should be used for on-the-job training and experience, which includes the instructor's supervising the doing of the job. Finally, large fire organization training must be carried on year after year so that fire control is not caught short of trained overhead when a bad fire year occurs.

HOW MUCH FOREST FIRE PREVENTION?

William W. Huber
Director, Cooperative Forest Fire Prevention

Forest fire prevention in the United States has been symbolized for the past 15 years by Smokey the Bear. Smokey was created by the advertising firm of Foote, Cone and Belding, Inc., of Los Angeles, Calif., in 1944, and appeared on posters in 1945. This firm, the appointed task force of The Advertising Council, has handled the Cooperative Forest Fire Prevention account free of charge since 1942. Its clients are the Association of State Foresters and the Forest Service of the U. S. Department of Agriculture, and the aim of the ad men is to stamp out range, woods, and forest fires. The tools used to attain this objective are the various public-relations media of television, newspapers, magazines, radio, posters, car cards, films, exhibits, and such items as Smokey Bear dolls, tent cards, wobblers, snuffits, to name a few.

The Smokey Bear campaign has been a very good one. The proof is in the reduction of forest fires from 210,000 in 1942 to less than 100,000 fires in 1958. The acreage burned has been reduced from 30,000,000 acres in 1942 to 3,000,000 acres in 1958. Of course, nobody can say that the Smokey program alone has been responsible for the remarkable success we are experiencing in forest fire prevention. The Keep Green Associations, the county, State, and Federal forest fire organizations all cooperate with Smokey, and are working hard to prevent forest, woods, and grass fires, and to put them out quickly if they start (fig. 1). Public opinion has turned, too, and the public is demanding better laws and better law enforcement to cope with the careless and deliberate setters of forest fires. Smokey the Bear is the focal point around which millions of Americans and Canadians interested in the protection of natural resources have rallied.

Yet a better job needs to be done. How much forest fire prevention is enough? The excuse given in most cases of poor forest fire prevention work is lack of money. Isn't it ironic that in the United States we spend 50 cents per person to control forest fires, and less than 5 cents per person to prevent them? In the past, when we were building up fire protection organizations and adequate fire control equipment, it might have been necessary to emphasize fire presuppression and suppression at the expense of forest fire prevention. But now, with management replacing protection alone, we cannot afford even one fire that might have been prevented, especially since we still have over 75,000 man-caused forest fires each year, all of which could have been prevented. What has happened to the old adage, "An ounce of prevention is worth a pound of cure"? If there ever was a field requiring greater concentration of effort to reach a goal, it is in forest fire prevention.

FIGURE 1.—A new brush burning poster is being used in 1959.

Our forest management program includes prescribed burning in many areas. We need to tell the public why we are doing prescribed burning and how carefully this planned burning is tied in with research and weather conditions. The national CFFP program cannot handle this type of project, but much forest fire prevention work on the local level is needed before prescribed burning projects can be successfully carried out. Like "either-sex" deer hunting, prescribed burning is going to require a lot of public-relations work.

The tools we use for the national CFFP program are good ones, and each year we come up with new items. Let's take a quick look at the Smokey material prepared for 1959. The basic theme is, "A match can be a deadly missile!" The basic poster gives visual form to this missile theme (fig. 2). The TV shorts feature "The Space Age." The news ads stress "Don't be a missile flipper" and "A spark can be a deadly missile." The theme, of course, ties in with orbiting and military missiles, which we feel are topical.

The trend is toward higher average highway speeds. Hence, larger Scotchlite posters with fewer printed words are replacing the smaller posters. Even the range poster this year is larger than usual.

The CFFP Committee is cognizant of the use of smaller handout items. These include the Smokey tent card, the small easel, the Smokey record book, the "True Story of Smokey" comic book, the Smokey calendar, and the Smokey bookmark. The new Junior Forest Ranger badge is included in the Junior Forest Ranger Kits, and this is proving very popular with our young Americans.

Personal contact is an important part of public-relations work. Yet we in the various forest services and fire protective associations are weak in our contact work in forest fire prevention. Many lookout towers are visited by hundreds of people annually, affording excellent opportunity for educational contact by the towermen. They need careful training to make these contacts fruitful. Many towermen lack sufficient forest fire prevention handout material.

The national CFFP and Keep Green programs are developing many new public-relations ideas. With the help of The Advertising Council and the task forces, Foote, Cone and Belding, Inc., of

FIGURE 2.—"A Match Can Be A Deadly Missile" is the basic theme for this poster and the 1959 CFFP Campaign.

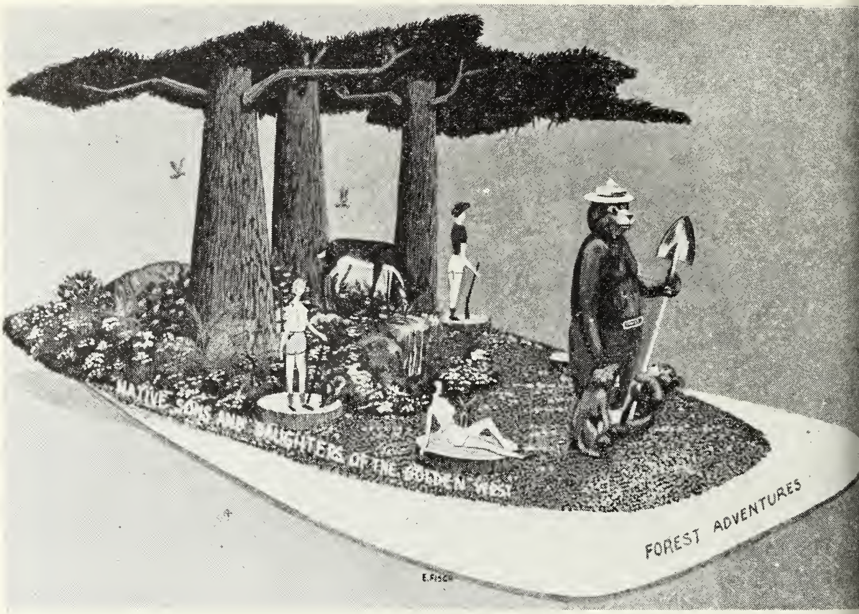

FIGURE 3.—This float won the Governor's Trophy on January 1, 1959, in the Pasadena Tournament of Roses Parade, competing with 61 other floats.

Los Angeles, and Liller, Neal, Battle and Lindsey of Atlanta, Ga., advertising agency for the Southern States CFFP program, the best public-relations media and advertising techniques are used in the interest of forest fire prevention. A unique example of this was the forest conservation postage stamp. This stamp was cancelled on the first day of issue with the figure of Smokey's head and the words, "Keep America Green." The year 1959 started off with a Smokey float winning the Governor's Trophy in the Tournament of Roses parade at Pasadena, Calif. (fig. 3). This promotion was carried out by field personnel—proof of the good work that can be done on the local level.

Smokey material must be used in the field to be effective. District foresters, rangers, fire wardens, and all field employees of the various forestry organizations need to give more attention to forest fire prevention. Schools, newspapers, TV and radio stations must be contacted; posters must be put up; and all foresters should eat and dream forest fire prevention. If they don't, we're all going to eat a lot of fire-camp grub, sleep in paper sleeping bags, and fight a lot of forest fires. And this is probably the hardest work in the world, no matter how scientifically we go at it!

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.*

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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.

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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 3

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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Forest Service, Washington, D. C.

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CONTENTS

TRACTOR-PLOW TACTICS

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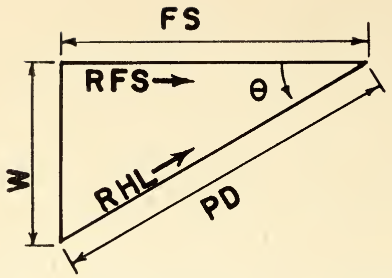
Tractor-plow fire suppression units have been in use in the South since about 1942. At present there may be as many as 2,000 units in use by Federal, State, and private forest fire control forces. Although these units are used to fight several thousand fires each year, relatively little has been written about the tactical use of tractor-plows in fire suppression. Hartman has described the development of the tractor-plow and early results from its use. He gave a typical crew organization used with a plow unit in 1947 and emphasized the desirability of attack by two plows rather than by one. In 1956 the writer mentioned the common practice of stopping the forward movement of the head of the fire by plowing a line in front of it, backfiring, and holding the plowed line.

Distinction has been made between ordinary fires and high-intensity fires and the characteristics of high-intensity fires are being studied. However, it appears that there has been no attempt to set forth any statement of the theory and practice of tractor-plow tactics in the suppression of ordinary fires. Yet, each year, there are enough fires which get away from tractor-plow crews to justify the belief that something could be gained in fire suppression technique by understanding the theoretical relationships that exist between the movement of the fire and the movement of the plow, and considering the practical applications which result.

One of the principal theoretical relationships is that of the rate of forward movement of the head of the fire to the rate at which fireline may be plowed, fired, and held. It is common practice to regard the fire as having three parts, the head, the right flank, and the left flank. Fires, like rivers, name their own flanks. Hartman observed that "on bad windy days heads run rapidly and produce a long cigar-shaped burn." Since the head moves more rapidly than the flanks, it is desirable to focus attention on the control of the head of the fire.

For this purpose, it is useful to consider the head of the fire as a straight line. In unpublished material used at Region 8 fire behavior training sessions the following appears, "Ordinary Fires —Behavior Factor: Advance of Head. More or less uniform line of fire or wall of flame, with wind or upslope." This line of fire may be regarded as the base of a right triangle and designated the Width (W). The Rate of Forward Spread (RFS) is the other leg of the triangle. The Rate of Held Line (RHL) is the hypotenuse. The relationship of rate of forward spread to rate of held line is that of the cosine of the angle they form (fig. 1).

The distance the head of the fire will run while a line is being plowed across the front of it, is called the Forward Spread (FS). It is the cotangent of the angle theta times the width. The distance the plow will have to travel to cross the head of a fire having a certain width and rate of forward spread is called the Plowing Distance (PD). It is the width divided by the sine of the angle theta. In table 1, which is for illustration only, the rate of held line is constant at 60 chains per hour.



$$\frac{RFS}{RHL} = \cos\theta$$

$$FS = \cot\theta\, W$$

$$PD = \frac{W}{\sin\theta}$$

FIGURE 1.—Relationship between movement of the head of the fire and movement of a tractor-plow unit.

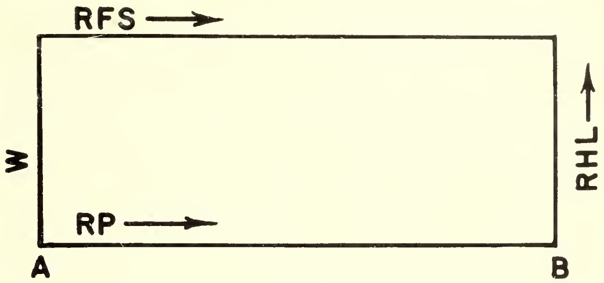
TABLE 1.—*Forward Spread (FS) and Plowing Distance (PD) for single plow, angle attack, at rate of held line of 60 chains per hour, by width of fire head and rate of forward spread*

Rate of forward spread per hour (chains)[1]	Width of fire head in chains is—							
	10		20		30		40	
	FS	PD	FS	PD	FS	PD	FS	PD
	Chains	*Chains*	*Chains*	*Chains*	*Chains*	*Chains*	*Chains*	*Chains*
10	1.6	10.1	3.3	20.3	5.0	30.4	6.7	40.6
20	3.5	10.6	7.0	21.2	10.6	31.8	14.2	42.4
30	5.7	11.5	11.5	23.1	17.3	34.6	23.1	46.2
40	8.9	13.4	17.9	26.8	26.8	40.3	35.8	53.7
50	15.1	18.1	30.2	36.2	45.3	54.4	60.4	72.5
	50		60		70		80	
	FS	PD	FS	PD	FS	PD	FS	PD
10	8.4	50.7	10.0	60.8	11.8	71.0	13.5	81.1
20	17.7	53.0	21.2	63.7	24.8	74.3	28.3	84.9
30	28.8	57.7	34.6	69.3	40.4	80.8	46.2	92.4
40	44.8	67.1	53.7	80.5	62.1	94.0	71.6	107.4
50	75.5	90.6	90.6	108.7	105.8	126.8	120.9	145.0

[1] 1 Chain = 66 feet; 10 chains per hour is a speed of 11 feet per minute.

For example, with a rate of forward spread of 40 chains per hour, a width of 20 chains, and a rate of held line of 60 chains, a single plow attack will require 26.8 chains of held line (Plowing Distance). The farther side of the head will run 17.9 chains (Forward Spread) while the line is being plowed. The area burned during the attack will be 17.9 acres. With two plows, attacking simultaneously from opposite sides of the head, the forward spread (in the center of the head) is only 8.9 chains. Although the length of line plowed by both plows is still 26.8 chains, the area burned during the attack is only 8.9 acres.

