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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 15 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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RECOGNIZING WEATHER CONDITIONS THAT AFFECT FOREST FIRE BEHAVIOR

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Violent or erratic fire behavior often develops as a complete surprise even to the more experienced fire fighters. Such behavior usually is not completely explained and is frequently dismissed with the remark that the fire suddenly "blew up." Unusual fire behavior is often closely related to certain weather conditions that can be recognized by visible characteristics. These weather conditions, some of their characteristics, and their relation to fire behavior are described here.

The descriptions and terminology used in this discussion agree with definitions in the U. S. Weather Bureau *Weather Glossary* of 1946, with two exceptions. These are *fire storm*, which has been used in published accounts of fires started from extensive incendiary bombings, and *fire whirlwind,* which is possibly used here for the first time. Weather conditions described are divided into two major groups, phenomena of stable air of which only inversion is discussed, and phenomena of unstable air including turbulent, convective, and whirling.

Stable air (stability).—Air in which vertical motions are suppressed primarily because of the vertical distribution of temperature. In stable air, underlying air is relatively cooler and heavier; overlying air is relatively warmer and lighter. If the temperature decreases no more than 5° F. per 1,000 feet increase in elevation in dry air, the air is stable. In extremely stable air, temperature may actually increase with height.

There are several indicators of stable air. Surface wind is steady or frequently calm and smoke tends to lie in layers. Clouds are the stratus or stratified type showing no vertical motion (fig. 1). Visibility is often poor, particularly in the lower layers. Ground and valley fogs form in stable layers near the ground. Air in the lower layers is usually stable during calm, clear nights, but becomes unstable in midday when heated by the warm ground.

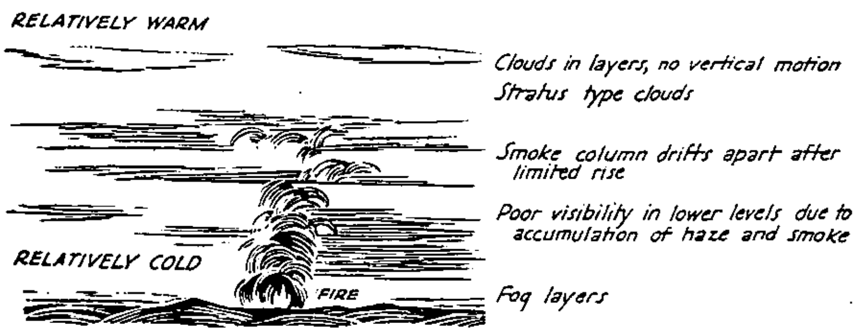

FIGURE 1.—Stable air.

Convective circulation into the base of a fire and in the column of rising hot gases above a fire is weak. Both the intensity of the fire and the amount of spotting is reduced. In stable air, smoke will not rise as high, and much drift smoke will remain in the lower layers. The most common stability phenomenon is the inversion layer.

Inversion.—A horizontal layer of air through which temperature increases with increasing height. An inversion is the most stable air condition. Inversion layers occur at any height and vary greatly in the thickness. As the ground cools at night, a surface layer of air becomes colder than the air above and produces a surface inversion. Surface inversions are most pronounced in valley bottoms to which cold air flows from surrounding slopes. This type of inversion is readily dissipated by ground heating during the day.

Since an inversion tends to suppress any vertical motion, its base is frequently marked by: (1) the flat top of a cloud or fog layer, (2) the common height at which rising cumulus clouds cease to rise, and (3) the height at which a rising smoke column levels off (fig. 2). There is often greater wind, or a shift in wind direction, above the inversion. An inversion near the ground affects a fire in the same way as stable air but to a greater degree. In the lower layers it tends to weaken drafts into and above a fire, thereby reducing the fire's intensity and spotting potential. It has been suggested that flammable mixtures of gases liberated by a slow-burning fire might accumulate under a surface inversion, and that these might ignite and burn explosively.

Unstable air (*instability*).—Air that tends to turn over owing to relatively warm, light air in the lower layers and relatively cooler, heavy air in the upper layers. The decrease in temperature with increasing height is greater than in stable air—5.4° F. or more per 1,000 feet in dry air. Vertical motions are accelerated. Upward and downward currents develop. Indicators are erratic surface winds with gusts and lulls, and a variation in direction and turbulence above the surface layers. Since smoke, dust, and haze are widely dispersed by mixing of high and low layers, visibility is generally good. Clouds in unstable air are the cumulus type with pronounced vertical development and restricted horizontal area (fig. 3). A deep layer of moist, unstable air may be marked

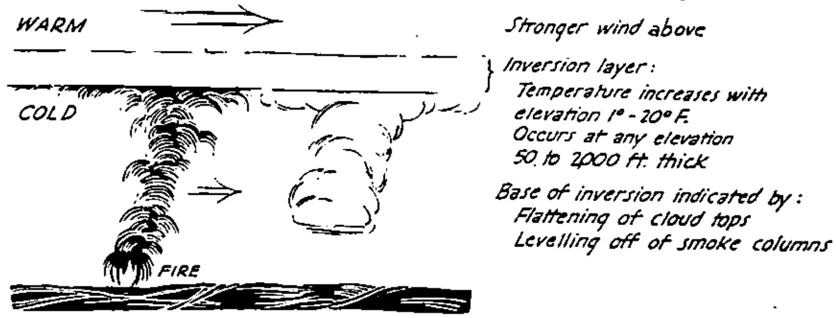

FIGURE 2.—Inversion.

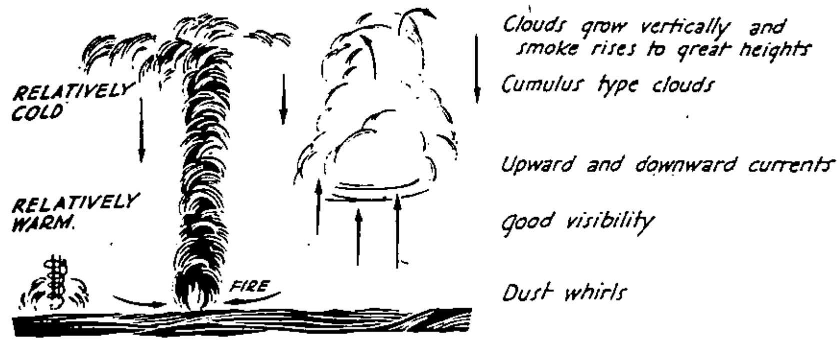

Figure 3.—Unstable air.

by cumulonimbus clouds or thunderstorms. Instability at the cloud level does not necessarily mean that this condition exists all the way to the ground. If it does exist, it may be indicated by dust whirls and erratic winds.

Unstable air affects fires in several ways. Spread of fires may be accelerated by gusty wind. The column of smoke over the fire will rise faster and to greater heights than in stable air, resulting in a stronger indraft at the base of the fire and a hotter burning fire. Spot fires are more likely because of the more intense drafts in the fire and the greater vertical speed in the smoke column. Unstable air is favorable for the formation of fire whirlwinds. These effects are discussed in more detail under the several instability phenomena described below.

Turbulence.—Irregularity in air motion shown by bumpy air for the pilot and gusty wind for the ground observer. Any obstacle to the wind sets up mechanical turbulence on the leeward side (fig. 4). Intermingled currents of rising warm and descending cool air cause thermal turbulence, which is characteristic of unstable air. Turbulence may be accentuated by an uneven surface heating that varies with color of soil, amount of shade, and type of ground cover.

Gustiness.—A characteristic of wind in unstable or turbulent air. Gustiness refers to surface winds that vary rapidly in vertical and horizontal speed and direction. Increasing instability and increasing turbulence caused by surface obstacles result in corresponding increases in gustiness. Since a fire greatly increases surface instability, the intensity of gusts is likely to be greater in the immediate vicinity of a fire. Gusts usually cause a fire to spread spasmodically in unpredictable directions. They also cause rapid fluctuation in fire intensity and rate of spread.

Convection.—Motion in the air resulting from temperature differences in adjacent bodies of air. Convective currents are characteristic of unstable air. They consist of rising warm air and descending cool air currents (fig. 5). Heating at the ground either by the sun or by fire may initiate the upward current. Surrounding air descends and flows toward the base of the column of rising air. The rising warm air above a continuing heat source is known as the convective column. Above a fire this is seen as the

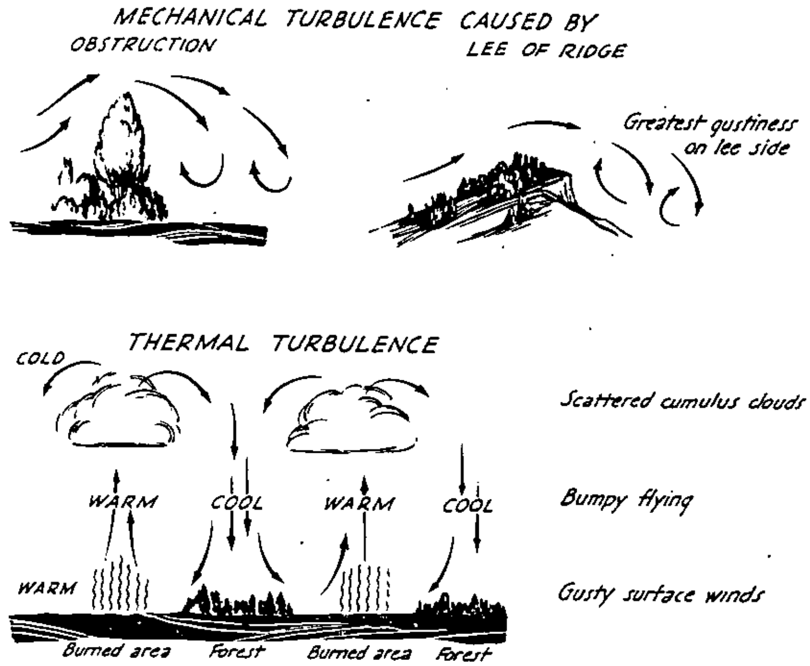

FIGURE 4.—Turbulence.

smoke column. Cumulus clouds are convective columns that have become visible because of moisture condensation. The greater the instability of the air or the greater the source of heat, the more intense becomes the convective circulation caused by a fire, including both indraft at the base and updraft in the smoke column. The more intense the convective circulation, the hotter and faster the fire will burn and the higher embers will be carried.

Thundersquall.—The sudden wind that blows outward from beneath a thunderstorm. Such a wind originates in the area of

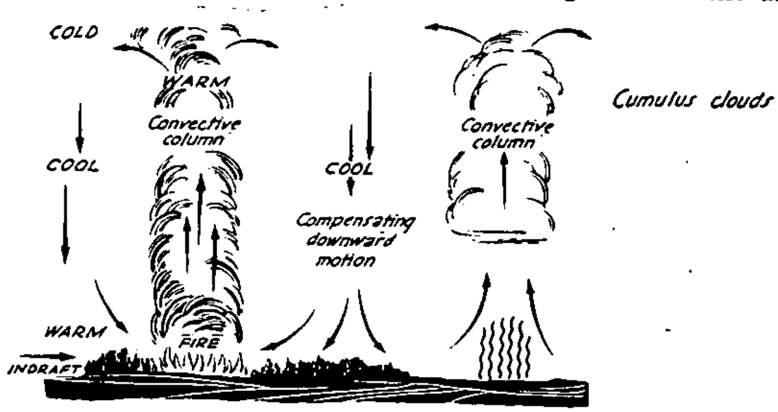

FIGURE 5.—Convection.

heaviest precipitation in a cumulonimbus cloud, a convective cloud type that occurs in unstable, moist air. Air, cooled by precipitation, descends from the cloud and fans out at the surface (fig. 6). The thundersquall usually occurs with a well developed thunderstorm and hits suddenly with speeds averaging 30 to 50 miles per hour for a period of several minutes. The thundersquall may occur beneath a thunderstorm from which no precipitation reaches the ground, and may extend outward a mile or more ahead of the storm edge.

These sudden, strong winds may sweep a fire far beyond its confines before the rainy section of the thunderstorm arrives. If the rain evaporates before reaching the ground, the fire may continue to burn unchecked.

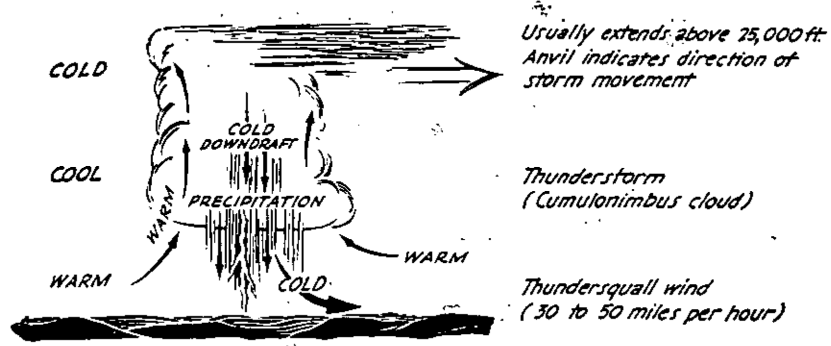

FIGURE 6.—Thundersquall.

Whirlwind.—Any revolving mass of air from the dust whirl to the hurricane. The tornado, a whirlwind associated with thunderstorms, is the most severe, though not the largest type. Whirlwinds are usually associated with extremely unstable air. Fires frequently make the nearby atmosphere unstable and produce fire whirlwinds. Two types of whirlwind will be described, the dust whirl and the fire whirlwind.

Dust whirl.—The smallest type of whirlwind, frequently known as a dust devil. Dust whirls indicate unstable air. They occur on sunny days with light surface wind when the layers of air next to the ground become much hotter than the air immediately above. These whirls are usually 5 to 25 feet in diameter and may extend upward several hundred feet. Though usually not of destructive force, dust whirls can throw small debris several yards. The greatest speed is near the center where a strong upward current occurs. Dust whirls occasionally form in the vicinity of fires and move into the fire area throwing sparks and embers in all directions and temporarily intensifying the fire as they pass.

Fire whirlwind.—Any whirlwind ~~that is caused by a fire~~. The fire whirlwind may vary in intensity from a small dust whirl to a whirlwind that easily snaps off large trees. The diameter of its circulation may vary from 3 to 50 yards or more. Fire whirlwinds encompassing whole fires 1,000 yards or more across have been reported. Besides the rotating horizontal winds, there is a

strong vertical current at the center which may raise burning debris to great heights. Even a small fire whirlwind may produce considerable spotting and local intensification of the fire. A central spout or tube may sometimes be present (fig. 7). Because of the wind and the resulting accelerated combustion, fire whirlwinds are sometimes accompanied by a roaring noise similar to that produced by a rapidly burning fire. Duration and behavior are variable. Fire whirls may occur and recur where the combination of fire-produced instability, topography, and wind are favorable. It is sometimes possible to dissipate a small, recurring fire whirlwind by cooling the part of the fire over which it forms.