If the rate of forward spread equals or exceeds the rate of held line, an "angle attack" cannot be made successfully. Advantage should be taken of the fact that tractor-plow units can plow about as fast as they can travel. The tractor-plow unit should move ahead, plowing but not firing and holding, to a Lead Distance far enough ahead of the fire to enable the crew to plow, fire, and hold a line across the head of the fire. The relationship and the calculation of the lead distance are shown in figure 2.



$$\text{Lead Distance (AB)} = \left(\frac{W}{RHL}\right)\left(\frac{RP \times RFS}{RP - RFS}\right)$$

FIGURE 2.—Relationship of a Lead Distance and a width of held line to the forward movement of the head of a fire.

Table 2 shows lead distances thus calculated for various widths of head and rates of forward spread.

TABLE 2.—*Lead Distances, where rate of held line is 60 chains and rate of plowing 240 chains per hour, by width of fire head and rate of forward spread*

Rate of forward spread per hour (chains)	Width of fire head in chains is—							
	10	20	30	40	50	60	70	80
	Chains	*Chains*	*Chains*	*Chains*	*Chains*	*Chains*	*Chains*	*Chains*
30	5.7	11.4	17.1	22.8	28.5	34.2	39.9	45.6
40	8.0	16.0	24.0	32.0	40.0	48.0	56.0	64.0
50	10.5	21.1	31.6	42.1	52.6	63.2	73.7	84.2
60	13.3	26.6	39.9	53.2	66.5	79.8	93.1	106.4
80	20	40	60	80	100	120	140	160
120	40	80	120	160	200	240	280	320

Taking a lead distance involves trading space for time and sacrifices area. For example, if RFS=60 and W=20, the lead distance to be taken is 26.6 chains, the area burned during the attack would be 53.2 acres. However, it must be borne in mind that this fire cannot be cut off by angle attack by a tractor-plow unit making held line at 60 chains per hour; 53.2 acres is the least area that will be burned by any method of attack with a single tractor-plow unit. Obviously if the rate of forward spread exceeds the rate of plowing, even greater lead distances must be taken by falling back to roads, plow lines, or other barriers.

That these theoretical relationships have practical applications may be shown by the following illustration. It is not unusual for a fire to start along a road and burn away from it. The tractor-plow on a transport arrives along the same road and is unloaded at the fire. All too often the crew begins to plow, fire, and hold line on one of the flanks, moving toward the head of the fire, unaware of the relation between the rate of forward spread and their rate of held line. The effect of the head start of the fire is found simply by dividing the length of the flank from point of attack to the head by the difference between the rate of held line and the rate of forward spread.

In the illustration, it would take the crew one hour just to reach an anchor point at the head of the fire from which a line could be plowed across the head. In that time the fire head would have advanced an additional 40 chains. The preferred method of attack is to plow along the flank to the anchor point, where flank fire becomes head fire, there estimate the rate of forward spread and decide on an "angle attack" or a "lead distance" attack (fig. 3).

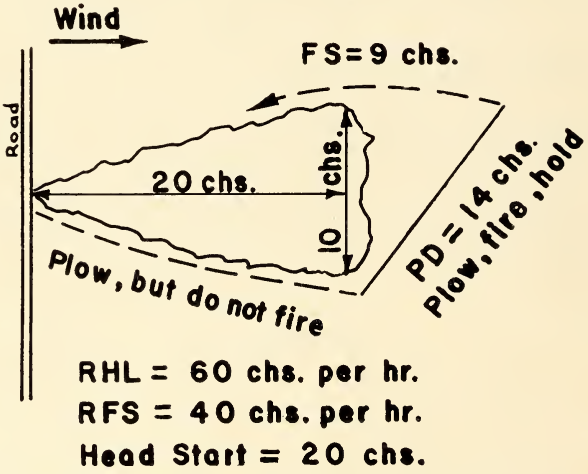


FIGURE 3.—Tractor-plow action to overcome a head start and make an angle attack.

In this case, with a width of 10 chains and a rate of forward spread of 40 chains, an angle attack can be made. The crew would plow and backfire a line 14 chains across the head. Meanwhile, the head of the fire would advance about 9 chains.

After the head is stopped either flank may be worked. In this case the line along the right flank may now be fired and held. If the line holding crew can be divided the tractor-plow and part of the crew could take the left flank at the same time. Since most wind shifts are clockwise, it might be a good rule (in the absence of actual forecast) to secure the south flank first.

The calculations made in the tables are, of course, theoretical. According to them the plow and the fire would reach the far side of the head at the same time. They do not allow for a Backfire Distance. To do so would complicate the presentation of the principle without adding anything of practical usefulness. It is, of course, necessary to allow a backfire distance.

As stated in a previous article, the meeting of head fire and backfire should take place at least $\frac{1}{2}$ to 1-$\frac{1}{2}$ chains from the plow line, under ordinary conditions. The rate of movement of backfire is so low (about 1 chain per hour) that this cannot be accomplished by time alone. Parallel backfiring by a man and drip torch is the best means now available for increasing the width of the burned-out strip. Igniters have been tried but did not produce parallel backfire as satisfactorily as a man and a torch. Parallel backfiring requires two men. The man setting parallel backfire should be from $\frac{1}{2}$ to 1 chain inside the plow line and about the same distance ahead of the line firer.

It appears from the information available that the rate of line holding is generally about one-fourth the rate of line plowing. Considering the relationship of rate of held line in the formulas, it is evident that the largest opportunity for improvement in tractor-plow suppression is by increasing the rate of held line. In addition to parallel backfiring, the most useful device for increasing rate of held line seems to be the tractor-tanker. The tractor-tanker is a light crawler type tractor carrying two 50-gallon tanks and a separate pump and engine capable of pressures of about 200 p.s.i. The tractor-tanker can follow a tractor-plow where a truck tanker cannot go. It can replace 5 to 10 men in line holding. Of course, it requires a suitable truck transport.

The tractor-tanker should be at or near the point where backfire meets head fire, since it is there that most simple breakovers occur. One, two, or more men should follow along the line helping with line holding. Where the woods are open enough, both tractor-tanker and line holders can work better back of the plow line, but if undergrowth is thick they have to move and work in the plow line.

In 1926, The Fire Code called for "Immediate attack—day or night—at the apparent point or points of greatest danger" "Scouting Fire: Going around it; checking probabilities; recalculating the job to be completed before the next 'burning hour,' determining its critical points."

With modifications to suit the conditions of rapidly moving fires in the Coastal Plain, these principles are still applicable. To accomplish a successful attack with a tractor-plow team the crew chief should know (1) the width of the head, (2) what's ahead of the fire, (3) what's ahead of the plow, (4) the rate of held line, and (5) the rate of forward spread. With fast moving surface fires, he needs to obtain this information en route to the fire or immediately after arrival at it.

The width of the head can best be determined by scouting aircraft, but, unfortunately, planes are usually not available with the initial attack force. However, a scout in a 4-wheel drive vehicle, on the far side of the fire, with radio communication, can often supply information as to width of head. Aerial photos can often help tell what is ahead of the fire and what is ahead of the plow. An unplowable swamp may lie ahead of the plow, making it impossible for one plow to complete a line across the head of the fire. However, aerial photos need to be supplemented by local knowledge and recent information. For example, the photos may show a swamp ahead of the fire but they will not show if the swamp is wet or dry. They will also not show a recent prescribed burn which may be of equal importance.

It is suggested that the rate of held line for various types and fuel conditions could be predetermined. It is also suggested here that rates of forward spread can be estimated satisfactorily by one-minute observations of the forward movement of the head, the distance being expressed in feet. In four training fires on the fire training strip on the Apalachicola National Forest, November 24 and 25, 1958, rates of forward spread of 30 chains per hour were measured. This rate occurred in mature longleaf pine timber, 3-year rough of wire grass and needles, under weather conditions as follows:

		Nov. 24	Nov. 25
Time 1:00 p.m.		Nov. 24	Nov. 25
Fuel moisture	percent	13.5	10.2
Wind (NNE)	m.p.h.	4.5	4.5
Burning Index (8-100 meter)		4	5
Danger Class		2	2
Build-up Index		47	51
Relative humidity	percent	68	50

Twenty fire control men of various degrees of experience found they could approximate the rate of forward spread to the degree of accuracy here required by estimating in feet the distance traveled by the head of the fire in one minute. Estimates were checked by marking the position of the head at one-minute intervals with steel can markers. The distances in feet per minute correspond approximately to chains per hour.

It was also found by timing and measuring that tractor-plow crews at the four training fires produced held line at about 60 chains per hour in the type and under the burning conditions given above.

The efficient execution of fast-moving tractor-plow attacks on fast-moving surface fires calls for a degree of skill and coordination that can be reached only by trained crews. Often fire occurrence is at a low level and it is not possible to give crews experience on a large number of actual fires. A good device for giving training in tractor-plow tactics appears to be the "fire training strip," first used, so far as the writer knows, on the Apalachicola National Forest, November 24, 1958:

I. Location and installation.
1. A strip 10 chains wide by 1 mile long.
2. Secure both sides and ends by a road, by plowing, or by prescribed burning.
3. Orient length of strip to prevailing wind.
4. Locate in mature timber to avoid excessive damage.
5. More than 1-year rough; preferably an area to be prescribed burned.
6. Stake both sides at 2-chain intervals.

This strip, fired on the windward end, represents the head of a fire 10 chains wide. The flanks are eliminated by the sides of the strip. Fires may be set and plowed out repeatedly in a number of demonstrations or tests.

II. Use of the fire training strip.
1. Set fire to the windward end and time it.
2. Estimate the rate of forward spread by one-minute sample.
3. Take a suitable backfire distance, or a lead distance.
4. Plow across strip, fire and hold line and time it. Use parallel backfiring.
5. Measure the forward spread to check the one-minute estimate.
6. Measure the plowing distance.
7. Obtain the average rate of held line.
8. Hold discussion of the execution of the operation and the results.

Four training fires were used on the fire training strip on November 24 and 25 with a group of 20 trainees. The one-minute estimate of rate of forward spread proved reliable and usable by the whole group. Rates of plowing checked between 240 and 300 chains per hour. Rates of held line were close to 60 chains per hour in each test. Parallel backfiring was successfully executed by man-and-torch but not by igniters. The effect of parallel firing—pulling the backfire away from the line and moving the meeting point of backfire with head fire away from the line—was adequately demonstrated. The tractor-tanker, which is not yet standard equipment in all fire control units, demonstrated its ability to hold line. In addition, the realism of the training fires may have had a beneficial effect on the less experienced trainees.

Both theoretical and practical considerations of what is to be accomplished in the suppression of fast-moving fires in the Coastal Plain lead to the concept of an Initial Attack Force of sufficient strength and proper composition for the task. The initial attack force should be instantly and constantly available. The following is suggested: one tractor-plow, on transport; one tractor-tanker, on transport; one truck, for line holding crew, with handtools; one scout car (4-wheel drive); one truck-tanker (4-wheel drive).

In addition to serving as "nurse tanker" for the tractor-tanker, the truck-tanker is useful for holding along roads, or for extinguishing spot fires it can reach, and for mopping-up.

Without attempting to be comprehensive, a number of points of theory and practice can be summarized as follows:

1. Fires should be thought of as having three sides: Head, right flank, left flank. Control of the head should be the first operation.

2. The principal method of control is the removal of fuel by burning, not by plowing. The principal function of the plow line is to make a fuel separation sufficient to hold the backfire.

3. The principal function of the line holding crew is to prevent the backfire from crossing the plow line.

4. The meeting of head fire and backfire should be far enough (½ to 1½ chains ordinarily) from the plow line so as to cause no breakovers and no great exposure of men to heat and flames. The distance can be increased by parallel backfiring, which should be standard practice.

5. The relation between rate of forward spread of the head and rate of held line by the tractor-plow crew in an angle attack is

the cosine of the angle they form. The distance to be plowed to cross the width of the head is the width divided by the sine of the angle. The distance the head will run while under attack is the width times the cotangent of the angle.

6. If the rate of forward spread is less than two-thirds the rate of held line an angle attack can be made from one anchor point to the other across the width of the head.

7. Two plows, attacking the head from both sides, can cut the time for control in half and reduce the area burned during the attack by half.

8. If rate of forward spread equals or exceeds two-thirds of the rate of held line, a lead distance should be taken sufficient to make and hold line across the width of the head before the fire reaches the line.

9. If fires must be approached from the rear, the time required to overcome the head start of the fire should be realized. Advantage should be taken of the present great difference between the rate of plowing and the rate of held line. Plow along the flank to the head of the fire, but do not fire and hold.

10. The tractor-tanker is the "sister" of the tractor-plow and affords the best opportunity now available for increasing rate of held line.