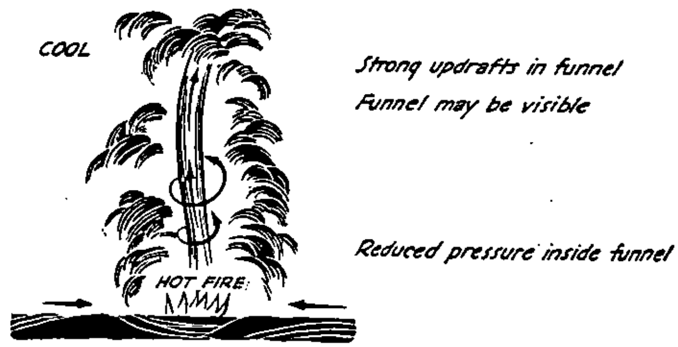

FIGURE 7.—Fire whirlwind.

Fire storm.—Violent convection caused by a large, continuous area of intense fire. This phenomenon was frequently observed after extensive fire-bomb raids in Europe and Japan. The convective system usually encompasses the entire fire (fig. 8). The surface draft into the base of the fire may be of destructive violence several hundred yards outside the fire. The fire storm, like other convective phenomena, increases in intensity with greater atmospheric instability. Burning material may be lifted several miles high. A fire storm is not likely in the usual wildfire where only the periphery is actively burning.

FIGURE 8.—Fire storm.

HELICOPTER USE—FIRE SUPPRESSION

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The Moose Creek District lies in the heart of the Selway-Bitterroot Primitive Area. The end of the closest road is approximately 25 miles from the station. Nearly all of the cargo and most of the personnel are transported in and out by air. All crews for fire suppression must be flown in from Hamilton or Missoula, Mont. Smokechaser action, beyond the small amount provided by the resident organization, is supplied by smokejumpers. Many of the drainages have been burned off during early bad fire years, leaving heavy brush and snag areas, and in a few places, dense reproduction. Elevations range from 2,300 feet on the Selway River to 5,000 and 6,000 feet on the lower ridges. These ridges continue higher, usually ending up on the rocky divide in the peaks of 8,000 to 9,000 feet. The 20-year average for fire occurrence is 31 fires a year.

In 1949 a project to study the field use of the helicopter was conducted on the Moose Creek District. This district was chosen because of the variety of ground and cover conditions, elevations, and a high fire potential in critical periods. During the study a total of 53 helicopter landing spots were made available for future use.

Ranger Jack Parsell participated in the helicopter-use project, and his long experience with problems of back-country fire suppression provides a sound background for his recommendations. The following, taken from his report on use of the helicopter at Moose Creek in August 1953, makes interesting reading and affords much for serious thought regarding future fire control action.

The Fire Situation

December snows fell on the dust at the higher elevations while the lower elevations were free of snow for most of the winter of 1952-53. Summer precipitation records at Moose Creek show only 2.91 inches up to August 23, 1953. Temperatures ranged high during July and August, reaching a record high of 108°. Humidity dropped to a low of 14 percent and fuel moistures to a low of 4.3. There were only a few days that winds were a major factor, but winds of 15 to 30 miles per hour occurred during a period of dry electric storms on August 6, 7, and 16.

With this buildup, the district was hit by a series of dry electric storms between August 6 and 16 resulting in a total of 38 fires—25 class A, 11 class B, and 2 class C. The class C fires were 23 to 30 acres. Twenty-eight of the fires occurred in fuel types that gave promise of major conflagrations, the other 10 were either at or near timberline, or otherwise surrounded by retarding elements.

Since the entire region had been hard hit by lightning storms, manpower, planes, and equipment were at a premium. Smokejumpers, when returned to the Missoula base, were sent out on other missions within a few hours. Often there were no jumpers available. District personnel consisted of 4 lookouts, 5 trail men, 3 tower crewmen, 4 firemen, 3 packers, 1 alternate, 1 dispatcher, 4 per diem guards, and 2 women cooks—a total of 27. Actually, only 17 of this number could be used as fire-goers; the others filled strategic positions in detection, dispatching, and service of supply. Additional manpower had to be supplied by air, 50 to 100 miles distant.

On August 7 at 5:00 a. m. 22 new fires had been discovered and reported. Initial action had been taken on as many fires as the 6 available jumpers and district personnel could reach on the evening of August 6. Three additional men came from Hamilton by patrol plane at 7:45 p. m. August 6, and were quickly dispatched to a fire near Shissler Lookout. There would be no more men available until 8:00 a. m. on August 7.

The helicopter arrived August 7 at 6:30 a. m. A patrol was initiated to make a reconnaissance of the situation on the ground at each fire. Known fire locations were spotted on a map and given consecutive numbers. Corresponding numbers were placed in a notebook with adequate space for writing notes. In 1½ hours a complete analysis of fuels, topography, manpower, and equipment needs for each fire had been obtained. This knowledge of the overall situation was invaluable because the shortage of jumpers, aircraft, and additional manpower was very acute.

Since a number of these fires were so located that they could cause considerable damage and result in costly fires, the knowledge obtained by a close analysis with the helicopter made possible the best use of such manpower and equipment available. It was quickly known which fires needed immediate reinforcements, which ones were adequately manned, and which ones would require a minimum of men and material because surrounding natural barriers would prevent their becoming major fires. There is no doubt that the helicopter saved thousands of dollars in unnecessary manning and delivery of equipment and supply.

A Few Examples of Helicopter Use

Battle Creek Fire (SW¼, sec. 34, T. 34 N., R. 14 E.).—At 2:30 p. m., August 18, Diablo Mountain sent in the first report of the fire, which was in a blind area near the creek bottom. Within a few minutes 3 more lookouts reported the fire. Fuel type maps showed it to be in High-Medium fuels surrounded by H-H, M-L, M-M, and L-L fuels. It was situated at the bottom of a very steep 4-mile slope, exposed to the prevailing winds. At this particular time the winds were variable 15 to 25 m. p. h. All available information to the district dispatcher would indicate a fire of large proportions very shortly.

The last 7 jumpers available were immediately dispatched to the fire. Five crewmen, including a fire boss, were sent by helicopter to the nearest landing spot at Elbow Bend. The fire boss

studied the fire with the helicopter before setting down and sent word by radio that more men would be needed. Arrangements were made with Ranger Moore at Powell for 14 more men to go in from the end of the Elk Summit road, a walk of 8 miles. By this time 32 men had been mobilized. Twelve men were on the fire and 20 more enroute. Ranger Moore notified Moose Creek that 50 more men were available at Missoula. Tom Smith, Forest Dispatcher, reported another 25 men at Hamilton. Since there had been no opportunity to make close observation of the fire, it was thought advisable to hold off further action until the situation could be assessed and the needs determined.

At daylight the following morning a reconnaissance trip was made over the fire. The observer reported that the effective work of the original 12 men had confined the fire to the only small area of open yellow pine in that drainage and that with the other 20 men soon to come, they could keep it from reaching the heavier fuels that surrounded the area.

Had it not been possible to make close observation of this fire, prompt dispatching action would most certainly have called for the mobilization of a hundred or more men, together with the necessary food, supplies and equipment. The probable cost of moving and supplying 100 men in that area would be about $30,000, while the actual cost will be approximately $5,500.

Meeker Ridge Fire (Sec. 7, T. 32 N., R. 12 E.).—Two jumpers were dropped on this fire on the morning of August 7. At 7:08 the 'copter was over the fire, which appeared to be adequately manned. The fire was located on a steep south exposure subject to the prevailing winds. Fuels were for the most part a thick stand of ceanothus with a considerable number of logs. In advance of the fire were vast bodies of H-H fuels, 6 or 7 miles in extent, the result of 1934 fires.

At 2:10 p. m. the helicopter was again over the fire with Dispatcher Dowling. He observed that the fire was out of control and that the jumpers had lost part of their equipment. A message was dropped for them to clear a 'copter spot nearby, and the helicopter was then dispatched to bring men from Shearer Ranger Station. Five men were mobilized with the 'copter by late evening of the 7th. As soon as the 'copter spot was complete, 5 men were placed on the fire at about 15-minute intervals, beginning at daylight on the morning of August 8. They soon sent word back that they could control the fire and there would be no need for more men.

In the event early discovery of the situation had not been made and these men would have had to walk the 15 miles from Shearer, plus the 8 miles to the fire, a project fire of considerable proportions would have no doubt resulted. Considering the fuels, slope and exposure, with burning conditions as they were, the fire would probably have reached 100 acres or more before control could be effected. Conservative costs of a fire of this size in primitive country would be around 40 or 50 thousand dollars.

The early detection of trouble for the initial attack force and the ease with which reinforcements were placed directly on the

fire held the blaze to a class B at a cost of $650, which included cost of the 'copter and cost of delivery of the first two smokejumpers.

Tony Point Fire (Sec. 22, T. 32 N., R. 12 E.).—This fire resulted from a previous lightning strike. It showed up at 1:30 p. m. August 20 during a heavy wind of 15 to 25 m. p. h. It was 6 trail miles from headquarters at Moose Creek, with a climb of 3,900 feet. Fuels were bug-killed lodgepole with an overstand of alpine fir and spruce. The fire had a possible ½-mile run uphill fanned by prevailing winds before a natural break occurred.

Five men were at Moose Creek, 4 of whom had just completed a 12-mile hike from 2 fires near Freeman Peak. The headquarters guard was the only fresh man available.

The helicopter was started immediately, and the first man was delivered to a spot on Moose Ridge approximately 1 mile above the fire. The helicopter returned in 24 minutes. The second, third, and fourth trips delivering men were made in 18 minutes each. The fifth trip was made in 16 minutes. By the time the last 2 men were up, the first 3 were doing effective work on the fire. In short the record is this: the fire broke at 1:30 p. m., by 2:25 3 men were on the fire and 2 more within a mile of it, and at 4:30 p. m. the fire boss called in by radio and reported that the spread was stopped at approximately 1 acre.

Even if jumpers had been available, it is doubtful that they could have arrived in time to save this from becoming a fire of around 20 or 30 acres. Certainly if ground forces had made the initial attack the fire would have run to the first natural break about ½ mile distant. This would have resulted in a 25- or 30-thousand-dollar fire. As it was, the cost was approximately $550 including helicopter flying time.

Conserving Manpower

At 9:20 a. m. August 22 a report was received of additional dry electric storms. There were no men at the Moose Creek headquarters. Twelve miles distant at the Log Ridge fire 8 jumpers had just completed control of the fire and were turning it over to a local crew, and preparing to walk to Moose Creek. In order to have men in better shape for another possible break, the helicopter was directed to bring these men to the Moose Creek base.

In just 2 hours flying time, at a cost of $170, all 8 jumpers were at Moose Creek with their jump gear and cargo chutes. We not only got these men back in good physical condition for another fire, but also saved a pack string and packer a 24-mile round trip for the jump gear. The ability to place men strategically and quickly and to conserve their strength is an important factor in handling a fire siege of this kind.

A False Report

At 11:20 a. m. August 22 a lookout reported a fire making fast headway in the headwaters of West Moose Creek. The location was about 15 air miles from Moose Creek station. According

to the lookout the fire was throwing a large volume of smoke with a rapid rise that would indicate a crown fire. The helicopter was dispatched immediately to investigate this report, and make an analysis of the situation.

It was found that the lookout was actually seeing a crown fire that was part of the Lizzard Peak Fire on the Clearwater Forest, and that no fire was present at the location given. Had it not been possible to make a quick survey of this situation, not less than 2 trimotor loads of jumpers would have been dispatched at a cost of approximately $500. It also would have taken men and airplanes from other fires that urgently needed them. The 'copter flying time cost $44.50.

Summary of the Helicopter Log

The helicopter was on the district 11 days and flew a total of 62¾ hours exclusive of the time coming in from Missoula and returning. The overall cost to the Government was approximately $5,330 for its services on the district. During this time the helicopter performed the following tasks: made 22 reconnaissance trips over 38 fires in the district to analyze needs or learn of progress being made; placed additional supplies and equipment on 7 fires; placed 48 men on 13 different fires; brought 18 men back from fires; replaced one injured jumper with another man, and brought the injured jumper out; transported 4 men from Shearer Ranger Station to Moose Creek; brought in from fires 20 sets of jumper gear and parachutes to be sent to Missoula for repacking; a replacement packer was brought in from the field to take over the district pack string when the first packer quit.

Comments On and Appraisal of Future Practical Helicopter Use

1. To get maximum performance, the helicopter must be operated by a pilot experienced in mountain flying. A good mechanic is also an essential part of the team in order to keep the machine operating.
2. The helicopter landed and took off with a full load safely at 7,500-foot elevations when temperatures at 3,000 feet were not in excess of 85° F.
3. The maximum payload for this type of machine (Bell-47-200 hp.) was 250 pounds from bottom to top and 300 pounds from top to bottom.
4. The average cruising speed was 60 m. p. h.
5. No bottom or high basin landings should be attempted above 4,500-foot elevations.
6. The majority of landing spots should be situated on ridgetops in accordance with C. E. Hardy's report on helicopter use made in 1949.
7. The helicopter has a decided advantage over the fixed wing type of aircraft in making a thorough analysis of actual conditions at the fire. Observations can be made at treetop levels and at speeds slow enough to allow time for thorough analysis.

8. By its use, the intangibles affecting the ordinary methods of calculating the probabilities on going fires is almost entirely eliminated. An experienced observer in making an analysis of the overall situation within a district can save thousands of dollars by proper distribution of men and materials. In most cases it will eliminate overmanning and oversupplying as well as undermanning and undersupplying. Either can be very costly. The observer can quickly determine which fires have the greatest potential for making large and costly fires, and direct action accordingly.

9. Responsible district or forest personnel can personally supervise the action on all going fires with greater ease than the same person normally could on a single project fire.

In anticipation of a greater future use of the helicopter in fire suppression work, the following suggestions are made:

1. That supervisors and rangers become more familiar with the effective use to be made of the helicopter in fire suppression. Learn its limitations and plan for its use on the forest or district.

2. That all district personnel learn the requirements for developing landing spots for the helicopter.

3. That landing spots be developed at strategic locations throughout the forest or ranger district, and such spots be located and recorded on the dispatcher's map.

4. That smokejumpers and other personnel be given special training in the preparation of 'copter landing spots in the event it becomes necessary to carry out sick or injured persons, or to prepare a place to land reinforcements.

The use of the helicopter to quickly analyze the situation on a great number of going fires can be accomplished on any unit regardless of development and will pay large dividends in the subsequent dispatching of men and supplies. This is no doubt the best use that can be made of the 'copter following the occurrence of a large number of fires within a unit. Its next best use is in the placement of men on or near fires and returning them for other fires, or moving men from one fire to another, thus conserving much needed energy and time. The third use would be on large project fires of two or more sectors where coordination of units and adequate scouting is of prime importance. With radio equipment on the ground at each sector and in the helicopter, the fire boss would have little difficulty in coordinating the groundwork and detecting the danger spots quickly enough to prevent the loss of control line.

In conclusion it is believed that the 1953 fire season can be rated as one of the worst experienced in fire suppression work in this district. The potential for large and costly fires was present. By the use of the helicopter it is believed the entire situation was managed with greater ease and efficiency, with fewer dispatching errors, greater economy and less loss of natural resources than in any previous fire situation of similar intensity. Use of the helicopter made it possible to hold 38 fires, which developed under severe burning conditions in remote areas, to a burned acreage of 90.8.

TEMPERATURES OF VEHICLE EXHAUST SYSTEM—A FIRE HAZARD [1]

ARCADIA EQUIPMENT DEVELOPMENT CENTER

U. S. Forest Service

The use of vehicles in cross-country travel has reportedly resulted in the ignition of forest fuels by the vehicles' exhaust systems. The subject is somewhat controversial, particularly as to the specific cause. Such fires may have been started by exhausted carbon particles or by fuels coming in contact with a heated exhaust line. As a cure, some favored overhead exhaust systems, others advocated spark arresters.

The Arcadia Equipment Development Center was requested by the Division of Fire Control, Region 5, to investigate the temperature conditions existent on the surfaces of standard automotive exhaust systems, and determine, if possible, the fire starting potential from the standpoint of heat generated alone and excluding sparks.

The forest fuels considered are grass, brush, twigs, and small branch wood. In determining the ignition temperatures of a forest fuel, the fuel size, shape, compactness, density, moisture content, and the air conditions are all influencing factors.[2] Different combinations of these factors give different ignition temperatures, and because of the number of these combinations possible and the difficulty in determining and controlling all the influencing factors, a minimum ignition temperature range is fixed.

This minimum ignition temperature range is based upon the ignition temperature of the major component of forest fuels, cellulose, and also upon actual ignition tests. This, then, fixes a temperature range in which ignition of forest fuels is most likely to occur.

This ignition temperature range as given by H. T. Gisborne[3] is, "For dry cellulose a temperature of only 400° to 600° F. is required. The average usually used is 540° F. . . . In other words the kindling temperature of grass, wood, cotton batten, or cellulose in any natural form is easily produced."

From tests made by Wallace L. Fons,[4] "it was found that surface ignition temperature of 650° F. was most significant for

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[1] Also published as Equipment Development Report No. 22, November 1953.

[2] TAUXE, GEORGE J., AND STOKER, RAY L. ANALYTICAL STUDIES IN THE SUPPRESSION OF WOOD FIRES. Calif. Univ., Dept. Engin. (Los Angeles). p. 5. Nov. 1950. [Processed.]

[3] GISBORNE, H. T. FUNDAMENTALS OF FIRE BEHAVIOR. Forest Serv., U. S. Dept. Agr., Fire Control Notes 9 (1): 14. 1948.

[4] FONS, WALLACE L. HEATING AND IGNITION OF SMALL WOOD CYLINDERS. Forest Serv., U. S. Dept. Agr., Fire Control Notes 12 (1): 5. 1951.

twigs and branch wood. . . . if part of the material was first reduced to charcoal, it would glow at temperatures as low as 450° F."

The minimum ignition temperature range is therefore 400° to 600° F. Dry branch wood could ignite at a minimum of 450° and almost certainly ignite at 650°. For the purpose of this report, 600° was selected as the critical temperature above which ignition would be likely to occur.

The five vehicles used in the tests were: Test unit A, 1948, 4-door sedan; test unit B, 1950, 4-wheel-drive, 1-ton pickup truck; test unit C, 1948, ½-ton pickup; test unit D, 1952, 4-wheel-drive, 15,000-pound (gross vehicle weight) truck; test unit E, 1950, 15,000-pound (gross vehicle weight) truck. Thermocouples were attached securely, by means of perforated metal straps, on the exhaust systems at the locations which were considered most likely to start fires. These locations were: Position 1, first bend in the exhaust pipe; position 2, muffler front; position 3, muffler rear; position 4, tail pipe; position 5, exhaust gases (fig. 1).

The vehicles were tested under idling (no load) conditions, and then under two conditions of load by means of a chassis dynamometer. Temperature readings were recorded until relatively stable conditions were reached.

In order to obtain the operating speeds and load conditions approximating cross-country conditions of from 2 to 13 m. p. h. in "low" gear, the vehicles were operated on the dynamometer at corresponding "high" gear transmission and wheel speeds of 20 and 30 hp. These particular conditions were recognized as not necessarily the maximum for temperature but were selected as average conditions of partial loadings which might be duplicated under actual field conditions.

These conditions, when converted, yield the following "low gear" speeds:

Vehicle test unit:	*Equivalent "low gear" speeds*	
	20 hp. (m. p. h.)	*30 hp. (m. p. h.)*
A	9.3	13.1
B	3.0	4.3
C	3.9	5.5
D	1.9	2.7
E	3.9	5.5

The cooling effect of wind created by a moving vehicle would have to be a minimum in order to attain the maximum possible temperature for the condition existing. On the dynamometer, the vehicle remained stationary while undergoing the tests, thus simulating the zero wind cooling effect.

The probable sources of error of any appreciable value are as follows: Instrument error, ±5° F.; calibration error, ±5°; instrument reading error, ±5°; error due to fluctuations in external conditions (wind, etc.) ±10°. The temperature readings, therefore, have a possible error of ±25° F.

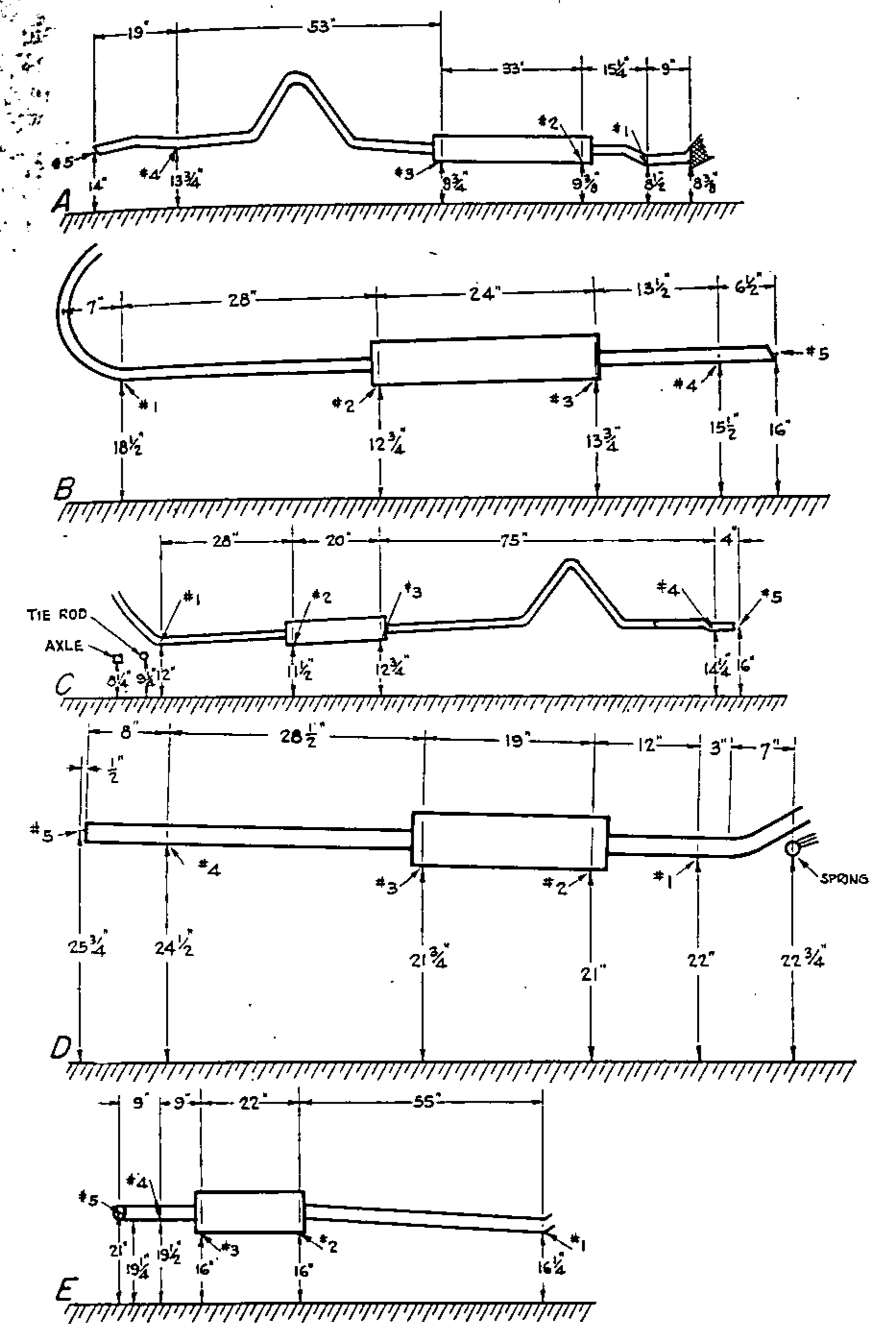

FIGURE 1.—Exhaust systems for test units A-E, showing locations at which temperature measurements were made: 1, first bend in exhaust pipe; 2, muffler front; 3, muffler rear; 4, tail pipe; 5, exhaust gases.

The temperature readings obtained at the five thermocouple positions under the three load conditions investigated were as follows:

	Vehicle exhaust temperatures		
	Idling (°F.)	20 hp. (°F.)	30 hp. (°F.)
Test unit A:			
First bend exhaust pipe	285	[1] *690*	*855*
Muffler front	165	395	510
Muffler rear	170	570	*625*
Tail pipe	190	515	*720*
Exhaust gases	265	*730*	*1,000*
Test unit B:			
First bend exhaust pipe	300	*800*	*860*
Muffler front	195	560	585
Muffler rear	160	550	*605*
Tail pipe	140	*670*	*775*
Exhaust gases	120	*660*	*915*
Test unit C:			
First bend exhaust pipe	390	*680*	*800*
Muffler front	230	415	460
Muffler rear	170	410	400
Tail pipe	195	445	570
Exhaust gases	300	*650*	*815*
Test unit D:			
First bend exhaust pipe	160	495	570
Muffler front	130	360	410
Muffler rear	115	310	360
Tail pipe	120	395	485
Exhaust gases	140	*600*	*720*
Test unit E:			
First bend exhaust pipe	215	*635*	*705*
Muffler front	170	280	295
Muffler rear	160	420	410
Tail pipe	160	525	*620*
Exhaust gases	120	525	*870*

[1] Italic temperatures are above selected minimum for fuel ignition.

To check the effects of radiator water temperature upon idling exhaust system temperatures, the water temperature of test unit B was raised from a normal idling temperature of 152° to 212° F. At 212°, the water boiled, but there was no appreciable rise in exhaust system temperatures. The first bend temperature rose only 11°, and the other temperatures remained at their normal idling levels. After several similar trials it was concluded that raising the water temperature to the boiling point had no immediate appreciable effect upon the exhaust system temperatures.

Results of the tests are as follows: (a) Under idling conditions, ignition temperatures were not attained. (b) Under a test condition of 20 hp. output, each vehicle had several points on its exhaust system which were capable of starting fires. The highest temperatures attained were at the first bend in the exhaust system and the exhaust gases, in that order. (c) Under a test condition of 30 hp. output, overall temperatures were higher than for 20 hp. run. The order of maximum temperature reverses but remains the same two points, exhaust gases and first bend.

A review of the data recorded during the test will show that in the majority of instances, the temperatures are more than sufficient to cause fuel ignition. Actually, other factors are present which reduce this hazard appreciably; one of the more important is motion or fuel contact time. At 3 miles per hour, travel is at the rate of approximately 4½ feet per second so that fuel contact time is instantaneous and normally could not be expected to cause ignition.

The hazard, however, exists because of the ignition potential in the exhaust system. It is possible, for instance, that a stop in a grass field, after a hard cross-country run on a hot day, would allow sufficient time for a fire start.

It should be noted, also, that in the region of the first bend of the exhaust system are the front axle, spring shackles, and steering mechanism, all of which are potential grass snaggers. Further, in this area is generally found the least clearance. Grass lodged here, if allowed to contact the first bend, could easily become ignited and probably fall off to cause spot fires.

It has been suggested that an overhead exhaust system may be the solution to eliminating the hazard. Actually, the conventional installation is not the answer. The usual procedure for installing an overhead exhaust system includes bending the exhaust line at a point behind the cab and extending the pipe beyond cab height. This does not eliminate the first bend hazard which, in most cases, can be expected to be the hottest point in the system.

Overhead exhausts will eliminate the hazard from the heat of exhaust gases and generally reduce the danger from small carbon sparks to a minimum. To be fully effective they should include provisions to prevent contact between the first bend of the exhaust system and flammable vegetative fuels.

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Smokey Bear Fire-Danger Prevention Sign

To attract more attention to our fire-danger rating sign, we came up with the idea of using a replica of Smokey Bear as an eye catcher. The problem was turned over to T. Huston Lockwood, our Shelton Butte Lookout, who is handy at such jobs. He enlarged a picture of Smokey from a prevention poster and traced the enlargement (68 by 33½ inches) on a piece of ⅝-inch marine plywood. The silhouette was cut out and painted. A bracket was made so that Smokey can be taken down at the end of the fire season.

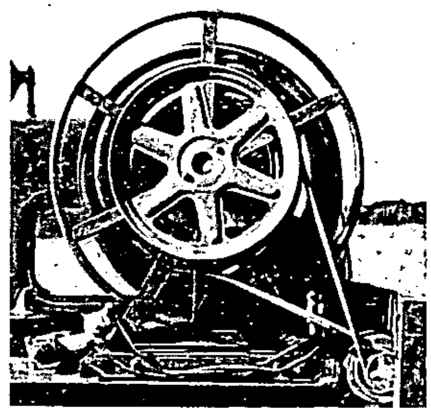
Tourists have made numerous favorable comments, and many amateur photographers have stopped to take pictures of Smokey. We feel that Smokey is really doing a swell job helping us put over an on-the-ground fire prevention message.—CHARLES A. YATES, *District Ranger, Six Rivers National Forest.*

POWER-DRIVEN HOSE WINDER

HAROLD A. LEE, *District Ranger*, and GORDON W. SAUL,
Forest Guard, Minnesota Forest Service

The power-driven hose winder described here was developed at Cass Lake, Minn., in 1953. The objective in mind was to minimize the labor involved in rewinding 200 feet of ¾-inch hose full of water and also to save time when working with the pumper unit on going fires. This length of hose may be rewound, neatly, in less than one-half minute.

The device is simple in construction, consisting of a 6-volt starter motor with a 2-inch V pulley attached, an 11-inch V pulley attached to the capped end of the live hose reel, and a short V belt for power transmission. An inexpensive switch, placed for foot control so as to leave both hands free to guide the hose, controls the electrical power application. Power is furnished from the unit 6-volt battery. A master switch is located inside the unit cab so as to eliminate accidental power application. There is no interference from the described attachments when the hose is being pulled from the reel.