11. In the few minutes between arrival and attack, the fire boss needs to find the answers to the following: (a) What is the width of the head? (b) What is the rate of forward spread? (c) What is ahead of the fire? (d) What is ahead of the plow? He should know the capability of his crew in rate of held line.

12. Rate of forward spread can be obtained satisfactorily by estimating the forward movement in feet for one minute and converting feet per minute to chains per hour.

13. Doing the job of fire suppression quickly and reliably requires the existence and dispatch of an initial attack force of sufficient strength and proper composition. This force is suggested as consisting of (a) tractor-plow, with transport; (b) tractor-tanker, with transport; (c) truck-tanker (4-wheel drive); (d) truck, for line holding crew and handtools; and (e) scout car (4-wheel drive).

14. Tractor-plow tactics can be taught successfully on fire training strips, which give repeated head fires in little acreage and without time consuming flank control work.

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CHANGES IN THE HELITACK TRAINING PLAN

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In 1958 turbo-jet helicopters made their debut as a part of the fire control team. The small helicopter dropped paracargo from a remote-controlled release for the first time. For flexibility on larger forests, ground crews as well as especially trained Helitack crews were fitted into the Helitack fire plan. Fire fighters from Forest Service Regions 1, 2, 3, 4, and 5, the California Division of Forestry, the Los Angeles County Fire Department, and the U. S. Park Service, Yosemite National Park, were introduced to helitactics. The new techniques and the expansion of operations required changes in both the organization and the training for Helitack.[2]

New trends in Helitack organization.—The Helitack crew continued to be the backbone of the helicopter operation, but on the larger forests the Helitack foreman and his 3- to 4-man crew were not able to handle the whole job. Additional crews were necessary to maintain the flexibility of Helitack operations. Tanker crews, "hotshot" fire crews, brush crews, timber stand improvement crews, and smokejumpers were all trained as reinforcement crews to round out the Helitack organization.

How the Helitack organization operated.—When a fire was reported, the Helitack foreman and possibly one of his crewmen responded in the helicopter. The rest of the Helitack crew went to a previously located and improved reinforcement base heliport near the fire. The nearest reinforcement crew was also sent to the reinforcement base. When the helicopter had placed the Helitack crew on the fire, it flew immediately to the reinforcement base. The reinforcement crew was ferried to the fire. Helicopter accessories such as the helitank and hosetray were available there, too, and as a result, the fire often was manned by adequate manpower and equipment many hours before a ground crew could reach it. However, the most important part of this kind of operation had to come before the fire occurred. The new organization had to be trained.

Who was trained.—Helitack training of different intensity was given to most of the Forest organization, to fire-going personnel (Helitack crews and Helitack reinforcement crews: Tanker, hotshot fire, timber stand improvement, and brush crews and smokejumpers) and to non-fire-going crews (engineering and timber survey) who might use the helicopter for administrative projects.

Where they were trained.—A week-long training school was held in each Forest Service Region for all Helitack foremen. Each foreman returned to his home unit where he was responsible for or-

[1]Maintained at Berkeley, Calif., by the Forest Service, U. S. Department of Agriculture, in cooperation with the University of California. Much of the work included in this report was conducted under terms of a cooperative student-aid agreement between Utah State University and the Experiment Station.

[2]See *Training the Helitack Crew*, Fire Control Notes 19 (2): 91-93, illus.

ganizing and carrying out his own Helitack training program. Most units held a school during the early fire season for all forest personnel. Helitack training was included as a part of this fire school (fig. 1). An outline of the revised training plan follows:

Training for Helitack Crews

I. Crew organization.
II. Tour of duty.
III. Ground operations—preparation for flight. Establishing the base heliport, alternate base heliports, and reinforcement base heliports.
  A. Location principles.
  B. Heliport facilities.
  C. Safety regulations.
  D. Assembling Helitack equipment.
  E. Helicopter operations map.
  F. Flight and other records.
IV. Training the Helitack crew.
  A. Pilot training.
    1. Helicopter use policies and working instructions.
    2. Fundamentals of fire behavior.
  B. Crew training.
    1. Helitack safety.
    2. Job familiarization.
      a. How the helicopter works.
      b. Maintenance and use of Helitack equipment.
    3. Development of skills.
      a. Physical conditioning.
      b. Refresher course in fire behavior, use of tools, and line construction.
      c. Map reading and use of compass.
      d. Ground-to-air visual signal code.
      e. Use of radios.
      f. Helijump training with protective suit.
      g. Hover-landing techniques.
      h. Helispot location and construction.
      i. Fire suppression procedure.
        (1) Initial attack.
        (2) Large fires.
      j. Heliport management.
      k. Helicopter loading principles.
      l. Standby duties: Prevention patrols, helispot networks, insect and disease control, search and rescue, aerial seeding.

Training for Helitack Reinforcement Crews

I. The place of the Helitack reinforcement crew in the Helitack operation.
II. Designating an air officer in charge and heliport management.
III. Crew training.
  A. Helitack Safety.
  B. Job familiarization.
    1. How the helicopter works.
    2. Assembling, maintenance, and use of Helitack equipment.
  C. Development of skills.
    1. Ground-to-air visual signal code.
    2. Use of radios.
    3. Helijump training with protective suit.
    4. Hover-landing techniques.
    5. Helispot location and construction.
    6. Helicopter loading principles.
    7. Fire suppression procedures.

Training for Non-fire-going Crews

I. How the helicopter works.
II. Helitack safety.
III. Helicopter loading principles.

IV. Ground-to-air visual signal code.
V. Helispot location and contruction.

Helitack, during 1958, spread to many new areas throughout the West. New areas presented new problems; flexibility of helicopter attack was a major one. To supplement the regular Helitack crew, other ground units were used as Helitack reinforcement crews. Training the old crews in new methods and the new crews in all methods became the key to the successful Helitack operation.

FIGURE 1.—Helitack crewmen are thoroughly trained in helijump techniques.

CARGO DROPPING FROM SEAPLANES ON THE SUPERIOR NATIONAL FOREST

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The fire which starts in an inaccessible area usually results in a difficult problem for Service of Supply. How to service crews in such areas, provide adequate supplies and equipment so that men can work with a reasonable degree of efficiency, has always vexed fire control officers.

The Boundary Waters Canoe Area, 1,800,000 acres in the Superior National Forest lying just south of the Canadian border in northeastern Minnesota, is just such an area. There are no roads and surface travel is slow and arduous by canoe and portage. The Superior, however, has had an "ace in the hole," its seaplane, because this part of the forest is studded with thousands of lakes and waterways. But even with the seaplane, which landed "hot-shot" crews at the nearest lake, pumpers, hose, handtools, gasoline, and supplies had to be packed, sometimes miles, to the fire. This slowed down the fire fighter and he, more times than not, arrived at the fire physically tired and too late.

The speed and effectiveness with which a fire is attacked usually determines the ultimate size of the burned area. Obviously then, any improvement that increases the speed of attack can be expected to reflect a corresponding degree of efficiency in fire suppression. This then was the problem on the Superior National Forest: (a) To get fire fighting personnel to fires in inaccessible areas as fast as possible; (b) to have them arrive in good physical condition; (c) to have fire fighting equipment and supplies ready for their use upon arrival at the fire.

Ely Service Center personnel decided that dropping equipment and supplies from the air offered the most practical solution to the third part of the problem. The dropping of cargo, one way or another, had been done almost from the time the airplane was invented. Reasons varied but usually dropping was the quickest way to get material and equipment into an area and to people in an emergency.

At that time, 1950, the Superior had three seaplanes, a Norduyn Norseman with a 27-inch belly hatch and two smaller Stinsons. Experimental work was started that year and material and supplies, packaged to fit the 27-inch hatch opening of the Norseman, were dropped both by parachute and free-fall. This proved successful even though only one drop could be made with each pass of the plane over a given area. It meant strong back and arm muscles for the droppers who had to hold the materials and containers in the hatch during the dropping run. But this was not nearly as arduous as if the supplies had to be packed to the fire and it allowed the fire fighters to arrive on the fireline comparatively fresh. Through the ensuing years considerable work has been done in determining proper type of container, contents and packaging, size of parachutes, and packaged weight of containers.

The acquisition of a DeHavilland Beaver seaplane for the 1957 fire season and the loss of the Norseman through trade-in presented a different problem. The DeHavilland Beaver had only a 17-inch hatch, which meant that many of the cargo containers would not pass through. It was not practicable to drop cargo through the door because of the danger of cargo or chute becoming snagged on the pontoons. It was then decided to experiment with cargo dropping of supplies and equipment from the pontoons themselves. If this proved feasible all three of the planes, the Beaver, a Stinson Station Wagon, and a Cessna 180, could be used. Forty-five drops, totaling 7,000 pounds, have proved the method not only safe and practicable but as far as is known unique in its field.

The Stinson seaplane was equipped first. A quickly attachable rack, to which the cargo drums are fastened, was designed to fit on top of a pontoon (figs. 1 and 2). Drums are held under tension by ½-inch elastic shock cord. When released by control cables extended into the cabin and conveniently located for the dropper to operate, they roll safely clear of the pontoons. Metal drums afford maximum protection to the equipment and are used mainly where equipment could be damaged. Pumpers, power saws, etc., are fastened inside drums with harness rings and steel runners. Plywood and fiber containers are being experimented with and can be used for hose, canvas goods, water buckets, and the like. Almost all fire fighting equipment except the heavy construction machinery can be dropped.

Numerous drops and observations, including motion pictures, were made to check for safety of operation. The original design proved so good and nearly foolproof that very little adjustment has been made, although packaging, chute sizes, and containers have been changed from time to time.

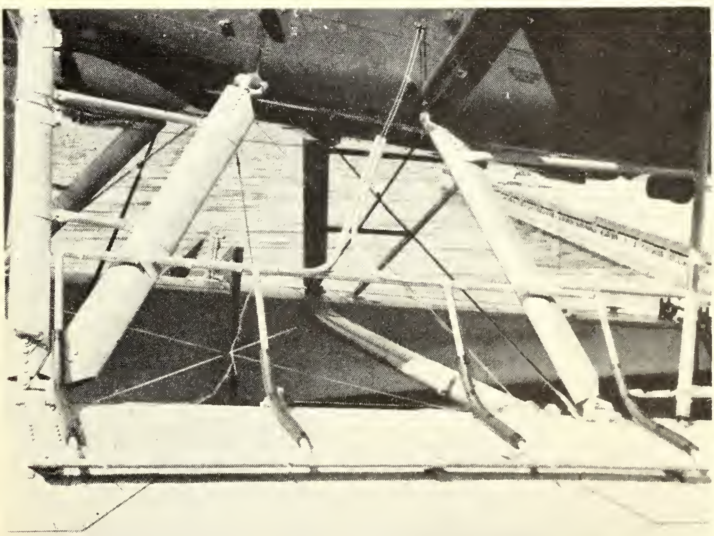

FIGURE 1.—Quickly attachable, light cargo rack constructed from conduit piping.

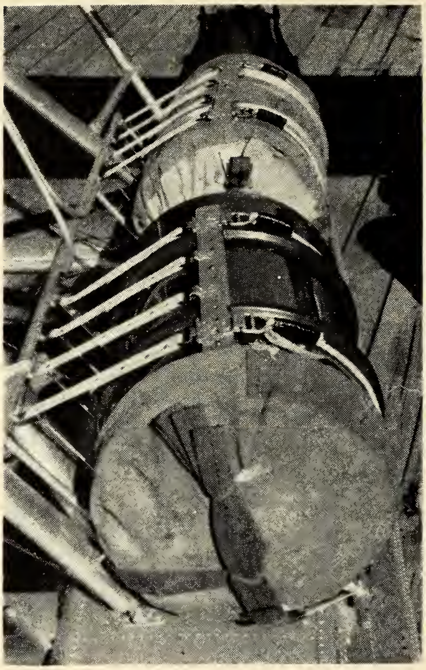

FIGURE 2.—Rack, containers, and fastenings.

Single, quickly attachable cargo racks are now available for each pontoon of the Stinson and Cessna 180 seaplanes and double cargo racks for each pontoon of the Beaver (fig. 3). By including a drop that can be made through the hatch of the Beaver, the three-

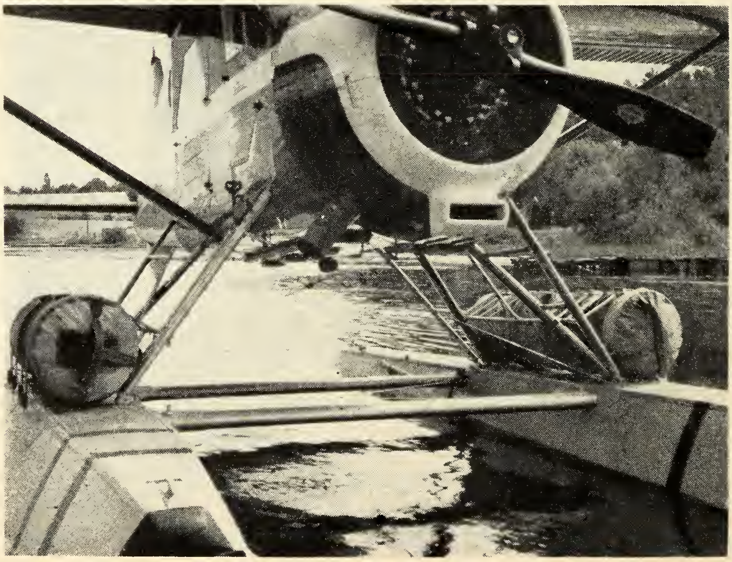

FIGURE 3.—Two containers mounted on each of the pontoons of DeHavilland Beaver seaplane.

plane fleet can deliver a total of nine drops of equipment and supplies individually or together. The many innovations available for packaging make it possible to drop almost all fire fighting equipment and supplies to suppression forces.

Weight of each container including parachute is held to a maximum of 160 pounds. Either the 24- or 28-foot military personnel chute is used (fig. 4). These parachutes are secured from military surplus and converted for cargo dropping. Lighter loads take a proportionately smaller parachute.

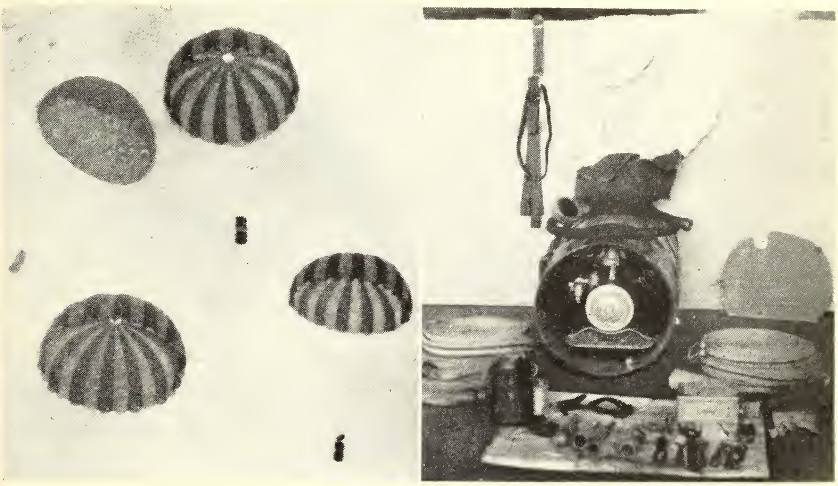

FIGURE 4.—*Left*, Simultaneous drop of four containers using converted 28-foot military surplus personnel chutes. *Right*, This container carries Pacific Marine Type A7 pumper, suction hose, 600 feet of 1½-inch linen hose, 1 gallon gas-oil mixture, nozzles, pumper tools, and spanner wrenches. Pumper is fastened securely to drum with bolts and wing nuts.

Depending upon terrain and wind conditions, drops are made from a height of 300 to 400 feet. Tests to date have shown very good accuracy. Pilots attempt to make drops as close to the fire as possible. Pumper and hose equipment is dropped to the nearest water supply. Up to now, where the container was properly packaged, no equipment has been damaged in the drop even though the container landed on ledge or rock.

Very important is the necessity of two-way radio communication, not only from a fire control standpoint but also for safety in clearing the area for dropping. Two-way radio, if not already available at the fire, is therefore the first piece of equipment dropped.

CARGO BAG HOLDER

KENNETH CALL
Dispatcher, Salmon National Forest

An easily constructed frame for holding a cargo bag while it is being filled was designed by the writer for the Salmon National Forest. The top of the cargo bag is spread and securely attached to the holder by four springs (fig. 1). The 6-inch platform (fig. 2) keeps the bag from moving away from the cargo packer and also provides a more convenient elevation for arranging packages.

Material list:

Plywood,	1 piece	¾″ x 24″ x 60″
	2 pieces	¾″ x 24″ x 18″
Lumber,	4 pieces	2″ x 6″ x 24″
	4 pieces	2″ x 6″ x 14″
	4 pieces	2″ x 2″ x 44″

Screw eyes, 4 No. 4 or 6
Springs, automobile brake shoe, 4 about 6″ long
Light strap iron, 4 pieces 2″ x 8″
Carriage bolts, 8 ¾″ x 4½″
Wood screws, 1½″ (to fasten base and tops to boxes)
Nails or screws (to fasten 2″ x 6″ pieces to make boxes).

Construction details.—Nail or screw together two pieces of 2″ x 6″ x 24″ and two pieces of 2″ x 6″ x 14″ to make a box 24″ x 18″ x 6″. Repeat with the remaining four pieces. Fasten these boxes with 1½″ wood screws to the ends of the 24″ x 60″ plywood base leaving a 24″ x 24″ opening in the center. Set the four pieces of 2″ x 2″ x 44″ in the four inside corners of the boxes. These posts should be mortised in so that their tops will be about 22″ apart. Bolt each post to a box side and end with two ⅜″ x 4½″ carriage bolts (at right angles, nuts on inside). Put tops

FIGURE 1.—Hooks on the ends of the springs are slipped into rope grommets to hold cargo bag open.

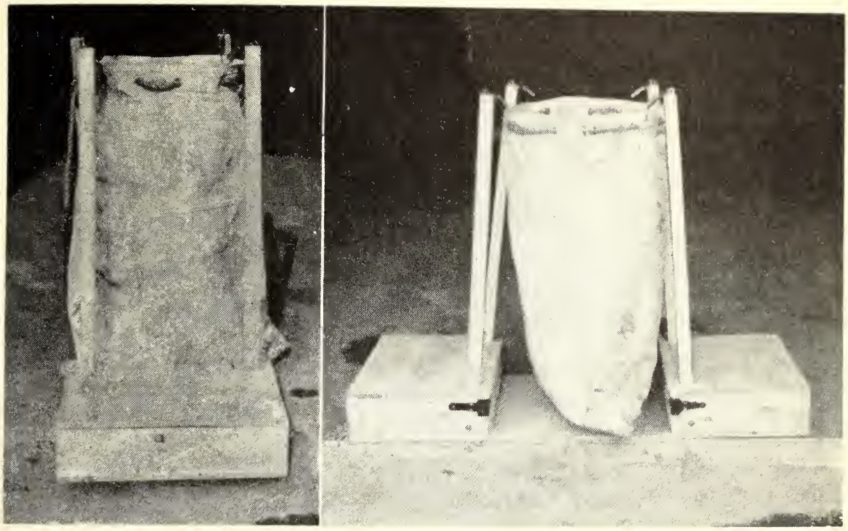

FIGURE 2.—Cargo bag holder. The plywood base acts as a spring and reduces shock on the four posts.

on boxes using ¾″ plywood (or 1″ material if more readily available). Fasten strap iron around each inside corner to reinforce posts. Make an eye in one end of each of the four springs and loop it through a No. 4 or 6 screw eye. Screw one of these into top of each post. Bend other end of each spring so it will hook into grommets of cargo bag.

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Aluminum Hard Hat Retainer

The use of chin straps to hold hard hats in place is objectionable to many people because the straps are uncomfortable and become loose easily.

A light, simple, and inexpensive retainer can be made from a piece of leather boot lace approximately 24 inches long. The ends of the lace are tied together, forming a loop approximately eight inches in diameter. This is attached to the hat by sliding the headband catches off and placing the lace behind them. The lace is fitted snugly to the brim around the front and sides of the hat, which allows a loop to drop down on the back of the head when the hat is worn. The loop can be adjusted to fit the head comfortably by pulling the lace under the slides toward the front of the hat.—*Albert H. Leuthauser, Forester, Williamette National Forest.*

UNIFYING FIRE DANGER RATING—A NATIONAL SYSTEM NEEDED

A. A. Brown
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Forest fire danger rating is now a little over 25 years old. Starting as an innovation devised by H. T. Gisborne and first applied in 1933 to guide the seasonal buildup of fire control forces in Montana and North Idaho, it has kept growing in importance and usefulness as a management tool for the administrator.

The concept of rating fire danger relates fire which is universal to environment which is local. It is only natural that this correlation, or combination should lead to some contradiction and to some confusion in thinking. Because the environment for the start and spread of fire in forest lands has infinite variation, efforts toward making danger ratings faithfully reflect its influence, have tended also toward detailed variation in the fire danger rating systems employed. These variations have become increasingly troublesome.

A regional system must necessarily reflect a variety of environments, yet it takes on a suggestion of highly localized adaptations and of fixed accuracy up to some jurisdictional boundary. Systems vary also in the purposes served, in their numerical expression, and in how they are to be interpreted. No one system is best. Each has its advantages and limitations. Each is serving a valuable function, and each has well repaid the time and effort devoted to them by fire research men and administrators. All require diligence in observation and reporting, and experience and skill in application for best results.

But further effort in this direction is not likely to be very productive. Individual refinement and administrative adaptation of the details of a variety of inexact danger rating systems is very time-consuming. It is not conducive to maximum contributions by research men and cannot contribute much to overall progress in fire control.

For maximum progress ahead, the time has come for fire danger rating to attain national status and for all danger rating to become part of a unified national system through a single project. This is a big task. It must take into account the universal response of fire to a few controlling factors, yet recognize just how these factors operate locally. The objective visualized is to develop a universal formula for rating fire danger and a more uniform method for giving it expression, but with full provision for substituting varying values in this formula to reflect local environment.

A 3-year project to produce a unified national system has been initiated. Mr. John Keetch was selected to head it up. In the following article he gives the history of the project and a brief progress report.

Further research in moisture and wind relationships under carefully controlled laboratory conditions will be necessary to establish points of reference for the national system. The help of a field committee which will soon be established will also be needed to resolve many other questions of systems and method.

UNIFYING FIRE DANGER RATING—PROGRESS TOWARD A NATIONAL SYSTEM

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Ever since the first probing estimate of the severity of burning conditions was made to guide fire preparedness planning, fire control men have earnestly searched for more reliable means to gage the current fire danger. Fire research technicians in all parts of the country have spent many years studying the problem, identifying the significant elements of fire danger, exploring methods of accurately measuring the key factors, and integrating the variables into useful ratings. In the past 20 years, fire danger measurement has progressed far beyond the trial stage, and is today universally accepted as an important tool in fire control management. The extent of use is emphasized by the fact that every day during the fire season nearly 3,000 trained fire danger observers, distributed throughout the forested areas of the United States, make careful measurements of fire danger elements according to accepted regional procedures.

Though there has been considerable progress in identifying and clarifying weather as a key variable, unfortunately the weather elements recognized, their method of measurement, and their integration in a scale of fire danger vary widely in different regions of the country. Since combustion and fire behavior follow the same natural laws everywhere, the multiple variation in existing fire danger systems serves to confuse rather than to clarify, particularly in interregional and national application.

In recent years there has been a growing determination to resolve this confusion. The possibility of standardizing fire danger rating methods was considered at the National Fire Research Conference held in Missoula, Mont., in 1955. The conferees agreed that standardization was technically feasible. The 1957 Report of the Fire Task Force, under the chairmanship of A. W. Greeley, stated the problem more urgently. The task force report strongly recommended that steps be taken as soon as possible to develop standard methods of rating fire danger. Although none of the fire disasters reviewed by the task force could be directly attributed to the confusion created by different danger rating systems, the report concluded that the situation was potentially dangerous because of the increasing interregional use of fire men, and the increasing use of fire danger data in all phases of fire control.

The need for better unification of fire danger ratings for use by Forest Service cooperators is also urgent. This need was emphasized by a request from the Bureau of Land Management for a single objective method of rating fire danger on their range areas. As a result of these and other recommendations, a joint committee of Fire Research and Fire Control men met in Washington January 1958, under the chairmanship of Dr. George M. Jemison. The group considered the needs for a unified rating system, the benefits to be gained, and agreed that a servicewide fire danger rating system was practical. The committee strongly recommended an aggressive development program which would result in the construction of a national fire danger rating system. Work on the project was started in the summer of 1958.

The first effort was directed at examining the problem region by region. As of May 1, 1959, a survey of the needs and uses of fire danger rating throughout the country, and a study of all the fire danger systems in current use, was completed. In all systems one of the major factors is the moisture content of the lightweight fuels forming the surface layer of the forest floor. In attempting to provide a more realistic measure of the complete litter drying rate, the majority of systems recognize two drying regimes, i.e., the surface drying and the buildup in the lower litter or larger fuel components. However, no two systems agree either on a standard for the surface litter, or the more complicated lower litter phase of the problem. In addition, drying in deep duff or organic soil to several feet below the surface is an important factor in many areas.