Installation is not complicated, cost is low, a minimum of space is required. For safety purposes the entire device is covered with a light metal shield. Amperage use of the starter motor is less than when used to turn over a truck motor. At no time is the starter motor pulling a load within 70 percent of that for which it was designed.

When the hose is ready to be rewound the nozzle end is carried back to the unit and placed on top of the toolbox. This eliminates dragging of the nozzle and avoids any damage to it. When the unit must be moved from one side of a fire to the other, this device not only saves time but also saves the energy and strength of the fire fighter who is operating the pumper.

IMPROVED RADIO CARRYING CASE

DIVISION OF FIRE CONTROL

Region 6, U. S. Forest Service

Francis Lufkin, Smokejumper Foreman at the Intercity Airport on the Chelan National Forest, Wash., has added some improvements to the standard radio carrying case. These provide:

(a) Straps for carrying the case on the back, so that both hands are free.

(b) A flexible metal tubing in which the antenna is inserted. In addition to protecting the antenna, this tubing is a safety measure in that the antenna can be removed without the possibility of its springing out and striking the operator in the face. The tubing is 3/8 to 1/2 inch in diameter and 25 inches long. Parachute ripcord housing from condemned parachutes is used in this case, but any BX cable housing can be used (fig. 1).

(c) Easy accessibility for the hand piece. This is fastened to the shoulder strap with a rubber band in a position from which transmissions can be made.

FIGURE 1.—*Left*, The flexible tubing into which the antenna is inserted is sewn to the bag at the ends only. *Center*, Carrying straps cross in back; radio bag in place. *Right*, Hand piece attached to the shoulder strap in position for transmission.

STATE-FEDERAL COOPERATION IN EASTERN KENTUCKY

G. E. NIETZOLD

District Ranger, Cumberland National Forest

The conditions under which the Kentucky Division of Forestry may provide forest fire protection for a county sets up a basis for State-Federal cooperation. Under existing law, the Division is allowed to "move in" if the county fiscal court agrees to share the costs and enter into a 5-year contract. The county's share is 2 cents per acre per year for all the privately owned forest land within the county, based on the recent Forest Service Reappraisal figures. Although the law permits counties to pay the 2 cents per acre fire fee from either its general fund or to assess it as a special fee against the forest landowners, the county fiscal courts usually choose to assess each forest landowner. This arrangement, of course, throws an excessive load on the Division in organizing compact units, in following through to assure proper payments by counties, and in planning ahead toward contract renewal and expansion.

Rowan County, on the northern tip of the Red River District of the Cumberland National Forest, was the first county within the Forest to receive countywide fire protection of its privately owned forest lands by the Kentucky Division of Forestry. A 5-year contract between the Division and the County Fiscal Court—equivalent to Board of Supervisors in some States—became effective July 1, 1950. Since that time 4 more counties, in a line southward from Rowan, have received similar protection within the eastern edge of the Forest. Rowan, Morgan, Wolfe, and part of Lee are within the Red River District, and the remainder of Lee plus Owsley, within the Rockcastle District. Counties to the east of the National Forest had previously been brought under Division protection with similar contracts.

The many scattered tracts of national-forest land within the jointly protected counties makes cooperative fire control more complicated than is normally found. As an illustration, Rowan County, which has more national-forest land than any other county within the Red River District, contains 48 thousand acres of Federal land scattered in 38 individual blocks or tracts. Three of these range between 5 thousand and 10 thousand acres, and the remainder from 6 acres to 1 thousand.

The factor of a very high risk is another complication entering the cooperative picture in this area. Because of the eroded plateau type of terrain, most of the population is evenly distributed throughout the many flatter ridge tops and stream bottoms. "Smokes" from tobacco beds, brush, sedge grass, "new ground," and other burning are very numerous in the spring. With the woods always conveniently at hand, and a large number of

juveniles roaming the woods as would-be hunters, the risk isn't reduced much in the fall. This combination provides a high potential of smokechasing and decision making in cooperative action.

The Rowan County Cooperative Agreement between the National Forest and State Division of Forestry sets up three zones of responsibility. Zone A, national-forest land, is the sole responsibility of the U. S. Forest Service. Zone B, the band of private land, about one-half mile wide adjacent to Federal land, is a joint responsibility. The Division bears the expense of suppression in Zone B and therefore is usually considered the initial action crew. The agreement specifies that the Division is also responsible for law enforcement for fires starting in this zone. This, however, works out as a cooperative effort, depending on the degree to which Federal land is threatened. Zone C, all other private land, is the sole responsibility of the Division.

The use of one central dispatcher is the most important factor in making this system function effectively. Fortunately, the Red River District headquarters is located in the county seat. Consequently the District dispatcher can conveniently handle the joint job with negligible increase of work, time, or expense on account of the cooperative agreement. Triangle Lookout Tower, a primary U. S. Forest Service tower centrally located within Rowan County, acts as a communications center and clearing house for Federal and State towers in the area, as well as radio contact for the Division's County Guard. The tower contains a radio on the Division's network, a U. S. Forest Service radio, and a telephone on the Forest Service system.

Actionable "smokes," crossed out by any combination of Federal and State towers, are reported to the Red River District dispatcher by Triangle Tower. Those showing definitely to be in zone C may be reported directly to the County Guard. All those in zones A and B are reported to the dispatcher, who makes the decision on action for the joint responsibility strip. If "smoke" in B is a reasonable distance from Federal land, and the County Guard is readily available, the dispatcher turns it over to the State for action. If the County Guard should not be readily available, or if the fire appears to be very close to Federal land, the Forest Service takes initial action. Should the fire, after control, be confined to private land by Forest Service action, it is turned over to the State as soon as possible for mopup.

Suppression costs for fires starting on national-forest lands are U. S. Forest Service responsibility. Costs for fires starting on private land and burning also into the National Forest are shared, based on the percentage of the total area of the fire within each of the two ownerships. The State is responsible for the cost of fires confined to private land. With both organizations stationed in the same town, free exchange of information for necessary fire reports is no problem.

The standard of law enforcement is being maintained at a good level throughout the county. This is possible because most of the county is within the National Forest, and has been subjected to a prevention program for nearly 20 years. The Division is

applying the same standards in the smaller areas outside of the Forest boundary. With the additional efforts of the Division the prevention, and fire control program in general, within Rowan County has been definitely strengthened. This was well demonstrated during the disastrous fall of 1952. Rowan County had a smaller percentage of land burned than any other county within the Division's protective area.

Morgan, Wolfe, Lee, and Owsley Counties, partially within the eastern edge of the Cumberland, entered the cooperative picture July 1, 1952. Morgan falls within the same State District as Rowan County, so their cooperative agreements are similar. Some minor land protection "swapping" is being tried in Wolfe County in an effort to reduce the complications resulting from scattered ownership.

Lee County is unique, in that all the national-forest land, 4,662 acres, north of the Kentucky River and within the Red River District of the Cumberland Forest is being protected by the Division of Forestry. The Division is also operating the Federal lookout tower in that area. In exchange, the U. S. Forest Service under agreement is protecting private land within an area of scattered Federal ownership in the same county within the Rockcastle District south of the river.

These are more or less experiments to see what can be done in simplifying cooperative protection within such a Forest as the Cumberland. Minor changes were recommended as a result of the fall of 1952 siege of bad fire weather but in general the arrangements stood the test. Other problems may develop as the counties expected to enter into cooperative agreements do so. Whatever problems do arise will be minor in comparison to the benefits derived from State protection of privately owned lands within the Cumberland National Forest.

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SMOKEY'S RANGERS

CLINT DAVIS

Director, Cooperative Forest Fire Prevention Program

"Since my son became a Junior Forest Ranger, I can't burn leaves or trash without him pulling his authority on me" writes a plumber from New Jersey. This father is only one of hundreds of parents who have written Smokey Bear to attest to the influence of their children in making adults more careful in the prevention of forest fires. A father from Monterey, Calif., writes, "Since his first appearance, Smokey has been a favorite of my two youngsters. Many times in my cross-country travels I have been admonished to 'do what Smokey says.' His campaign has certainly been a success in this family."

These are only samples from the 76,000 letters and postal cards addressed to Smokey's personal attention and received at his headquarters in Washington from June through last December. Every one has been read and answered.

We wish that every person responsible for forest fire control could read some of Smokey's fan mail. It shows real evidence of an aroused interest in fire prevention and the conservation of our forest and other natural resources. Many of them are very touching. One letter was from a Sister Mary who wrote that the children in her school knew all about Smokey and his messages; they even memorized his song in music class. But they didn't really know what their friend was like until someone gave the class a Smokey teddy bear which they could feel and love. You see, her students attend the St. Joseph's School for the Blind.

Smokey's helpers also have complaints to handle. One father wrote, "My son is a Junior Forest Ranger. He is proud of his Junior Forest Ranger card. He has his certificate in the window. But he has no badge. Now for heaven's sake get me off the hook. I've bought him every Smokey Bear item he saw. But no badge. Where do I get a badge?" Needless to say, we had the badge manufacturer send a badge. But the complaints have been few and are far outweighed by the thousands of favorable comments received from satisfied and hard-working Junior Forest Rangers.

How did all this business get started? Well, the advertising experts working with us through The Advertising Council recommended years ago that we develop a symbol for forest fire prevention. The story of how Smokey was first used on a poster in 1945 is well known to all. Smokey's first appearance created public interest. Since that time, we have used Smokey as the central theme of our annual Forest Fire Prevention Campaign.

By 1950, Smokey was getting fan mail from young friends who wanted "a hat like Smokey's" or games about Smokey. Educators began to point out the desirability of using Smokey in games and other commercial items that were educational in nature or which could be used to convey educational messages on forest fire prevention and conservation. Our advertising experts were consulted and they advised that Smokey and his mission could be greatly broadened through a well-controlled commercial program.

The legal authorities of the Department of Agriculture investigated the matter. We were rather amazed to find that, although Smokey was created and developed by the Cooperative Forest Fire Prevention Program, he had no legal protection against misuse nor did we have authority for protective licensing of Smokey. The Solicitor's Office recommended immediate action for legislation to protect Smokey against misuse and to provide for commercial licensing.

This problem was presented to our partners and co-sponsors of the CFFP Program, the State Foresters. At their annual convention in 1951, a committee was appointed to draft legislation and secure its introduction at the next session of Congress. The State Foresters' committee performed a valiant job. Early in the 82nd Session of Congress, January 1952, companion bills were introduced as nonpartisan legislation. The Smokey Bear Act became a reality when passed unanimously in both Houses of Congress and signed by the President in May 1952.

After rules and regulations were issued by the Secretary of Agriculture, the CFFP Executive Committee, consisting of State Foresters and Forest Service members, drafted a plan for launching the Commercial Educational Support Program on forest fire prevention.

After months of planning to insure a sound and constructive program, the first licenses were issued in the fall of 1952. As a means of insuring maximum educational value from the licensing program, the CFFP Executive Committee approved our sponsorship of an informal organization to be known as Smokey Bear's Junior Forest Rangers. Where possible, the various commercial items, such as hats, T-shirts, dungarees, flashlights, belts, etc., were to be designed and promoted as Junior Forest Ranger equipment. Certain items were to be permitted to include a mail-in card furnished at the manufacturer's expense for writing to Smokey's Headquarters for a Junior Forest Ranger kit. This kit includes a letter from Smokey, membership card, window certificate, stamps, and a bookmark. Distribution of the kit has been confined to written requests in order to give the items greater value. Over 100,000 kits have been distributed to date and the requests are still pouring in.

Forest rangers, state wardens, and park rangers will meet thousands of youngsters this summer carrying their Smokey Bear Junior Forest Ranger membership cards. The youngsters will also be "policing" their parents on the prevention of forest fires. Give them the cordial handshake of understanding fellowship.

These Junior Forest Rangers take Smokey and his job very seriously. They will be looking for Smokey when they register at a picnic area or when they enter a National Forest or Park. They've seen Smokey on TV, in the streetcars, and in their classrooms all year. They'll be mightily disappointed if they don't see their friend at work in the forest areas that they visited this summer. This may call for a review of fire prevention posting plans to insure that Smokey will be posted at every logical point to make his Junior Forest Rangers feel right at home.

RUSTPROOFING FIRE TOOLS

DIVISION OF FIRE CONTROL

Region 6, U. S. Forest Service

On late fall fires it is not uncommon to have hundreds of rusty fire tools returned to the Portland Fire Cache. Many of these may not have been used on fires but were part of the "ready" tool supply at the various fire camps. Thus, except for the rust brought about by rains which end the fire season, they could go back into stock without reconditioning. Because of the rust, these tools required almost as much reconditioning time as the used ones.

Roy Walker, in charge of the Portland Fire Cache, thought that it would be worth while to investigate some of the rust preventives available on the market. Two axes, one untreated and the other painted with a commercially produced rustproofing, were exposed to the weather for 30 days (fig. 1). The result was rather startling. As a consequence, all handtools—axes, pulaskis, adz hoes, and shovels—are now treated with this preventive. The cost is estimated at 1½ to 2 cents a tool, a figure certainly below the cost of reconditioning rusty tools.

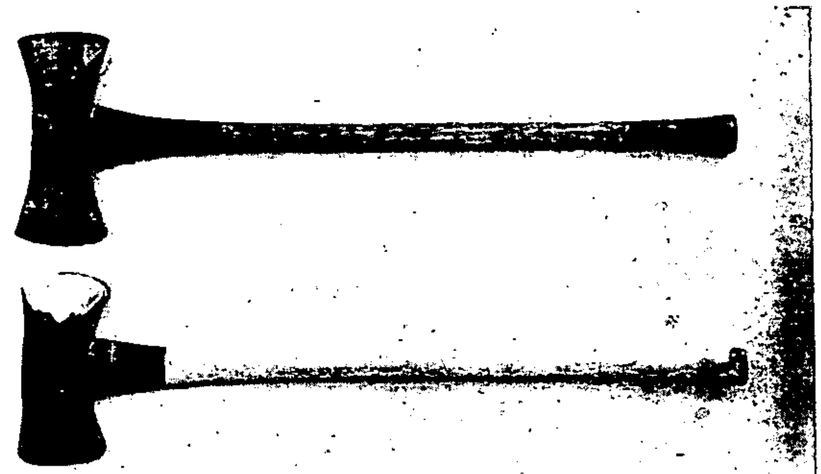

FIGURE 1.—Two axes after exposure for 30 days; *upper*, untreated; *lower*, treated with a rust preventive.

The preventive is a clear liquid which dries quickly and covers the tool with a plastic-like covering, not easily rubbed off, as is the case with grease or oils. Logging operators who have trouble with tools rusting in sealed, woods-located toolboxes may find that a rust preventive of this kind will be very much worthwhile. Additional information may be obtained from Regional Forester, U. S. Forest Service, Post Office Bldg., Portland, Oreg.