An objective of the national system will be to measure uniformly the effect of weather on standard fuels. To do this will require the development of several servicewide fuel standards as a first step. Work so far has been concerned specifically with the moisture content of surface fuels. A suggested standard for identifying surface fuels and an outline of the research needed to test the standard and to develop a method of measuring surface fuel moisture have been sent to all national-forest regions and experiment stations for review.

The moisture content of surface fuels was considered the first phase of the study, to be followed by development of separate standards and methods for measuring lower fuel moisture and deep duff conditions. The correlation and weighting of the standard fuels in a uniform fire danger system and their correlation with wind speed will be made.

One of the prime objectives of the national system will be to provide as accurate a measure as possible of the relative seriousness of burning conditions as an aid in fire control. To accomplish this objective, and to interpret the national system for local application in specific situations, a later phase of the study will be the development of separate fire indices that include fuel type and topography as variables.

USE OF THE 60-SECOND-PRINT CAMERA FOR STEREOPHOTOGRAPHY OF PROJECT FIRES AND RELATED ACTIVITIES

VINCENT J. SCHAEFER
Consultant, U. S. Forest Service

The polaroid system of photo reproduction is rapidly becoming a recognized and reliable tool in forest research and field activities. Perhaps the greatest advantage of the 60-second-print camera in Forest Service use is its rapid processing feature. In an activity so dependent on field evaluation, the value of an immediate visual record of a going fire, a lumbering operation, an insect kill, the progress on a new road, the site of a planned operation, etc., can hardly be overestimated. Since many pictures must be taken under poor atmospheric conditions, it is also of great value to be able to make an immediate check on the quality of the photo so that if necessary another exposure can be made.

STEREOPHOTOGRAPHY

The advantages and usefulness of stereophotography in forest and range practice are accepted facts. The 60-second-print camera has unique advantages for such use especially when combined with a small, reliable airplane. For fire suppression activities its value can hardly be overestimated. Although good stereo-pairs are simple to prepare, they result only if the camera is properly used.

In practice the most effective simple method for obtaining good stereo-pairs is for the observer to photograph the same object twice with a hand-held camera. The time between photographs is governed by the distance of the area of interest and the speed of the plane. As a general rule the photographic base line should not be greater than a quarter of the distance to the object. Thus if a fire is a mile away the base line should be in the range of 1,000-1,500 feet. In a plane traveling 100 miles per hour in calm air the time interval between photographs should thus range from 7 to 10 seconds.

The plane should be flown in a clockwise direction around the fire area or other object of interest. The distance is governed by the focal length of the camera. The photographer-observer is best equipped to decide this matter and should use the finder on his camera to advise the pilot. Photos are of best quality if taken through an open window. If this is not feasible the camera should be held with the lens nearly but not quite touching the window. During the photographing period the pilot should hold a straight course for the time interval between pictures and the photographer should pick out some feature of the subject in the center of the field and photograph it twice. The pilot should call the time although the photographer can also measure it in seconds by the familiar "one little second," "two little seconds" count down. Insofar as possible the photographs should always be taken with the sun to the rear or at right angles to the photographer.

With the quick-print camera the first photo is taken and immediately "pulled"; the second photo is then taken after the appropriate time interval. The second exposure is then "pulled" after the regular 60-second development interval.

If the photographs are of a fire and they are to be dropped to the fire boss it is recommended that the photos be coated while in the plane or slipped into suitable clear plastic envelopes. This latter procedure is recommended since it is possible for the observer to adapt the photos to stereographic mounting while the pilot is maneuvering for his drop run. The compass bearing of the photo direction, time, and date should be indicated on the mounted pair.

FILTERS

The filters that are available, including neutral, polarizing, and color filters, provide some of the most effective attachments to a camera. Experimentation will quickly establish their proper values for special purposes.

The "polascreen" is most useful in directions at right angles to the sun for cutting through haze, increasing contrast in critical directions, and controlling reflected light. The red filter provides high contrast for clouds and smoke against the sky or forest. A combination of red filter and properly oriented polascreen gives the maximum contrast possible. Proper orientation can be obtained by holding the polascreen over one eye and rotating it for a half turn. When the desired effect is attained the orientation with respect to the plane of the camera can be noted by the flats and numbers on the filter holder. If the polascreen is used with another filter it should be mounted on top so it is readily available for checking orientation.

With low light intensities a red filter may need to be replaced by a yellow filter. Rough rules based on Type 44 Polaroid can be given. A combination of red and polascreen filters gives an ASA rating of 10, the same as for 35-mm. Daylight Kodachrome. Good results are only achieved by practice and a few rolls of film used experimentally is a sound investment.

CONCLUSION

The 60-second-print camera can become a powerful tool in forest practice when properly exploited. With the present availability of 4″ x 5″ polaroid type sheet photos, all press type cameras become usable for this purpose. A special, relatively inexpensive attachment can be adapted to such cameras to greatly widen their usefulness. The 4″ x 5″ photos are large enough for use as illustrative material in reports. A little realized feature is that if protected from light, the negative which is normally discarded can be hardened in hypo and used as a first-class negative. For stereophotography the special quick-print camera turns out to be most practical and economical.

HEATER TO KEEP PORTABLE PUMP ENGINES DRY

Earl A. Weed
Fire Warden, Clatsop Tree Farm, Crown Zellerbach Corporation, Oregon

The problem of condensed moisture in the electrical components of small motors used to power portable pumps has been a constant source of trouble to all people connected with forest protection. This problem is especially acute in the Pacific Northwest coastal areas where cool nights with high relative humidity prevail. Several different storage methods have been tried at the Clatsop Tree Farm, but it was found that in a 2-week period enough moisture had formed in the electrical system to lower the output of the magneto 50 percent. This was sufficient to cause extremely hard starting, and in some cases rendered the pump unusable. The practice of starting each motor every 2 weeks and allowing it to run long enough to thoroughly warm the engine has been tried. This however is a costly, time-consuming job, as each motor must be taken from its stall and then returned. It was also found that if atmospheric conditions favored high humidity and low temperatures, excessive condensation was caused when the motor cooled. Therefore, there is a definite need for some device to prevent this condensation within the magneto. It is felt that the device described herein will economically and effectively fill this need.

The device consists of a sheet metal cone having a diameter of 10 inches and an altitude of 8 inches. At the apex of the cone a standard light socket, containing a 25-watt bulb is held in place by a radiator hose clamp (fig. 1).

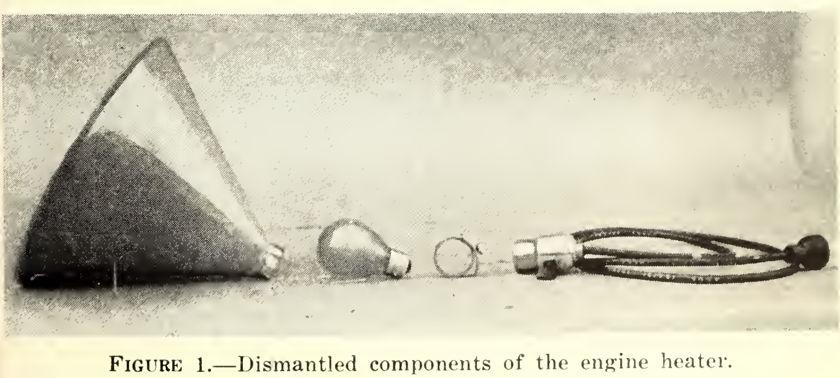

Figure 1.—Dismantled components of the engine heater.

The cone should be tailored to fit over the flywheel cover. The 10-inch diameter will fit most medium size motors. The cone is held in place over the flywheel ventilating screen by 2 sheet metal screws (fig. 2). To facilitate quick removal, the holes in the cones are elongated and the sheet metal screws are attached permanently to the motor.

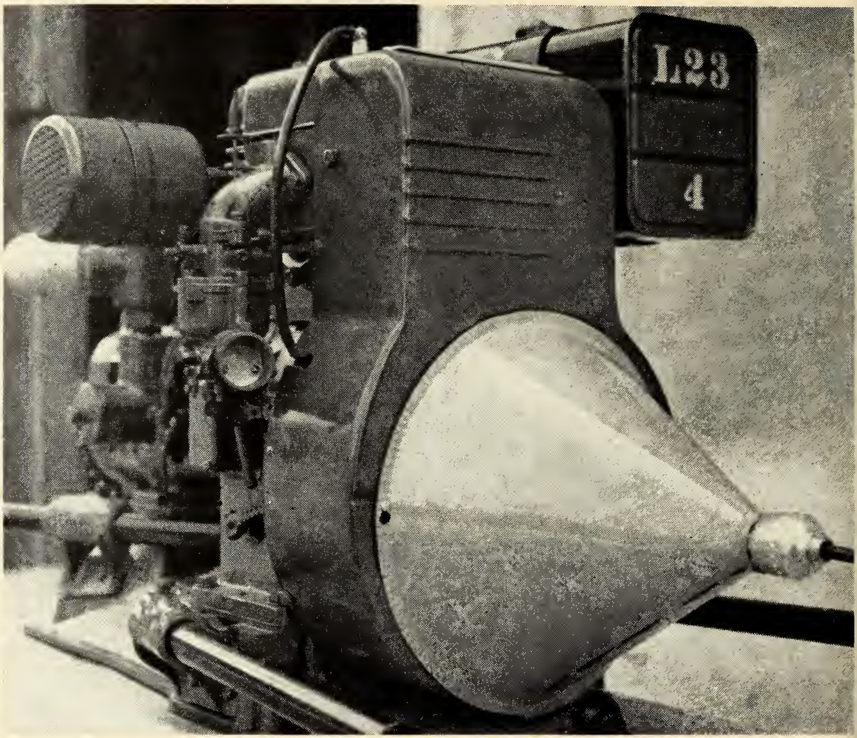

FIGURE 2.—Engine Heater fastened to the motor.

It has been found through tests that a 25-watt light bulb burned continuously is sufficient to provide heat enough to keep the magneto and breaker points dry enough to insure full output at all times. It is now only necessary to start the motors for periodic tests, thereby saving a considerable number of man-hours in periodic starting and in some cases, complete disassembly in order to dry out the magneto.

HOW FOREST FIRES WERE STARTED—CUMBERLAND AND MORGAN COUNTIES, TENN., 1953[1]

TENNESSEE DEPARTMENT OF CONSERVATION DIVISION OF FORESTRY AND TENNESSEE VALLEY AUTHORITY DIVISION OF FORESTRY RELATIONS

The Cumberland-Morgan County area is one of several high forest fire occurrence areas in the Tennessee Valley. Situated on the Cumberland Plateau in East Tennessee, it is fairly typical of the whole Cumberland Mountain area—not only in forest conditions but also in land ownership, agriculture, and industry. Eighty percent of the two-county area is drained by the Emory River, a troublesome tributary of the Tennessee.

The area is characterized by the rugged topography of the Cumberland Mountain Range and the rolling uplands of the Cumberland Plateau. There are few good access roads on the plateau and fewer still in the mountains. This makes rapid transport of fire fighting personnel and equipment impossible and increases the fire hazard.

Between 1945 and 1950 10 percent of the total forest area in Cumberland and Morgan Counties burned over each year. The average annual burn was about 67,000 acres. Under such conditions, watershed protection benefits are limited and long-term timber management is discouraged.

Although the Tennessee Division of Forestry had established organized fire protection in both counties in July 1949, too frequent fire occurrence continued to be the number one problem. Collaborating with TVA's Division of Forestry Relations, the State forester instituted an intensive prevention program in 1951. The objective was to reduce the number of fires through a concentrated attack on major fire causes. The project forester, employed by the State, tackled the well-planned project with energy and skill. However, experience in 1952, a "bad" fire year, was discouraging.

When representatives of the two agencies reviewed the project, they concluded that more precise and detailed information was needed on fire causes; recorded data appeared to be inaccurate. For example, past fire records indicated that 59 percent of all fires were caused by incendiarists. But careful observations during 1951 and 1952 led to quite different conclusions.

The project was accordingly revised. The direct prevention program was dropped, and the project forester concentrated on a detailed study and report of each fire. First he had to test and perfect a system for determining precise fire causes; then he had to establish the specific cause of each fire in the two-county area and the motivation behind the cause.

[1]Condensed from *How Forest Fires Get Started in Cumberland and Morgan Counties, Tennessee,* [34] pp., illus. March 1954. [Processed.]

FIRE CAUSE ANALYSIS

The method developed for determining fire cause proved successful. Of the 238 fires that occurred during the dry year of 1953, specific causes were reliably determined for all but 9.

When the project was set up, determination of fire cause was listed as the project forester's primary job. This took precedence over everything else. He worked under the direct supervision of the State forester and had full freedom of action in conducting his investigations. Technical and advisory assistance was provided by TVA foresters as requested.

Although nothing was allowed to interfere with his fire investigations, the project forester did assist the district forester and TVA personnel with related forestry activities in the two-county area. As time permitted, he established two fire danger stations and one fire damage demonstration plot, organized 29 volunteer fire crews, conducted approximately 30 community meetings, and assisted with reforestation and timber harvesting demonstrations.