MICHIGAN'S HYDRAULIC PLOW

STEVEN SUCH

Engineer, Michigan Forest Fire Experiment Station

Another product in the rapidly expanding field of oil hydraulics is the latest addition to Michigan's diversified line of fire fighting equipment, a hydraulically controlled plow for crawler tractors. Designed around hydraulic principles that are older than Methuselah, the pilot model was built several years ago. Since that time much work has gone into field testing and changing and improving the plow in an effort to produce a practical and effective fire tool. The model is now ready for small-scale production on a trial basis, and the first of these plows should be ready for field assignment this spring.

Contrasted with the means of handling heavy equipment in the early days of forest fire control, hydraulic control is revolutionary from the standpoint of an operator. He can, with only fingertip pressure, produce many times the amount of work formerly possible. This extremely desirable feature of easy manipulation of heavy equipment is the outstanding characteristic of Michigan's new plow. Its versatility centers around its ability to react quickly to the touch of the tractor driver.

All naturally inherent disadvantages of hydraulic control are overshadowed when compared with the ease of handling of the plow. However, the most serious of these disadvantages are the degree of stiffness of the linkage, the limitation on the size of plow that can be practicably mounted, and the always present danger of a ruptured oil line. These are all very real drawbacks, but each must be dealt with as an individual problem and the proper importance attached to it.

One cannot overemphasize the importance of quick action on any fire. Provided there are no serious drawbacks to its use, a tool that can save time and convert the saved time to fast, positive fire control is the kind that should be sought. The hydraulically controlled plow is instantly available for use on arrival at a fire. With the slightest hand motion the operator can move the plow from a road-carrying position to a working position and back again in reverse order. This means that brush and other debris can be cleared from the plow by the operator without leaving his seat. It means that he can stop immediately, reverse, and in many instances, pick up "skips" or other lost line. He can maneuver more readily into spots most favorable to line construction. Actually, in his one hand he carries the power to free the plow of troublesome tieups. Chances for burying the plow or of turning it over are practically nil.

In 3 minutes the entire plow and its allied parts can be removed from the tractor. Two men can perform this operation by removing 4 key pins and disconnecting 2 detachable hydraulic

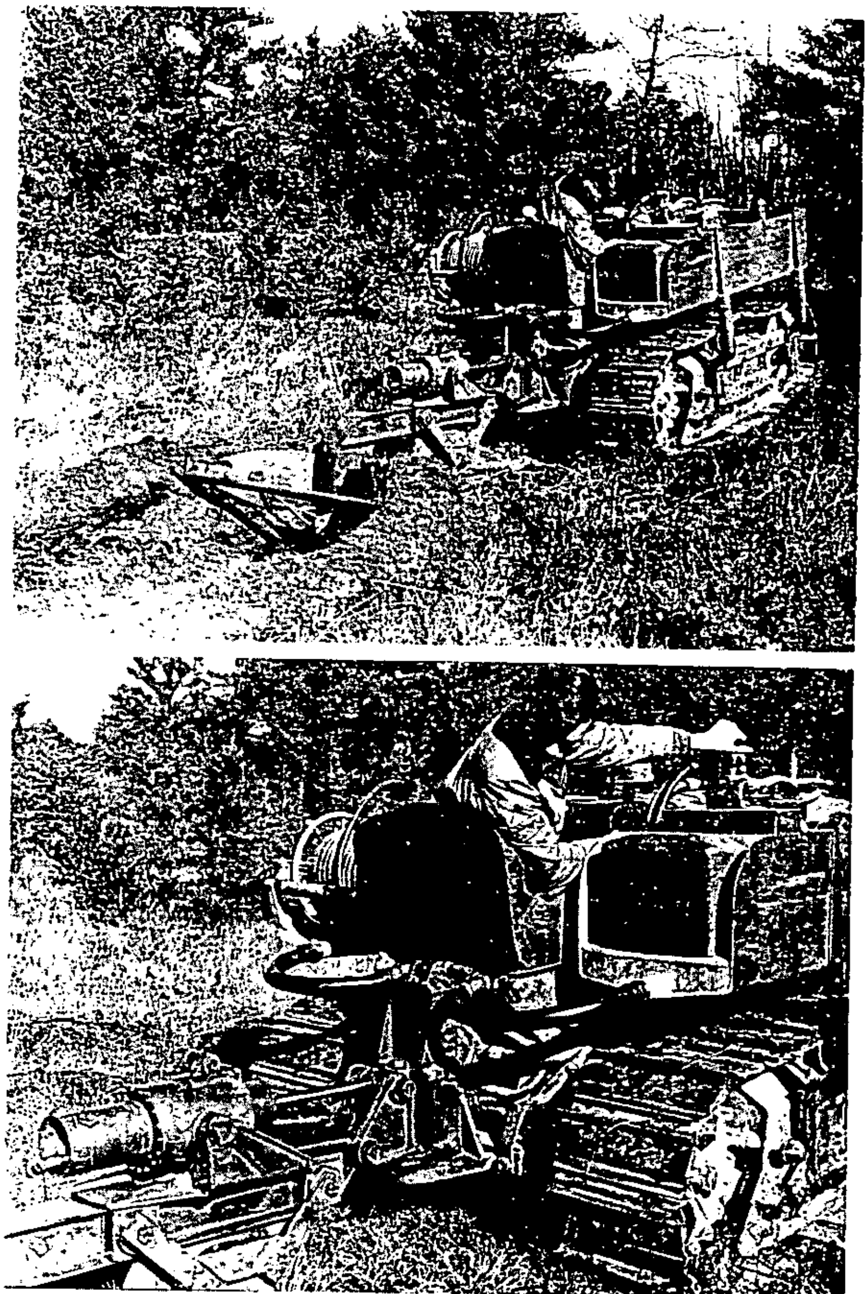

FIGURE 1.—*Top,* The plow in operation, producing a typical furrow. Turf knives aid line building in eliminating rollbacks. *Bottom,* Working position for plow with cylinder fully extended. In this position the spring is compressed, creating a down pressure on the plow point. Castings and cylinder assembly are clearly visible.

couplings. The tractor is then available for other purposes if required. Assembly to tractors is only slightly more difficult. Except for the hydraulic pump installation, which on this model is driven by the rear power takeoff, the plow and all its components can be made up in kit fashion in the shop and attached to a tractor with very little "down time." Although only one model of crawler tractor has been used, there seems to be no reason why any crawler machine in or over the 30-hp. class could not be adapted to this plow mounting.

Performance of Michigan's new dirt turner (fig. 1) is characterized by its ability to swing laterally behind the tractor, thus enabling it to track around turns. Down pressure is obtained through the double-acting hydraulic cylinder that actuates an integrally mounted compression spring within the cylinder assembly. The spring creates a constant pushing force downward and to the rear of the plow, the purpose of which is to catch low spots on an irregular ground surface. The spring also gives a certain amount of vertical floating action, thus overcoming in part some of the stiffness found in other models of hydraulic plows.

A self-centering device permits the plow to assume the correct place for positive locking when in the raised road-carrying position (fig. 2). This is particularly helpful when operating the tractor on the side of a hill where gravitational pull swings the plow to the downhill side. Unless some means is provided for

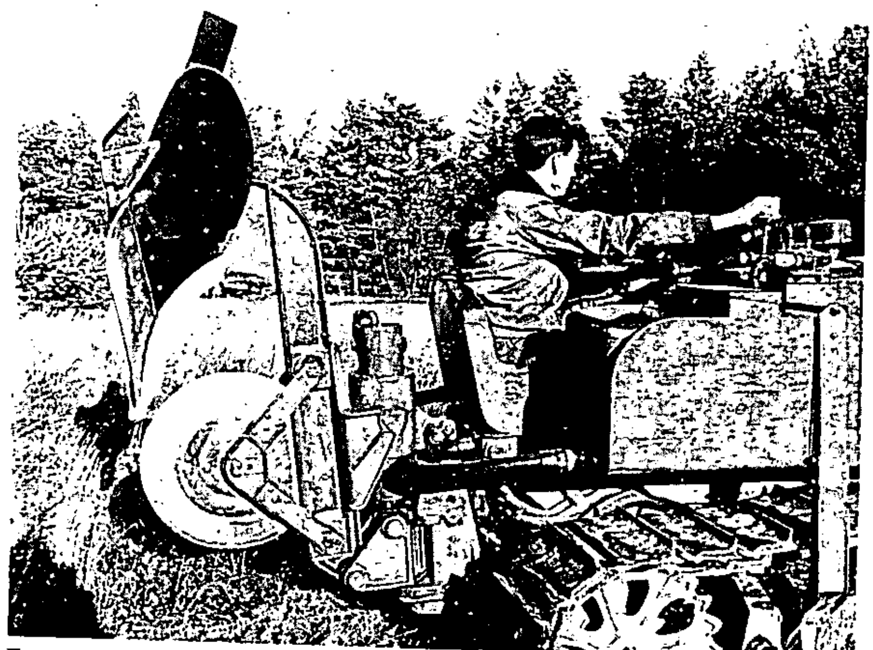

FIGURE 2.—Plow in road-carrying position. Note locking pin on top of large cylinder. Large cylinder also houses compression spring.

bringing a plow back to position, the tractor center of gravity can be badly upset. Although no cases of serious accidents are known, it is conceivable that such have occurred because this matter was ignored.

Height adjustment (plowing depth) is governed by vertical settings near the drawbar. For most work it is expected the plow will operate to depths of 5 or 6 inches. This figure will fluctuate, of course, with the demand of fire conditions.

Introduction of the hydraulic plow is by no means an attempt to replace existing State equipment, but rather an effort to strengthen Michigan's forest protection system. How hydraulics will affect future equipment is left to speculation. It is possible that we can look to this field for the most significant design changes and improvements in fire fighting techniques in the years to come.

Manufacture of Michigan's hydraulic plow is simplified through the extensive use of steel and malleable iron castings of which the plow principally consists. The rolling coulter, the plow bottoms, and the castings form about 90 percent of the whole assembly. Physical specifications may be had on request.

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An Essential Addition to Device for Taking the Weight Off Springs of Tank Trucks in Storage

In July 1951, Fire Control Notes had photographs and a description of a handy device to prevent spring sag in loaded tank trucks. The truck frame is backed up on a roll-back block that lifts the weight off the springs. This device is not entirely foolproof, because it is possible to back the truck with enough power to push the roll-back toward the loading dock or wall. At least one serious injury resulted from this when a worker was caught between the truck and the dock.

The remedy is simple. Fasten a log or timber to the floor at a point beyond which the rear wheels cannot be moved after the roll-back block has taken the load off the springs. Then nobody needs to go behind the truck. One more injury source is eliminated.—SETH JACKSON, *Administrative Officer, U. S. Forest Service.*

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Azimuth String Rethreaded for Better Use of Fireman's Protractor

A simple change in the method of threading the azimuth string in the fireman's protractor makes use of the protractor easier and more accurate.

Drill a hole, same size as the center hole, near the outside edge of the protractor in a due south line from the center. This can be done with a pocket knife by working from both sides. Then run the string through the center hole and back up through the outer hole, tying the knot on the upper side instead of underneath. The protractor is easier to hold steady since the knot is not on the bottom to form a pivot point. More accurate centering is also possible since the knot is out of the way and the center hole can be sighted through. This is especially desirable in taking bearings on aerial photographs.—M. R. STENERSON, *District Ranger, Gifford Pinchot National Forest.*

VERSATILITY IN WATER APPLICATION

A. B. Everts

Equipment Engineer, Region 6, U. S. Forest Service

Since the end of World War II there has been a steady increase in the number of tankers, both fixed and slip-on types, in the States of Oregon and Washington. A recent, fairly accurate survey placed the number at 555 in all ownerships—private, State, and Federal. In addition it was estimated that there were 1,033 portable pumpers available for forest fire fighting in the 2 States.

There are two important considerations in planning the accessories to be used with pumping units. The first is standardization; the second is versatility. Standardization, or rather the lack of it, has probably been experienced by most of us in the past with off-breed hose threads and odd-sized accessories that have prevented efficient water application on far too many fires. However, this discussion is confined to the second consideration—versatility.

The "slick chick" choosing her accessories does so with a definite purpose in mind. While our objective is different from hers, ours is no less important. Accessories, in both cases, should be chosen in keeping with the outfits with which they are to be used. The outfits, in our case refer to the pumping units. As examples of the wrong accessories, the following are cited:

1. It is not unusual to find on fires 1½-inch, straight-stream nozzles with ½-inch tip openings. It takes 66.8 g. p. m. of water to provide 80 pounds nozzle pressure (through a ½-inch nozzle opening), a figure generally considered as desirable, especially where tall snags are concerned. Most of our pumps have a water-delivery rating of about 50 g. p. m. This figure, of course, decreases rapidly as lift (head) and long hose lays (friction loss) enter the consideration. It is obvious that 50 g. p. m. will not provide a good fire stream through a ½-inch tip opening. Yet the number of people who still use nozzles of this size is rather surprising.

2. Another fallacy noted is the use of high-volume, periphery-type combination nozzles on live reels. The writer has seen such nozzles, which use up to 35 g. p. m., on the end of 250 feet of live reel hose, the inside diameter of which is probably ¾ inch or less. Disregarding friction loss, 20 g. p. m. is about all the water that can be passed through hose of this size under normal, tank-truck operating pressures. Again it should be obvious that a 35 g. p. m. nozzle will not function properly when 20 g. p. m. is all the water that can be forced to the nozzle.

These two examples illustrate that one of the factors to consider in choosing accessories is the capacity of the pumping unit. Other factors are general availability of water and fuel types.

Region 6 will have all slip-on tankers in the future. One of the features of the slip-on is a removable pumping unit that can be carried to a stream, lake, or other source of water for continuous operation. This is done on many fires, particularly on the west side of the Cascade Mountains where there is a greater availability of water than on the east side.

Accessories, then, should provide for two types of operation: (1) when the unit is being used as a tank truck and the water must be used conservatively, and (2) when the pump is drafting directly from a stream and the only limiting factor is the amount of water the pump is capable of delivering under a given hose layout. The standard accessories now in use in this region are shown in figure 1.

By standardizing, all of the tips—spray, fog, or straight stream—will fit on the applicator (1) or on nozzle (5) or nozzle (7). Applicator (1) will fit on either nozzle (5) or nozzle (7). Versatility is provided for by the selection of tips with which to do the job; 3-, 6-, 15-, or 30-g. p. m. spray (fog); or 3/16-, 1/4-, 5/16-, or 3/8-inch straight streams.