He was stationed in the local district office (Harriman) where he could get immediate notification of fires as they occurred. When in the field he maintained contact with either the district office or a "key" tower—one in each county was equipped to communicate with all other towers. He was thus able to begin his investigation of many fires soon after they started. This was important, because the quicker an investigation is started, the more likely it is to succeed. Actually he determined the precise cause of approximately 15 percent of all fires while they were still burning.

On each fire he first got all available information from towermen and fire crew leaders before making any inquiries in the field. This included date, time of day, location where first seen, how reported, etc. A towerman could often supply information on land ownership and the presence of hunters, fishermen, campers, loggers, or other persons in the area. In the case of debris burning or incendiary fires, he frequently could point out the exact spot where a fire had been set. Crew members could often provide information on point of fire origin and attitude of landowner (some people wanted their land burned over).

Next came a thorough search of the burned area for any evidence that might help establish cause—shell cases left by hunters, den trees that had been fired, remains of brush piles, burned stills, etc.

People living in the immediate area were then interviewed. Many times such questioning produced immediate positive information. In other cases, people were reluctant to express an opinion for fear of being "burned out" or otherwise harmed by the one who had set the fire. Discussions around general stores frequently revealed the name of the responsible party. As a general rule, at least five neighboring landowners were questioned about each fire. The primary purpose of these interviews was to get information, but they also served notice to a lot of people that the State was interested in eliminating forest fires.

When investigation pointed to a suspect, the project leader called on him and diplomatically informed him of the purpose of the investigation. Reactions varied. Brush burners usually admitted responsibility. While incendiarists and still operators resented being approached, they would often confess if tactfully handled. (Fixing *legal* responsibility was not a part of this project.)

The time required to thoroughly investigate a fire varies considerably. About 65 percent of the cases successfully concluded in this study were solved the first day; another 25 percent within a week. For the remaining 10 percent, some required intermittent investigation for as long as 2 months before the true cause could be established.

RESULTS

While the information assembled is for the two-county area only, it may be representative of a much wider area of the Cumberland Plateau.

Specific causes were determined for 96 percent of the 238 forest fires that burned in Cumberland and Morgan Counties during 1953. As data on fire causes, landowner attitude, and fire occurrence are quite similar, the two counties are treated as a single unit in this report.

The distribution of fire causes in 1953 was found to differ considerably from that previously reported. Debris burners, rather than incendiarists, were the chief cause. Sportsmen (hunters, fishermen, and campers) were also responsible for a large number of fires.

Precise causes were many and varied. The wide range, plus contributing reasons, argues strongly for some refinement in the standard classification customarily used.

Debris burners caused 35 percent of all fires. In this category are fires resulting from range burning, land clearing, burning tobacco beds, and cleaning fields, yards, and gardens. Only 7 debris burners out of 84 had taken any precaution to keep fires from spreading or becoming wildfires.

Sportsmen were responsible for 29 percent of all fires. Of the 68 in this category, 42 were started by hunters trying to smoke game out of den trees. The other 26 fires were traced to warming fires left by hunters, fishermen, and campers, their carelessness with smoking material, and an attempt to burn out bees.

Twenty-two fires (9 percent of the total) were found to be incendiary. Only those fires set with the intent to do harm (those stemming from meanness, spite, grudge, or revenge) were included in this category. For example, one involved an attempt to burn a church; another was a "cover up" for a still; another was set in an effort to obtain timber cutting rights. Those set with the idea of improving (?) woodland pasture or range were classified as debris burning fires.

Lumbering fires include those traced to burning sawdust or slab piles, loggers' warming fires, or their carelessness with smoking material in the woods. Fifteen fires (6 percent of the total) were thus traceable to lumbering.

Of the 11 railroad fires (5 percent of total), 5 were caused by fusees, the other 6 by sparks from engines. Diesels operating in the area were responsible for some fires. They, too, on hard pulls, throw off sparks capable of starting fires.

Twenty-one fires (9 percent of the total) were attributed to smokers. Where a smoker fire was traceable to one of the other causes, it was charged to that cause. That is, if a hunter caused a fire through carelessness with smoking material, the fire was classified as a sportsman fire. Only those that could not be traced to some other cause were called smoker fires.

Seventeen fires (7 percent) were classed as miscellaneous. Four of these resulted from children playing with matches, two from warming fires, and two from washpot fires. One was set for the avowed purpose of killing snakes.

The most surprising outcome of the study was that 54 percent of the owners of burned woodland were not concerned. They either wanted their woodland burned or didn't care one way or the other; and they didn't hesitate to admit their indifference. One landowner whose property burned summed it up this way: "Just don't see what it will hurt." Some landowners, however, do burn as a protective measure. They burn their woodland during February in an effort to prevent late spring and summer fires.

Responsibility for 32 percent of all fires was directly traceable to landowners. This does not include fires charged to sportsmen, lumbering, or smokers even though some of them were undoubtedly landowner caused.

Three-fourths of all fires originated from debris burning, smoking out game, land clearing, range burning, or maliciousness. Accidental fires—those caused by railroads, lumbering operations, careless smokers, and miscellaneous causes—accounted for only one-fourth of the total.

CONCLUSIONS

This project proved first of all that fire causes can be pinpointed with a high degree of accuracy and that facts essential to a sound fire prevention campaign can be assembled.

The records show no concentrations of fires by causes, except in the case of railroad fires. It appears that forest fires can be expected anywhere in the two-county area from any cause.

Posting land against hunters appeared to be a basic cause for several of the "spite" fires set by incendiarists. One landowner who posted his land prior to the hunting season, found practically all of it burned that fall. He removed the signs the following year and had no fires.

Landowners are predominantly indifferent toward fire regardless of how much land they own. Owners of small tracts seem to be a little better informed about fire damage, but more than 40 percent of them favor burning or just don't care. Only 46 percent of those whose land had burned had definite convictions against forest fires.

Woodland in absentee ownership was the target of many fires. There seems to be little local respect for any land lacking constant custodial supervision. Wildfires controlled by local residents on their own land are often allowed to burn freely on land having no local custodian. Unauthorized backfires are also more common on these woodlands than elsewhere.

Apparently the distribution of fire causes is affected by changes in land ownership pattern, local employment conditions, and the industrial picture generally. For this reason fire causes should be checked periodically to keep prevention programs on the right track.

There seems to be a strong correlation between number of fires and class of fire day. Ability to forecast fire danger accurately should be helpful in planning prevention activities.

Day of the week is apparently unimportant in fire occurrence—one day is as bad as another. As could be expected, more fires started during the day than at night; 85 percent originated between 8 a.m. and 5 p.m.; more started between 1 and 3 p.m. than in any other 2-hour period.

A man assigned to this type of project should be adept at meeting people. He should be capable of mature judgment, based on a careful sifting of facts. He should be thoroughly familiar with the policies and procedures of the fire control agency and have some understanding of the customs and habits of the local residents.

HOW FOREST FIRES WERE STARTED—NORTHERN GEORGIA AND SOUTHEASTERN TENNESSEE, 1957[1]

Georgia Forestry Commission, Tennessee Department of Conservation, and Tennessee Valley Authority Division of Forestry Relations

For years the Georgia and Tennessee counties surrounding Chattanooga have been plagued by an extremely high number of forest fires. As far back as the early 1940's, foresters and landowners have sought answers to this perplexing situation.

In 1956, Dade and Walker Counties, Ga., and Hamilton and Marion Counties, Tenn., had next to the highest incidence rate in the Tennessee Valley. They had 724 fires in 1953, 826 in 1954, 519 in 1955, and 626 in 1956, an annual average of 91 for each 100,000 acres of forest land. The 20-year average (1934-53) for the 125 Valley counties was 41 fires per 100,000 acres.

State organized protection was established in Hamilton and Marion Counties in 1949. Dade County was organized in 1944, Walker County in 1950. As suppression forces became better trained and equipped, the area burned dropped sharply. However, there was little appreciable drop in number of fires.

In 1957, the Georgia Forestry Commission, Tennessee Division of Forestry, and Tennessee Valley Authority joined in a survey to determine the precise causes of fires, who is responsible, why people permit forests to burn, and what they think about forest fires in general.

DESCRIPTION OF AREA

Total area of the four counties is 1,069,000 acres, 71 percent is forested. Much of the forested area lies in the Cumberland and Lookout Mountain extensions of the Appalachians.

The rural population—177 persons per square mile—is more than two and one-half times as dense as that in the surrounding counties. Some of the rural wage earners are coal miners and woods workers, but most of them are part-time subsistence farmers with regular employment in Chattanooga, Rossville, or Lafayette.

Many business, professional, and political leaders had expressed interest in better fire protection and development of timber resources. Some landowners had been practicing forestry for more than 15 years. Radio and TV stations and the press were interested and cooperated in conservation projects. Several wood-using industries supported and participated in forest protection and development programs. Spotting past fires on maps revealed 11 definite concentrations in the four counties. These included only 22 percent of the forest area but accounted for 53 percent of the fires.

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[1]Condensed from *How Forest Fires Were Started in 1957 in Northern Georgia and Southeastern Tennessee*, [13] pp., illus. May 1958. [Processed.]

FINDINGS

Every one of the 112 fires that occurred in the 11 designated areas during calendar year 1957 was investigated. Cause was determined with a high degree of confidence for 100 of them. The causes varied widely, as did the conditions under which fires occurred.

The pattern of debris burning (household, agricultural, garden, and dump burning) was pronounced in four areas. In two areas, fires originated from burning household refuse—paper and other trash. Burning is done at edge of yard, usually at the back of the lot. The fire is left unattended and escapes either directly into woods or through adjoining grassy area into woods. Adults, mostly housewives, were usually responsible. In another area, most fires start when new ground is being cleared for strawberries. Brush and small trees are cut and piled or bulldozed into windrows and then burned. Because material is green, burning is usually done on dry, windy days. In still another area, fires can be expected at spring gardening time. Early gardening and windy weather coincide. In some cases the clean-up is done simply by setting fire to the dead grass, weeds, and briars and letting it spread over the garden.

Who started the fires? Housewives and farmers led the list with 19 and 18 percent, respectively. Children were responsible for 14 percent, woods workers 11 percent, general laborers and factory workers 9 percent each. Six percent were caused by coal miners, 6 percent by unemployed persons, 3 percent by garbage collectors, 3 percent by moonshiners, and 2 percent by store clerks.

Why do so many people let the woods burn? As revealed by this analysis, they don't do it deliberately. Of the 112 landowners involved, 102 were opposed to woods burning, 5 indifferent, and 5 noncommittal. And yet, 26 percent of the fires were started by landowners. In 81 percent of the cases no precautions were taken to keep the fire from spreading.

Fires occurred most frequently between 1 and 4 p.m. Saturday was the worst day of the week. Incidence build-up began on Friday, reached a peak on Saturday, and tapered off to a low on Wednesday and Thursday. Fires caused by men were most frequent in the early evening. Fires caused by women followed no set pattern. Two-thirds of the fires occurred during the spring fire season, one-third during the fall season. March was the "hottest" month with one-third of the total.

FOLLOWUP

The survey and analysis revealed nothing of an unusual nature that would require major revision of present prevention programs in either State. It does indicate the desirability for some "tailoring" of present methods to fit each area. The occupational and habit patterns of local residents differ by areas even though fire causes are similar.

A fire prevention program, based on survey findings, was developed by a committee representing field forces of the three cooperating agencies and put into effect by the two States. These are some of the activities undertaken:

1. Personal contacts were made in the neighborhood of each fire. There were many indications from this survey and analysis that inquiries about fires have a deterrent effect.

2. Eighteen industrial establishments (over 250 employees) were supplied with enough fire prevention posters to service their safety bulletin boards for a year. Purpose was to reach the group of debris burners who work at plants but live in the country.

3. Three television stations were supplied with 23 appropriate film shorts; seven radio stations with 45 platters. Five newspapers were given weekly forestry material for publication.

4. Foresters discussed fire prevention at meetings of the local strawberry growers association and District 50, United Mine Workers.

5. Some 400 landowners received five pine seedlings each. They were given to all persons who had started fires, and also to some of their neighbors. Purpose was to create interest and ease followup contacts.

Other plans included:

1. Development and selective distribution of a poster on how to burn household refuse safely.

2. Encouragement of more citizens to report fires. To accomplish this, the States would provide better information on how and where to report fires. Telephone companies would be asked to list "How to report a forest fire" under emergency calls in telephone directories. Persons who reported fires would be telephoned later as to what action was taken and size of the fire.

3. Continuation of semi-annual meetings of the interagency committee on forest fire prevention to evaluate past prevention techniques and to develop new ideas.

4. Use of tree planting as a fire prevention tool: (a) Continue the practice of distributing a bundle of five pine seedlings to persons who started fires and to their neighbors; (b) canvass residents in a very limited area of high fire occurrence to determine interest in planting 100 tree seedlings each supplied without cost. This would be done as a club project aimed at creating interest in forest fire prevention.

5. Demonstrations to be held in cooperation with Home Demonstration Clubs on how to burn trash safely in the vicinity of woodlands.

The general public is becoming more and more aware of the effect of forest fires on timber resources and watershed values. However, there are local areas where the damage is not fully understood or appreciated, where further educational work is needed. While the effectiveness of steps now being taken cannot be evaluated for several years, some comparisons should be possible by 1960. By then, there should be a reduction of 300 fires. The rate should be down to about 40 fires per 100,000 acres of forest land. That is the immediate goal.

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.

Prevent Forest Fires!

VOL. 20 OCTOBER 1959 NO. 4

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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Forest Service, Washington, D. C.

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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]

C. C. Buck
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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.

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[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

H. B. ROWLAND and S. S. COBB
Chief and Assistant Chief, Division of Forest Protection, Pennsylvania Department of Forests and Waters

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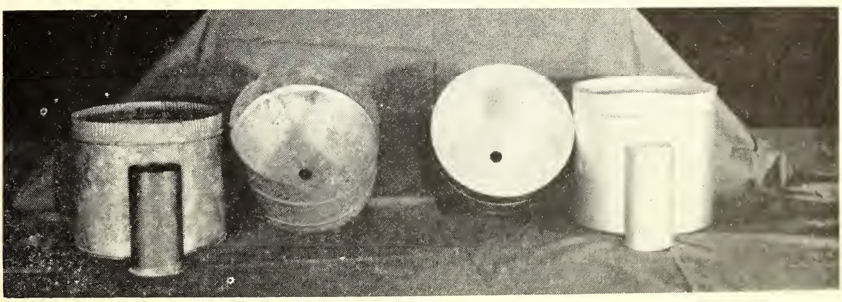
Aluminum Rain Gage and Plastic Measuring Stick For Fire-Weather Stations

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

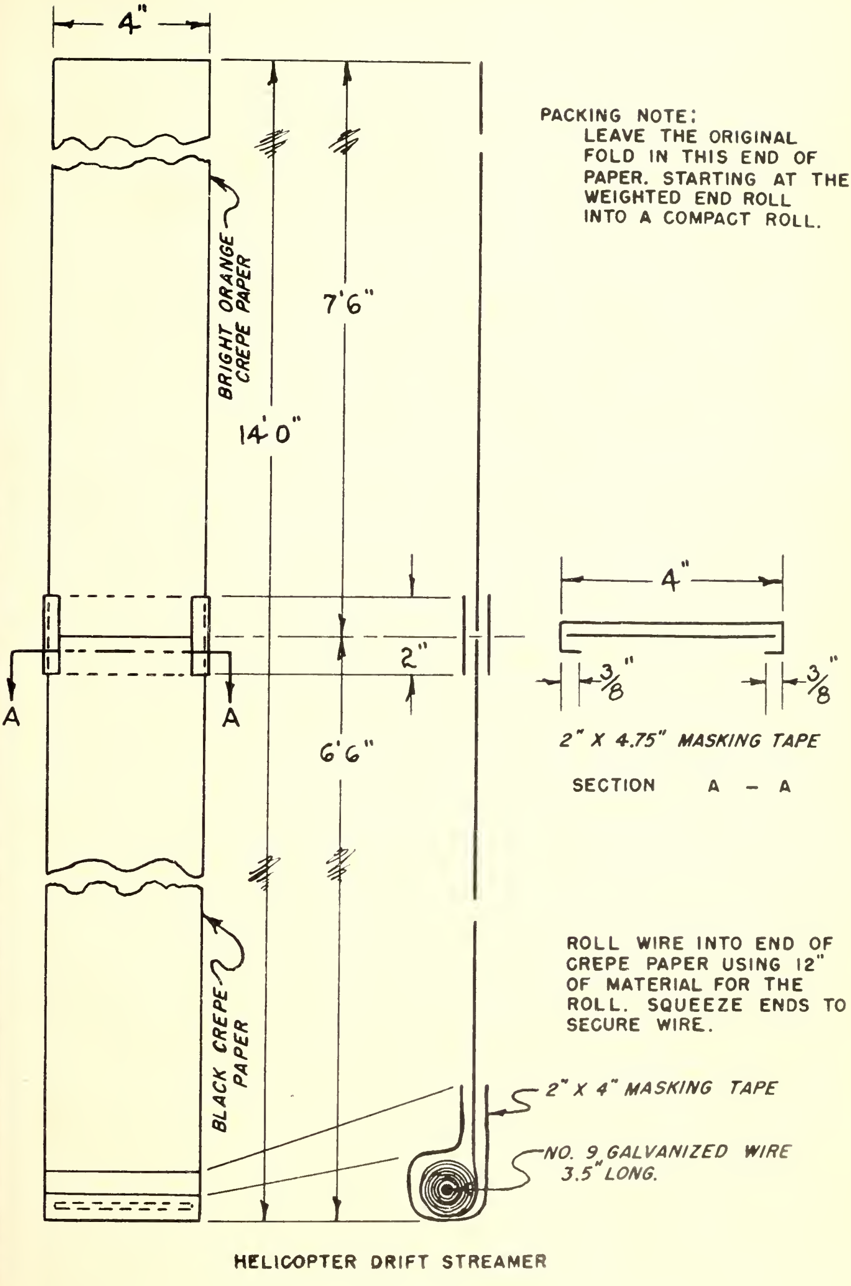


FIGURE 1.—Helicopter drift streamer (drawing ED-185-R1, July 59).

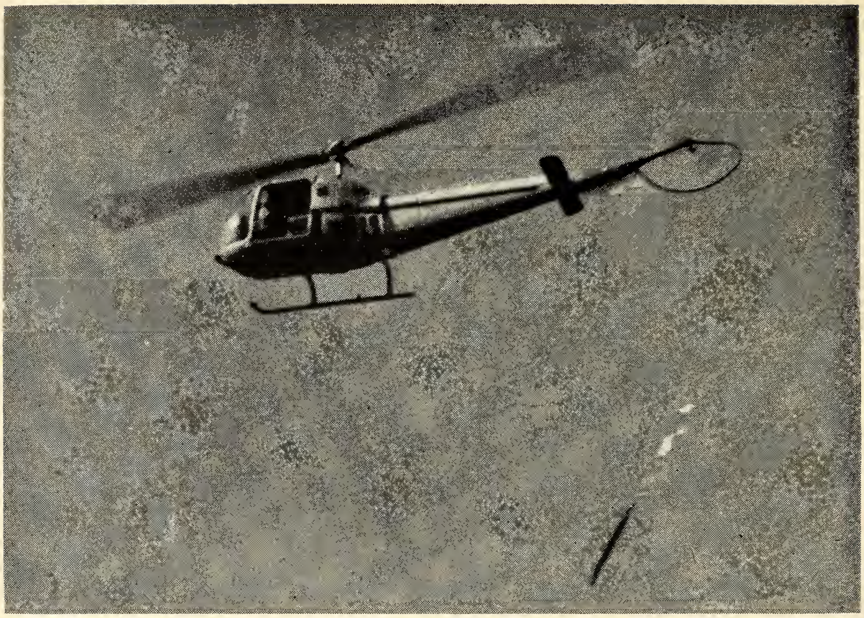


FIGURE 2.—Pilot throws drift streamer out above helispot and circles to observe wind.

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.

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[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.

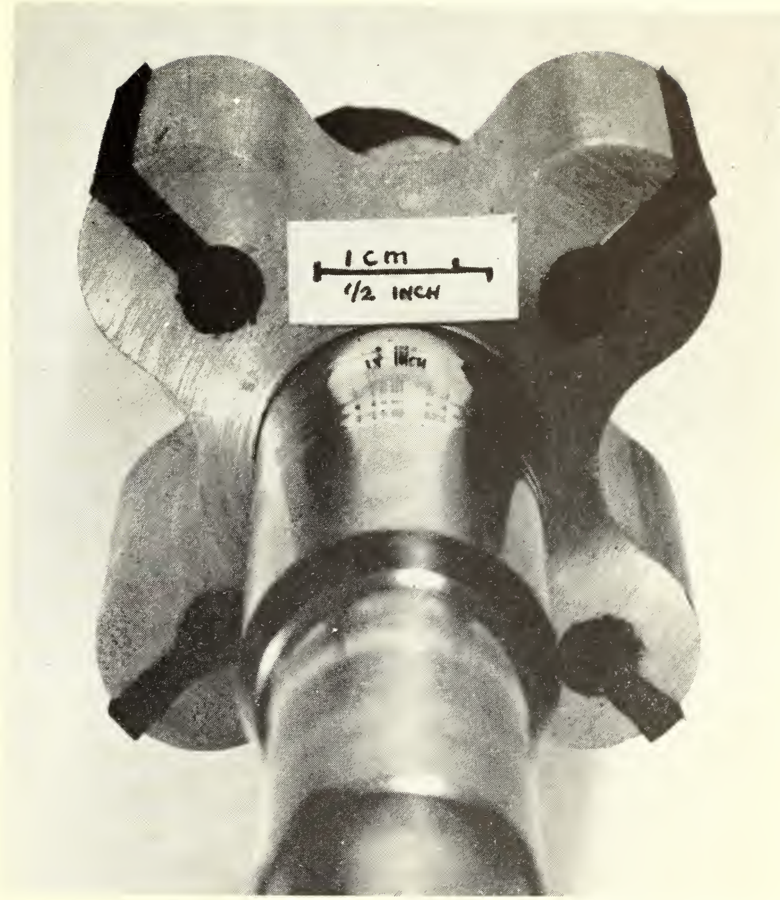

FIGURE 1.—Gear lobes fitted with inserts.

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 $\frac{3}{8}$-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.

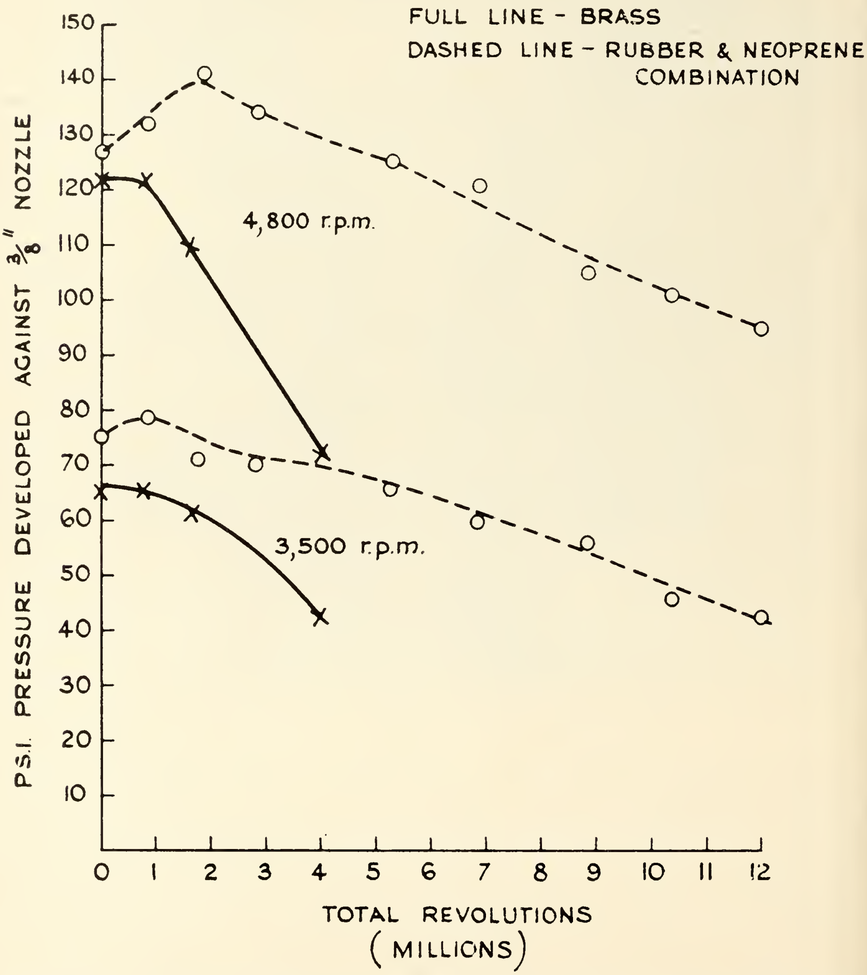

FIGURE 2.—Loss of pressure with use for gears with and without inserts.

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.