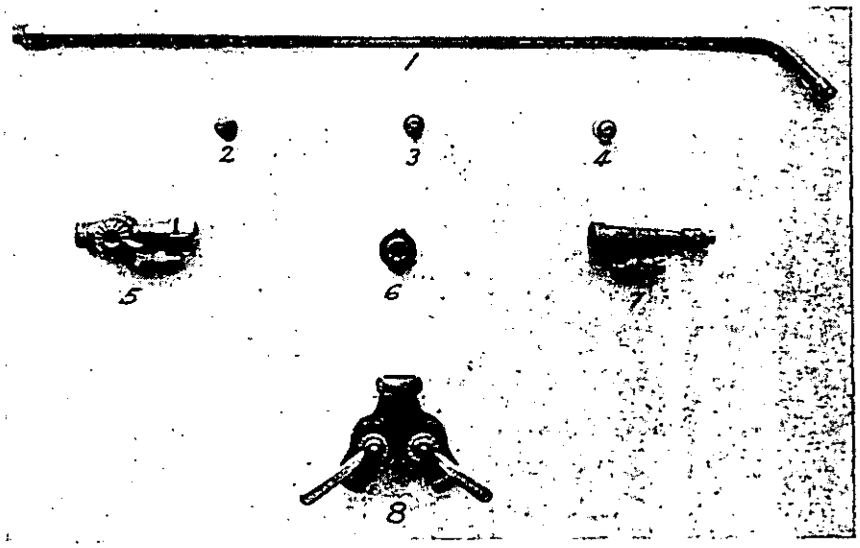

FIGURE 1.—Region 6 standard accessories: (1) 4-foot aluminum applicator with ¾-inch garden-hose threads, a swivel female coupling on one end, a male thread on the other; the fittings are brass; (2) 3-g. p. m. spray tip, ¾-inch female garden-hose threads; (3) 15-g. p. m. spray tip, ¾-inch female garden-hose threads; (4) 30-g. p. m. fog tip, ¾-inch female garden-hose threads; (5) 2-port discharge, ball-type shutoff nozzle, ¾-inch male garden-hose threads; nozzle has a 6-g. p. m. projection-type fog tip and a 3/16-inch straight-stream tip; (6) reducer from 1¼-inch female to 1-inch male I. P. T.; (7) changeable tip 1½-inch nozzle with ¾-inch garden-hose threads on the discharge end; tips are ¼, 5/16, and ⅜ inch; (8) ball-type, 2-lever siamese.

A wide range of hookups is possible with the accessories listed, some of which are shown in figure 2. There seems to be an increasing use of garden hose in mopup, the idea being to spread water over a wide area. In figure 2 the 1½-inch nozzle is shown being used as a reducer, direct from the siamese to garden hose. The tip on the applicator is the 3-g. p. m. spray tip. Actually, 10 such takeoffs could be made from a 1½-inch main line (a total of 30 g. p. m.), assuming that a continuous supply of water is available and that the pump delivery is cut back by 20 g. p. m. because of lift and friction loss in the hose lay. In this case no nozzle shutoff is needed. Ten such takeoffs, used in conjunction with aggressive shovel or pulaski men who scrape, dig, and roll out, can accomplish a great deal of effective mopup in a day's time. Actually, takeoff tees properly spaced between the lengths of hose would be more economical, but the nozzle does offer another means of making the hookup.

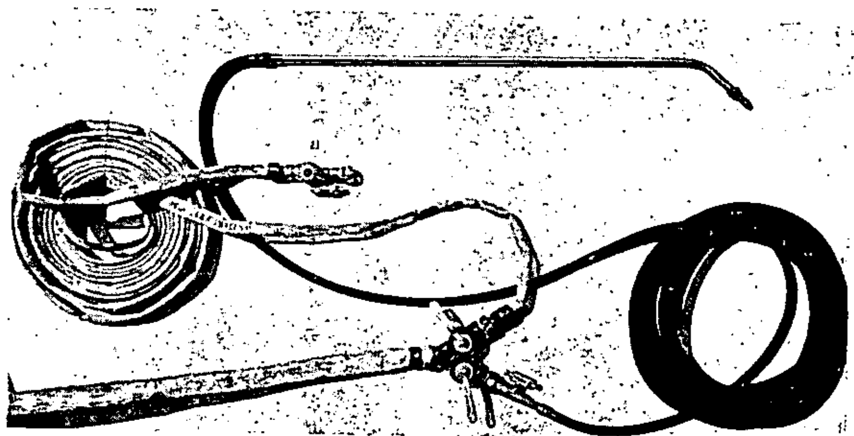

FIGURE 2.—Some of the hookups possible with R-6 standard accessories.

Most nozzlemen, once they have used applicators, especially on mopup, never want to be without them again. An applicator makes the work easier and more effective. At 80 to 100 pounds pressure the water flowing through the applicator has a tendency to lift its own weight because of the 45° bend, and the whole unit seems to float in the hand. The shutoff can be easily worked with the thumb. It is easier to get at fires under logs, around stumps, and in the ground with an applicator than it is with the straight-stream splash system. At 80 to 100 pounds pressure the spray (not fog) droplets have body which gives carrying weight, and the spray is not dissipated by normal winds. This observer is of the opinion that true fog can be too fine to be fully effective, except perhaps in grass types. Wind drift and entrained air become a problem when exceedingly fine fog and excessively high pressures are used.

It is in deep-seated fuels that the applicator really pays off. Many of our difficult fires occur on logged-over lands. Around log

landings it is not uncommon to have fire burning 4 feet deep. Usually the fuel is mixed with dirt that was dragged in by the tractors during logging. When this fuel is fully ignited it is a veritable charcoal pit, and it may be covered by dirt to the extent that no smoke is showing. Narrow fissures or open cracks in the soil warn of these underground hot spots. The 15-g. p. m. wide-angle spray on the end of the applicator is an excellent device for probing in these fissures. The orifice of the applicator does not clog because the force of the water keeps it open. When probing locates a hot spot, the spray converts to steam. This causes a blowhole which will permit further probing. By contrast, a straight stream in this fuel is less effective because it bores narrow holes and does not get at *all* of the fire. The steam produced by the spray has a tendency to spread through all of the minute openings in the soil and produce a smothering effect. We have learned that an area of deep-burning fuels mopped up by applicator is very much less likely to re-ignite than one given the straight-stream treatment.

On east side fires, with a limited amount of water available, the 3-g. p. m. spray tip has found favor. This tip is also the favorite one with which to apply treated (wet) water.

The 30-g. p. m. impinging jet fog is usually employed where there is an unlimited supply of water. The exception to this is when a fire has to be knocked down fast. A building fire is a good example.

Building fires generally constitute a small percentage of our fire fighting. When such a fire is well under way, a large volume of water is needed. If the fire is wholly within a building, fog offers the quickest means of control. Fog is considerably more effective on enclosed fires than on open fires. This is true because the fog, converting to steam, expands 1,700 times; and steam, when it can be held in a fire area, is an excellent extinguishing agent.

In fighting internal building fires there is one technique to remember—always vent. This may mean knocking out a window, or opening a hole in the roof. The idea is to drive the flames, smoke, and gas out the vent. Suppose that you have only 100 gallons of water; a 30-g. p. m. tip will stretch your water supply for more than 3 minutes. If you don't get your fire by that time, you have lost it anyway.

If it is desired to use the 30-g. p. m. fog tip on a shutoff nozzle, use on nozzle 5 (fig. 1). However, it should be used on the straight-stream port, because the fog port is not large enough to pass 30 gallons of water per minute. Limit your 1-inch hose to 1 or 2 lengths. If longer hose lays are needed, reduce down from 1½-inch hose.

The 30-g. p. m. fog tip is also a good one to get a quick wet-down on the outside of a line to be backfired, or to wet down inside the line after burning out to prevent sparks from blowing outside the line.

Figure 3 illustrates one frequently misunderstood technique in water application. Many experienced fire fighters believe that the smaller of two nozzle openings will provide the higher reach.

The reverse is true. Figure 3, left, shows a 1/4-inch nozzle tip in use. Simply by replacing the 1/4-inch with a 3/8-inch tip, the reach shown in the right photo can be obtained. To follow this line of thinking one step further, suppose we remove the 3/8-inch tip, leaving the nozzle with a 1/2-inch opening. What happens then? The reach of the stream decreases. Why is this? The answer will be found in the paragraph labeled 1 at the beginning of this article. Having made the circle we are right back where we started, which is always a good place to stop.

While friction loss and head enter into all pumping calculations, there has been only the briefest mention of them here. Changeable tips allow the pumper foreman to get the most out of his pump, whether he is using 1 hose line or 2, or even 10 to 12 garden-hose takeoffs to effect maximum water spreading. Changeable tips, spray and straight stream, are the keys to versatility in water application, which is so necessary if maximum efficiency of pumping equipment is to be achieved.

FIGURE 3.—*Left*, A 1/4-inch nozzle tip in use; *right*, a 3/8-inch tip.

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Use Outlying Fire Caches for Display of CFFP Posters

The waterproof Smokey Bear, and other CFFP posters, fastened to outlying fire-tool caches that are located in places visible from roads or at stores and resorts makes a striking appearance against the red background of the fire cache. The poster is stapled to wooden caches and may be fastened to metal caches with thin cement.

This simple and effective way of displaying fire prevention posters was hit upon by Ranger Assistants Serena and Kersten of Watersmeet District, Ottawa National Forest.—REGION 9, *U. S. Forest Service.*

AERIAL OBSERVER VERSUS LOOKOUT

H. K. HARRIS, *Forester, Region 1, and* GEORGE R. FAHNESTOCK, *Forester, Northern Rocky Mountain Forest and Range Experiment Station, U. S. Forest Service*

Introduction

An aerial observer is more likely to see small smokes than is a ground observer scanning the same area simultaneously. The advantage is greatest for the aerial observer if the smokes are on or very near the skyline as seen by the ground observer. Distance to the smoke affects the efficiency of both aerial and ground observers, but the former appear to have somewhat greater visual range. Direction of illumination may have less effect on the visibility of smoke at relatively short distances than has been thought. These conclusions are drawn from a day-long study that pitted 2 aerial against 2 ground observers under a rather wide range of smoke-detection conditions.

Right after World War I various people began trying to use the airplane for forest-fire detection, but success was deferred until adequate, two-way plane-to-ground radio communication was perfected. Systematic aerial detection was begun in 1945 on the so-called Continental Area in Region 1;[1] popular and apparently successful air-ground systems are now operating on 12 of the region's national forests. Planning has been based largely upon long experience in operating ground detection systems and on keen interpretation of a few preliminary aerial-detection experiments.[2] The present study was prompted by the need for (1) a comparison of the relative effectiveness of aerial and ground observers operating simultaneously under the same conditions and (2) reliable quantitive information concerning the effect on aerial fire detection of various factors that affect the visibility of small smokes.

Design of the Experiment

The essential feature of the experiment was comparison of periodic observations by an aerial observer of several smokes in different directions and at different distances from him with simultaneous observations by ground observer at some central point. Smoke candles[3] were set off at each of four points approximately in the cardinal directions from a central fire lookout station that was occupied by a ground observer. An observation plane flew in a 4-mile circle centered near the ground observer's station. Figure 1 shows the layout of the experiment. The aerial

[1] NORTHERN REGION, U. S. FOREST SERVICE. UNIT PROTECTION BY AIR PATROL. Fire Control Notes 7 (1): 3-5. 1946.

[2] HAND, R. L., AND HARRIS, H. K. PRELIMINARY REPORT ON AERIAL DETECTION STUDY. Fire Control Notes 8 (1): 28-32. 1947.

MORRIS, W. G. A PRELIMINARY SURVEY OF FACTORS OF VISIBILITY OF SMALL SMOKES IN AERIAL DETECTION. Fire Control Notes 7 (2): 22-25. 1946.

——— LOOKING FOR SMOKES FROM AIRPLANES. U. S. Forest Serv. Pacific Northwest Forest Expt. Sta. Res. Notes 34, 2 pp. 1946.

[3] EVERTS, A. B. IMPROVED SMOKE CANDLE. Fire Control Notes 13 (3): 24-26. 1952.

observer reported the visibility of each smoke from each of eight observation points on the circle. A simultaneous observation of each smoke was made by the ground observer. The observations were repeated by a second observer in a plane following immediately behind the first, and by a second ground observer at the control station. Each observer reported his estimate of smoke visibility, background brightness, and topography visibility in the vicinity of the smoke. The entire round of observations was repeated at 2-hour intervals beginning at 5:30 a. m. and ending at 7:30 p. m. Duration of the experiment was 1 day.

Fieldwork was done in June 1951 on the Coeur d'Alene National Forest in northern Idaho. The ground observers occupied Grassy Mountain Lookout. Smokes were set near lookouts on Little Guard, Cougar Peak, Lookout Ridge, and Griffith Peak. Figure 2 shows the general nature of the country.

The experiment was designed to permit examining the effects of four variables in addition to method of observation: atmospheric visibility, smoke location, distance between observer and smoke, and direction of illumination. Atmospheric visibility, measured by means of a Byram hazemeter, was found to be 27+ miles at the start of each round of observations; it therefore had no changing effect on the results and was not considered further. Distance from each observation point to each smoke was measured on a scale drawing of the experimental area. Direction of illumination was expressed as sun angle, which may be defined as the

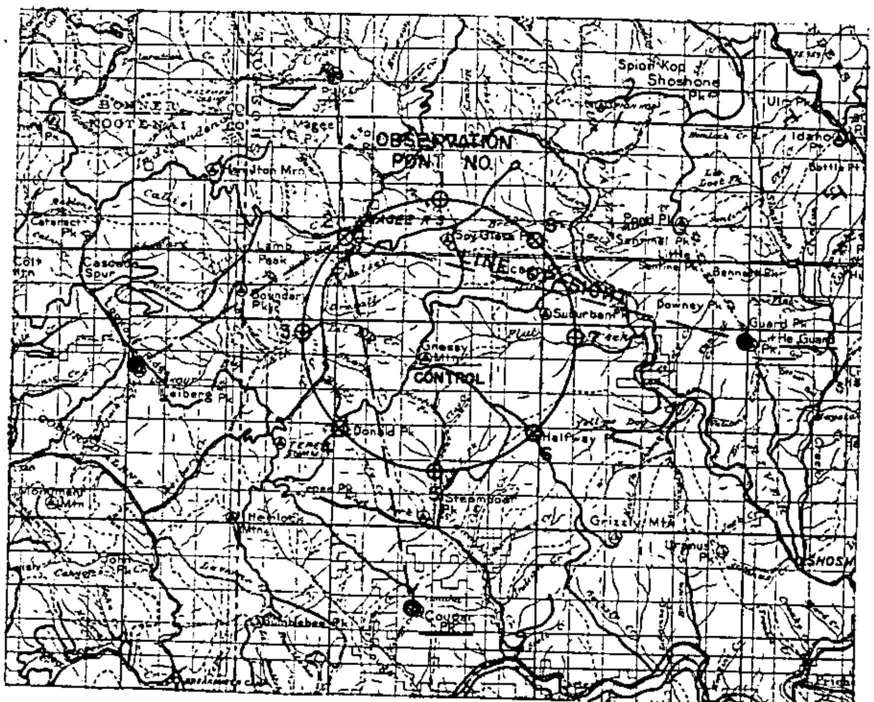

FIGURE 1.—Design of the aerial detection study.