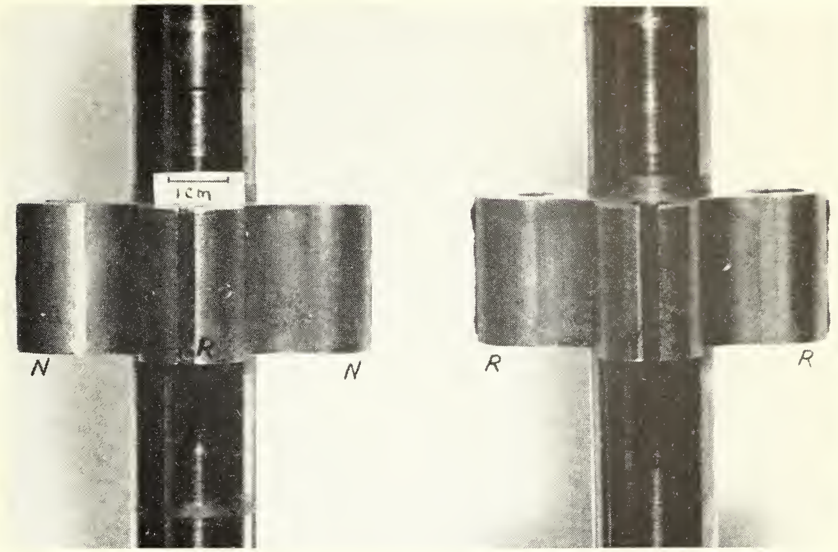

FIGURE 3.—Gears with neoprene (N) and rubber (R) inserts after 12 million revolutions.

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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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.

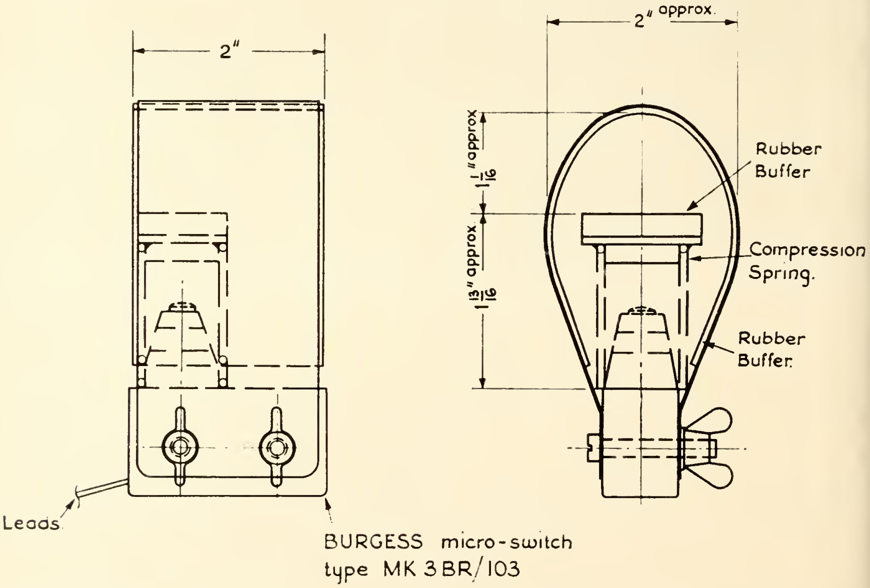

Figure 1.—Automatic pump cutout. Further details may be obtained from Chemical Research Laboratories, Division of Physical Chemistry, drawing S-548.

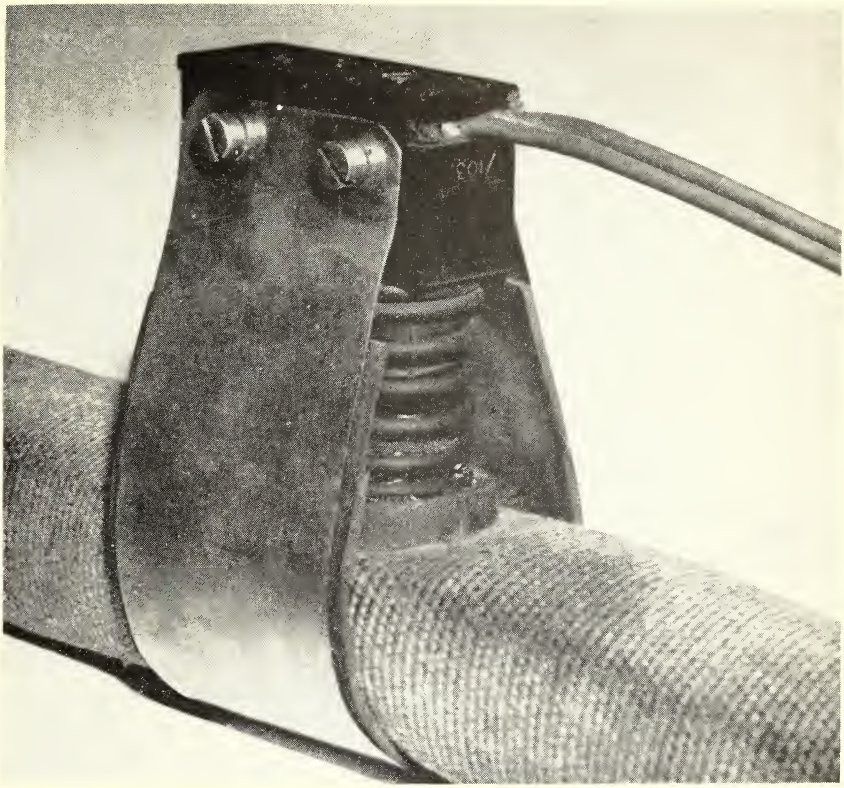

FIGURE 2.—Automatic pump cutout in place.

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.

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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.)

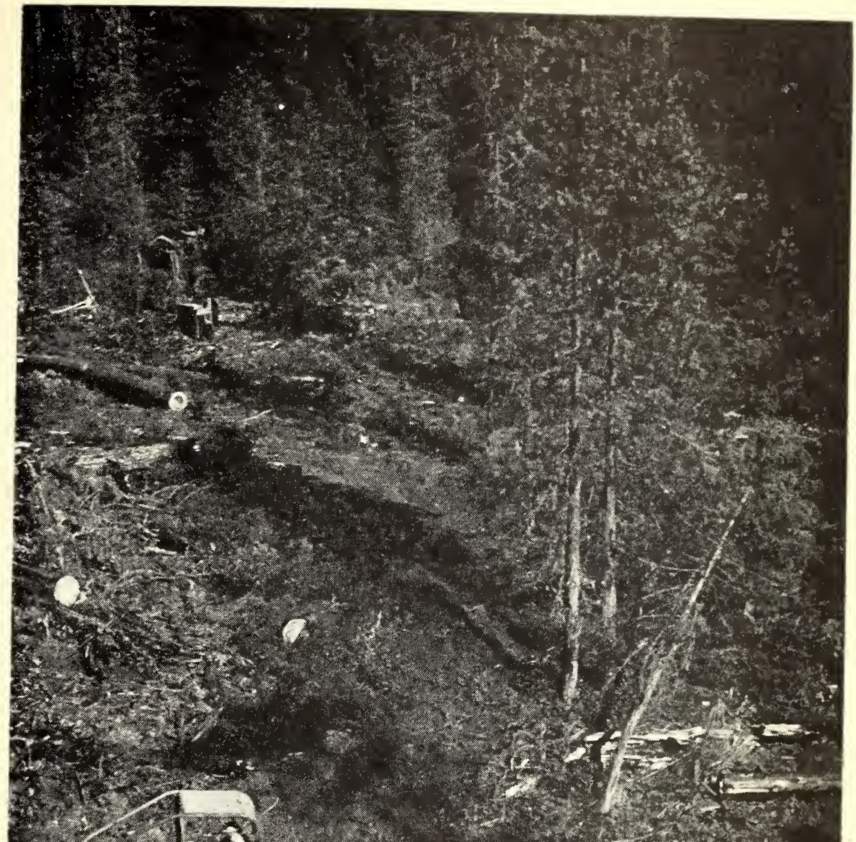


FIGURE 1.—Bulk of slash is in the form of cull logs that have to be pulled into clear area for piling and burning.

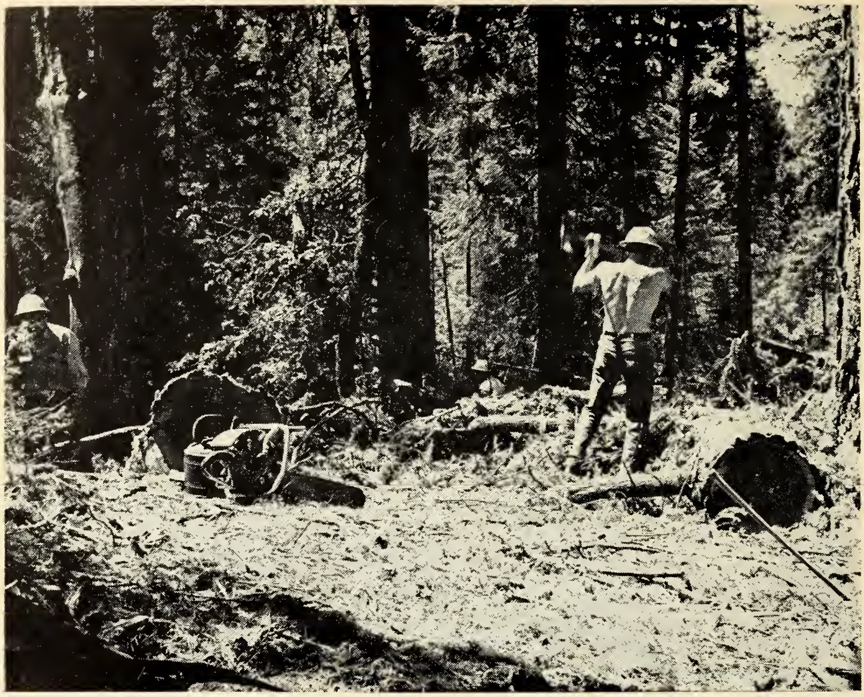


FIGURE 2.—Hand piling slash in critical saddle on Mill Creek Sale area. This crew works in key areas that are uneconomical for machine operation.

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.

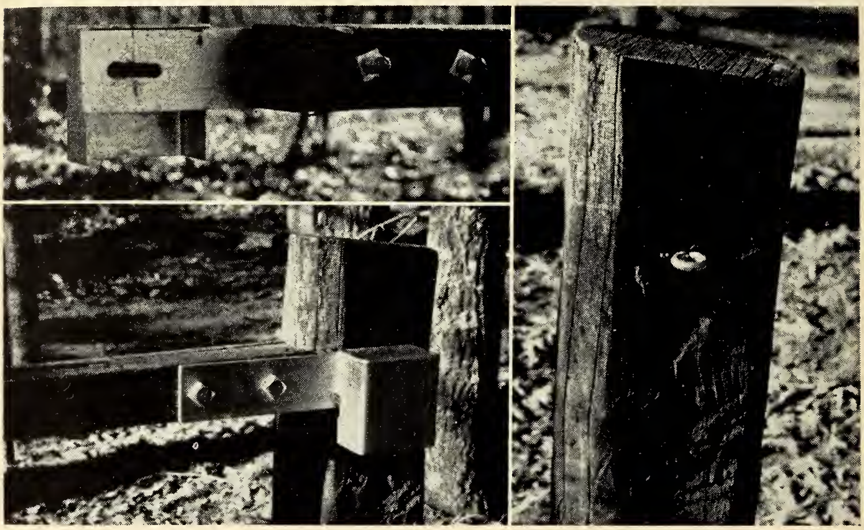
The concept of unit-area control, which was first adapted to the mixed conifer stands by William Hallin, opened the way for development of a similar system in the Douglas-fir on Klamath Forest. The Klamath unit-area control system of marking was such a radical departure from anything used before that 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.*

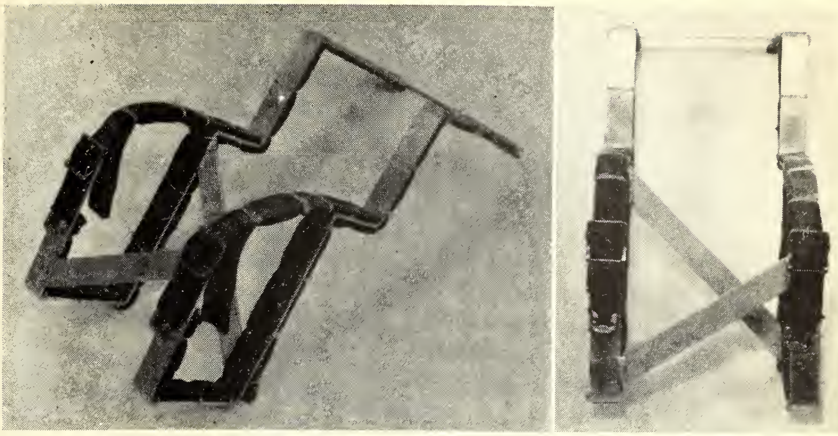
☆ ☆ ☆

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!