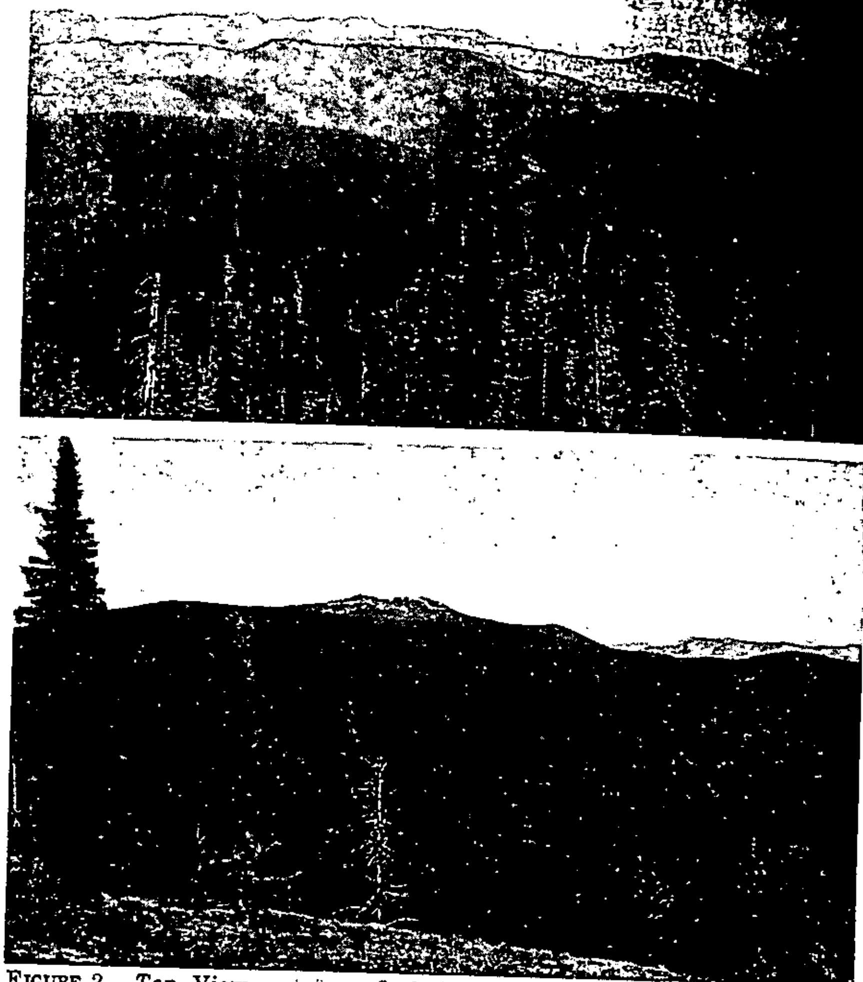

FIGURE 2.—*Top,* View east from Jacknife Lookout showing northern half of study area, with typical topography and ground cover. *Bottom,* View southeast from the control station on Grassy Mountain showing the solid timber cover typical of the south half of the study area.

angle at the observer between his line of sight to the smoke and his line of sight to the sun. Sun angle is composed of angular elevation of the sun, angular difference in elevation between the observer and the smoke, and the difference in azimuth between the smoke and the sun. Sun angle was calculated from Solar Ephemeris and navigational tables.

Percent of successful observations was determined for each observer by smoke location, sun-angle class, distance class,

and background. Differences among the various classifications were tested for significance by analysis of variance. The effect of distance and sun angle on success by aerial observers was analyzed by multiple regression. Simple regression analysis was used to test the effect of sun angle alone on success by ground observers. Because of very frequent disagreement among observers, background was excluded from the statistical analyses.

Results

Table 1 summarizes the findings of the experiment. The most outstanding result was the clear superiority of aerial observers over ground observers in their success at seeing the test smokes. At comparable distances aerial observers were success-

TABLE 1.—*Comparison of the gross results of aerial and ground detection, by percent of successful observations, with respect to factors affecting smoke visibility*

Factor	Griffith Peak (North)		Little Guard (East)		Cougar Peak (South)		Lookout Ridge (West)		All Smokes	
	Air	Ground	Air	Ground	Air	Ground	Air	Ground	Air	Ground
Observer:										
No. 1	98.4	100.0	41.8	24.5	73.1	19.6	86.0	70.9	75.8	56.3
No. 2	95.9	92.5	30.6	11.4	80.5	33.3	77.6	65.9	70.7	52.0
Weighted average	97.3	96.4	36.5	18.6	76.3	25.5	82.1	68.7	73.5	54.4
Distance (aerial observation only), miles:										
4.1– 6.0	100.0	.....	78.5	.....	100.0	.....	100.0	.....	95.4	.....
6.1– 8.0	100.0	.....	46.1	.....	94.7	.....	100.0	.....	82.3	.....
8.1–10.0	100.0	.....	.....	.....	82.6	.....	92.3	.....	90.1	.....
10.1–12.0	88.9	.....	26.9	.....	59.2	.....	76.9	.....	64.8	.....
12.1+	97.3	.....	15.7	.....	30.6	.....	65.8	.....	51.2	.....
Sun angle, degrees:										
0– 30	90.0	.....	66.7	66.7	.....	.....	92.8	87.5	88.9	81.0
31– 60	100.0	100.0	30.0	.....	100.0	.....	76.9	61.1	76.1	78.2
61– 90	100.0	100.0	30.4	14.8	65.5	24.5	94.1	86.7	69.7	41.4
91–120	98.0	93.6	46.7	6.7	81.8	40.9	95.2	52.1	86.9	65.8
121–150	92.3	.....	24.3	15.1	88.9	.....	50.0	80.0	49.3	17.3
151–180	.....	.....	50.0	26.6	100.0	.....	80.0	50.0	60.9	31.5
Background:										
Bright	100.0	100.0	41.2	18.8	86.7	11.1	82.3	68.8	85.7	63.2
Mottled	100.0	81.2	57.6	18.5	75.0	36.8	92.1	85.7	79.8	56.7
Shaded	92.5	97.5	22.2	18.5	69.8	29.5	74.0	56.2	62.0	47.8

ful in 74 percent of their observations, ground observers in only 54 percent. The difference was chiefly made up of smokes which the aerial observers saw only poorly, but which the ground observers could not see at all.

Smoke location was the most important factor affecting both types of observers. Success by all observers combined varied from 28 percent for the eastern smoke to 97 percent for the northern smoke. Aerial observers were strikingly more successful in spotting the smokes that were difficult to see. Figure 3 illustrates this superiority and summarizes the general effect of smoke location. The reduction of visibility due to smoke location appeared to result primarily from proximity to the skyline or ridgetop. Air currents at the south and east smokes carried the smoke out of sight on numerous occasions.

Direction of illumination proved to have no significance for the location and conditions of this particular study. This statement is startling when one considers that the gross results show a success in the 0- to 60-degree class of 80.3 percent weighted but only 39.5 percent weighted in the 121- to 180-degree class. The trouble is that the gross figures are misleading: sun angle appears significant only because it is confounded with the very significant factors of smoke location and distance. Analysis by individual smoke locations showed conclusively that success percent was not correlated with sun angle.

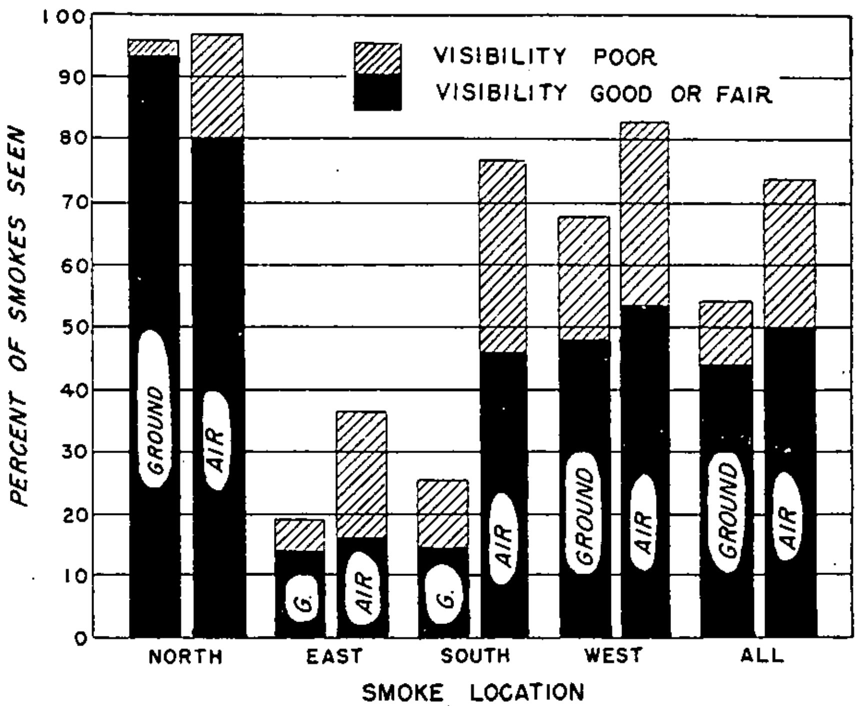

FIGURE 3.—Visibility of each test smoke to aerial and ground observers.

Next to smoke location, distance was the most powerful factor affecting visibility of smoke to aerial observers. Within 10 miles the aerial observers saw 70 percent of the smokes. Figure 4 illustrates the relationship of percent success to distance. Aerial observers had the same degree of success at 11.5 miles as ground observers had at an average distance of 8.5 miles.

The rating of background brightness was a matter of personal opinion, and the observers commonly disagreed in their reports. Consequently, all that can be said is that smokes were seen much better in full sunlight than in the shade.

The observers agreed closely enough in their ratings of visibility of topography to permit the conclusion that aerial and ground observers see topographic features about equally well.

Conclusions

In some situations aerial observers can see about 40 percent more of smokes known to be present than can ground observers looking simultaneously. The apparent reason why aerial observers have such an advantage is that they have a better vantage point for spotting smokes high on ridges where a light, sky background reduces visibility to ground observers. This fact indicates the suitability of aerial detection for use in mountainous country where lightning strikes frequently occur near the ridgetops.

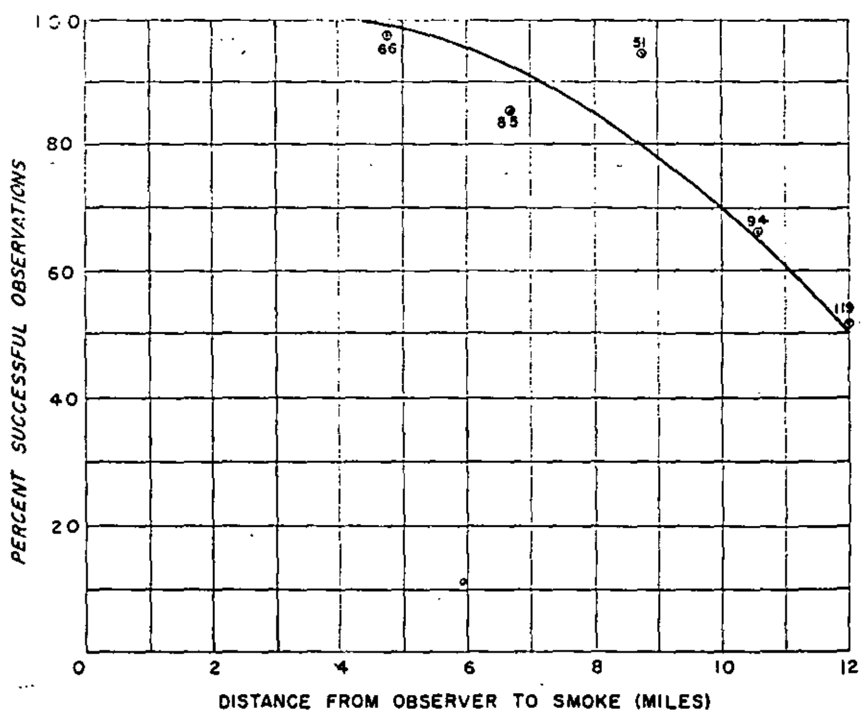

FIGURE 4.—Effect of distance on ability of aerial observers to see smokes. Plotted points indicate measured success in each distance class; numerals show number of observations on which points are based.

Beyond about 4 miles, distance strongly affects the ability of aerial observers to detect small smokes. Expectancy of success falls off to 70 percent at 10 miles and 50 percent at 12 miles. Aerial observers can see the same smokes somewhat farther away than ground observers (3 miles farther in the study), probably again because of better ability to spot those near the skyline.

To conclude that direction of illumination does not affect smoke visibility would be to contradict the well-supported findings of earlier investigators.[4] Evidence from the present study is not strong enough to support such a contradiction because (1) too few observations of some smokes were made at sun angles less than 60 degrees and greater than 120 degrees; and (2) no exact analysis could be made of the effect of background and shading of the smokes, factors that are known to modify somewhat the effect of sun angle. What can be said is that direction of illumination appears to have less effect than distance and topographic location of the smoke on the ability of observers to see small smokes at distances up to 12 miles when atmospheric visibility is good. It still is important to heed the older conclusion that smoke visibility is reduced when the sun is either directly in the observer's eyes or low behind him. Making aerial detection patrols when the sun is high is desirable also because then more smokes are likely to be in full sunlight where visibility is best.

This study has answered in part the question of how aerial detection compares with ground detection, and it has brought improved knowledge concerning the effect of distance on the probable success of aerial smoke observations. It has shown also that sun angle is less important than distance and topographic location of smokes, but otherwise nothing has been added to previously existing knowledge of the various effects of source and intensity of illumination. A big opportunity remains for investigations that will establish reliable, quantitative expression of the effects of all factors on the ability of aerial observers to see small smokes. More information is needed that can readily be interpreted in terms of when, where, and how to fly in order to detect, within acceptable time limits, the maximum number of fires in periods of high occurrence and during critical weather.

Duration and frequency of observations are the remaining important factors that must be considered in evaluating the relative effectiveness of aerial and ground observers. Observers at fixed lookout stations can scan the country for which they are responsible many times during a day and can, if need be, keep a specific location under constant observation for many minutes at a time. Aerial observers, on the other hand, are severely limited as to both the number of observations a day and the amount of time they can spend looking at one place. The time factor dictates the continuing need for lookout stations in certain critical fire areas and the importance of scheduling aerial patrols to ensure maximum effective coverage of each flight.

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[4] BUCK, C. C., AND FONS, W. L. THE EFFECT OF DIRECTION OF ILLUMINATION UPON THE VISIBILITY OF A SMOKE COLUMN. Jour. Agr. Res. 51: 907-918. 1935.

COMMISSARY ON LARGE FIRES

A. R. KALLAUS

Administrative Assistant, Lincoln National Forest

Proper control of commissary issues on large fires has long been one of the most frustrating problems confronting a fire administration. Experience has proved that commissary work will be efficiently handled only if (a) the procedure is understood by key members of the business management organization, (b) responsibility is clearly placed and maintained, and (c) the work is adequately supervised. Planning should be in accordance with these objectives.

The rule, "Losses sustained by the government as a result of failure to follow prescribed commissary procedure will be charged to the officer or employee responsible therefor" should be clearly understood by all closely involved in the work.

This work is fundamentally a problem of the regular business management organization, final responsibility to the forest supervisor resting with the administrative assistant. The immediate responsibility in a fire camp normally falls to the head timekeeper, but whoever is delegated this duty should personally issue or closely supervise the issuance and charging of stores.

The first essential in planning is to determine the items to be handled. This should be confined to items essential to the personal welfare of members of the fire organization that cannot be charged otherwise. Inventory should be confined to the smallest number of items and brands. There will be some variation by localities but the following items will generally suffice, the amount indicated being the stock to be carried in the average fire camp: 10 cartons each of 4 popular brands of cigarettes; 1 carton brown cigarette papers; 1 carton each of 2 brands of cigarette tobacco; 1 carton each of 2 brands of chewing tobacco; 1 roll snuff; 12 pair each small, medium, and large socks; 24 pair cotton gloves, with leather palms and knitted or strap wrist bands; 24 pair assorted shoe laces; and items of clothing, such as shirts, pants, shoes, etc., but only when specifically requested. Candy and gum are sometimes included as items of commissary stores, but this materially increases the work of the timekeeper. Such items are plainly items of subsistence and government funds are available to be used for that purpose.

When a standard list of commissary items is adopted, a sufficient number of boxes, chests, and other containers should be constructed to meet probable fire season needs. These should be sufficiently large to house needed stocks, and made in a manner that will provide maximum protection and control by the person placed in immediate charge.

Accessibility of the fire camp will have a bearing on the type of container to use. In areas where delivery is possible only by pack outfits or cargo dropping, old mail sacks or canvas bags

provided with car seals and padlocks are the most practicable. Where accessibility is good and delivery possible by truck, a container similar to the one originally designed by Lloyd A. Dahl, present Deputy Fiscal Agent of Region 2, is more desirable.

In the Dahl commissary chest (fig. 1), compartments for each item are sufficiently large to house normal stock requirements. In addition, a large compartment is provided to house commissary records and to furnish sufficient space for storage of overflow stock and items of special orders awaiting delivery.

This chest will aid in keeping stocks to a minimum and will expedite the work of issue and inventory control. It is provided with a letdown lid designed to serve as a desk, and with removable legs so that it can be readily set up or dismantled (fig. 2). It can be easily locked during periods of nonuse. It is a good companion piece to the timekeeper's kit (fig. 1). The two pieces placed together permit more efficient handling of greater volumes of both commissary and general timekeeping work.

With this chest, work of organization and training is greatly simplified. The least complex and most self-explanatory organization is always the best. With this in mind, 3 forms, Fire Camp Commissary Record, Record of Commissary Sales, and Fire Camp Requisition, have been designed. An adequate supply of these, or such forms as are used in the particular area, should be included in the chest, together with other items as follows: 6 numbered car seals, 1 padlock with keys (for use of responsible employee during the period of his custody), 1 clip board, and 20 F. S. property transfer form 874-16 (for transferring supplies to other camps).

FIGURE 1.—Dahl commissary chest on left, with some stock in place. Timekeeper's kit on right.

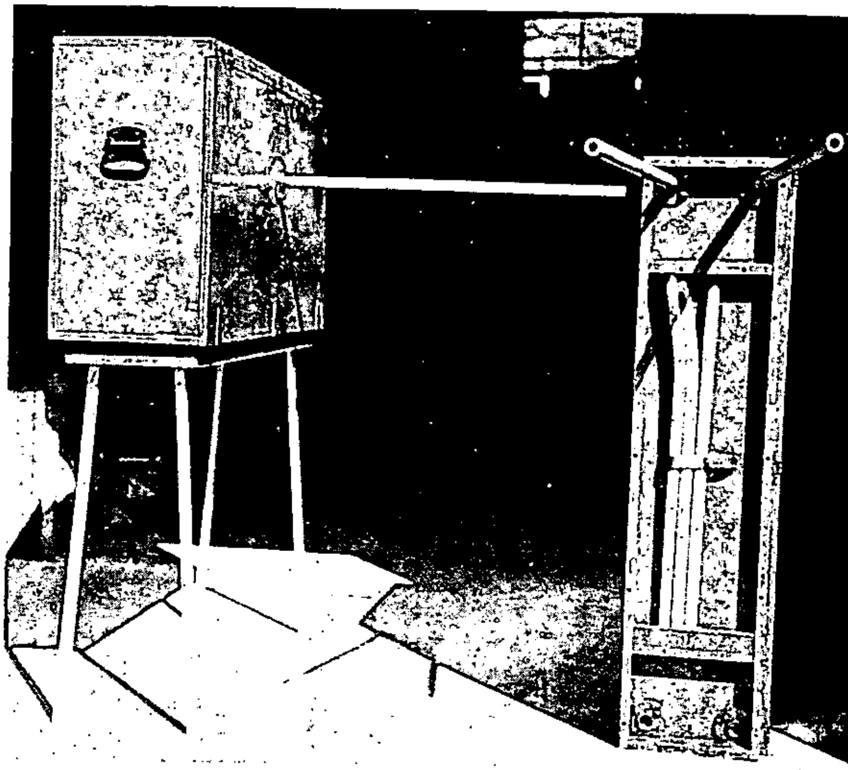

FIGURE 2.—Commissary chest can be easily set up or dismantled.

A "Fire Camp Commissary Record" form should be completed by the property custodian to cover accountable supplies included and the chest sealed with the seal number indicated on this form. The chest should be moved to the fire camp with other camp equipment and sent to the timekeeper's headquarters, when the fire camp is first organized.

Issuance of commissary stores on a fire is normally necessary immediately. It should not be deferred until actual need develops. The resulting dissatisfaction among employees because commissary is not available is a deterent to good morale. Authorization to break the seal on the chest and begin issuing stores should be given by the fire camp boss. The head timekeeper (or employee designated by camp boss) should sign for the stores in the chest and mail one copy of the receipted camp record form to the forest supervisor's office. Issuing of stores should not be made until all timekeepers on the job have a clear understanding of issuing, receiving, and transferring stores, and of recording on time slips.

For all practical purposes the accounting, handling, and control of commissary stores comes under the property accounting procedure for nonexpendable property. The principle exists that responsibility is not properly assumed, or relief granted, except in writing. Therefore, issuance of stores should be entered on the

"Record of Commissary Sales" form and the items signed for in each instance by both casuals and regular forest employees (including those on detail from other units). Posting should be made to time slips as work at hand permits.

"Fire Camp Requisitions" covering replenishments or special items of clothing should be prepared, approved by the camp boss or service chief, and transmitted to the central procurement section for the fire. The purchasing officer should make purchases accordingly. When the merchandise is sent to the field, two copies of the camp requisition are sent along as shipping tickets. These should have prices, or copies of the priced purchase order or dealer's invoice, so that the responsible fire camp commissary stores custodian can determine costs and issuing prices.

The truck driver hauling the merchandise to the field should sign the purchasing officer's file copy of the camp requisition, and be cautioned that the delivery of commissary stores should be made to timekeeper's headquarters. The truck driver should obtain a signed receipt for the merchandise and return this to the purchasing officer.

The issuing price must be established on the approximate cost from the merchant. Some adjustment is occasionally in order, as when similar items have different costs, or safety matches are obtained and distributed, their cost being included in cigarette and tobacco prices.

When a timekeeper is relieved of responsibility of commissary stores an inventory will be taken. The camp commissary record is completed and to this is attached all documents relating to the work such as "commissary sales record" forms (which must have been posted to time slips), records of transfers, issues, receipts, and stores condemned on Department of Agriculture forms AD-109, 111, and 112. Differences between book value and inventory value should be explained if possible, as shortages may otherwise be charged to the timekeeper.

The new custodian should sign for the property on the "camp record" form. If a custodian is not to be assigned, then the chest should be sealed and the seal number indicated on the "camp record" final report. When the camp is finally closed, the chest should be sent to the designated headquarters point, properly sealed. In due time the chest should be opened, audited by the property custodian who then assumes responsibility, and re-sealed.

Procedures involving the property custodian, procurement, payrolling, and vouchering work must be made very clear and ample training given to key people handling the work so that each will function automatically when an emergency comes. Also, a few of the more important fundamentals should be outlined to district rangers, potential fire bosses, camp bosses, and service chiefs. Potential fire timekeepers should be given training if this is possible. They should at least be furnished with a copy of the instructions on the "camp commissary record" for study, and later reviewed. The subject should also be reviewed with the Forest Board of Survey.

Stores damaged or spoiled must be covered by AD-109 and 111, and losses and shortages covered by AD-112 in the same manner as any other item of nonexpendable equipment. A control form 331 property card (F. S. form) should be maintained in the supervisor's office to which debits and credits are to be recorded on a dollars and cents basis without regard to items. In a few cases it may be necessary to maintain this control by ranger districts, fires, or other units but ordinarily one control account is sufficient.

Commissary stores represent so much cash on hand. As a rule the merchandise is suitable only for personal use. Issues are to be covered by payroll deductions, a form of collection. Shortages usually indicate improper handling or charging somewhere, caused by lack of planning, training, and/or supervision. Important losses can happen where there is a combination of circumstances not necessarily the fault of the forest personnel. Such losses are less likely to occur if the control of commissary issues is carefully planned along the lines suggested herein.

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Aircraft Amplifying Systems

The Michigan Conservation Department recently increased the usefulness of its aircraft in fire control by installing permanent loudspeaker units. Such a unit was first used in the airplane located in southern Michigan farming country. It proved so successful that a unit is now being used extensively in the heavily forested sections in the northern part of the State.

In most cases, after the arrival of mechanized fire equipment on a going fire, air-to-ground communications are handled by radio. However, when spot fires jump the plow line, nonradio equipped crews in the immediate vicinity are notified by the aerial amplifier, and they take corrective action before the fires become a serious problem. The aerial amplifier has also been used to advantage in directing men with handtools to the best place of attack on a fire, and in evacuating homes in the path of fire in the more remote areas of the State.

In addition to solving various fire control problems, the loudspeaker has been used successfully in law-enforcement activities. Prior to the opening of the 1953 waterfowl season, it was used extensively over the larger marshes of the State to advise hunters of the opening shooting hour. During the past deer season it was used to orientate hunters and to direct them when they were lost.

These loudspeaker systems are installed in Model 170 Cessna aircraft. The speaker is mounted under the rear seat, flush with the belly of the airplane, directly behind the pilot. The amplifier is located in the baggage compartment on a rack equipped with quick-release fasteners and can be removed when not in use. Total weight of the set is approximately 40 pounds, and the 6-pound speaker is the only permanent part. It is powered by the electrical system of the airplane and can be operated by either the pilot or an observer by means of a control switch and separate microphone installed on the instrument panel.

After a series of tests with radio-equipped crews on the ground, we found that the best altitude for amplifier transmission was from 800 to 1,000 feet. Effective coverage was approximately one-half mile.—ROBERT J. ICKES, *Pilot, Michigan Department of Conservation.*

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.

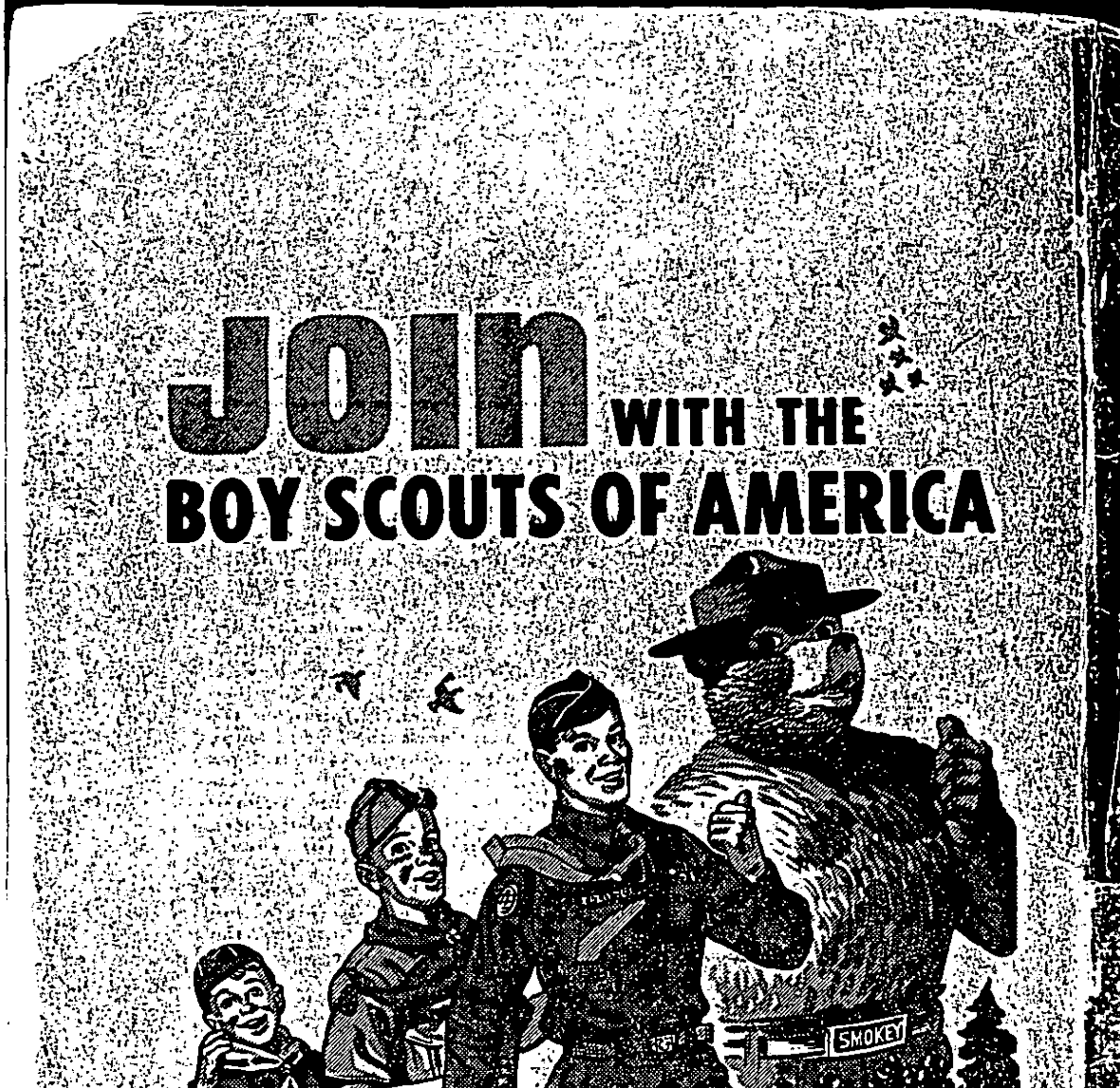
The title of the article should be typed in capitals at the top of the first page, and immediately underneath it should appear the author's name, position, and unit.

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 reproduction. Please therefore submit well-drawn tracings instead of prints.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