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FIRE CONTROL NOTES

U.S. Department of Agriculture
Forest Service

FIRE CONTROL NOTES

A quarterly periodical devoted to forest fire control

CONTENTS

INFORMATION FOR CONTRIBUTORS

Please submit contributions through appropriate channels to Director, Division of Fire Control, Forest Service, U.S. Department of Agriculture, Washington, D.C. 20250. Articles should be typed in duplicate, double 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 organization.

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Cover—Wildfire in southern California: damage to valuable watershed and a threat to homes and other improvements.

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UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
WASHINGTON 25, D.C.

IN REPLY REFER TO

To Readers of Fire Control Notes

Early in 1936 the participants of the Fire Control Meeting at Spokane, Washington, agreed that a publication was needed to exchange fire control ideas and developments nationwide. Publication of Fire Control Notes began later that year. Since then, the original concept of a national medium for interchange of ideas has grown to international scope. Our distribution list now shows 172 copies being sent to 55 foreign countries.

Time and progress mean change. The traditional size and format of Fire Control Notes is changing with this issue. The new format is much more adaptable; it will do the job more efficiently, allow more illustrations, and provide easier reading.

Fire Control Notes is published to disseminate ideas that will help readers do a better fire control job. Discoveries, new methods and techniques, and different adaptations are vitally needed. No job, no matter how well done, can make its maximum contribution until the story is known by others.

Merle S. Lowden

MERLE S. LOWDEN, Director
Division of Fire Control

THE PLACE OF SOUTHERN CALIFORNIA IN THE NATION'S FIRE PROBLEM

M. M. NELSON, *Deputy Chief, U.S. Forest Service*
National Forest Protection and Development

My intent is to draw some contrasts and similarities between southern California's fire problem and that of the rest of the Nation. I hope to show evidence of strong team effort directed toward the fire problem here, and while the Federal investment has been significant, it is a two-way street.

We are frequently asked, candidly and pointedly, what the U.S. Forest Service is doing in southern California. Why do we spend about a quarter of our fire protection money on 2 percent of the National Forest land? It has been said, referring to southern California people, "This is *their* problem—one *they* should solve themselves." To most of us in the Forest Service the very words "their problem" applied to southern California have a strange sound. With Robert Frost we can say "whose woods these are I think I know," for since 1905 these National Forests and their inseparable association with the total environment of southern California have been *our* problem—*ours* as a team member with all other individuals and agencies who accept responsibility for management, protection, and development.

While speaking of mutual interest in mutual problems, I might say that I was keenly impressed at our last budget meeting in the Department of Agriculture by a statement made by our newest Assistant Secretary. He is a Californian. His statement was, "There wouldn't be any Los Angeles, as we know it, if it weren't for the work the Forest Service is doing in the high mountains—and I mean that literally." That may need some explanation. Let's illustrate with this glass of water. Who can tell me where it came from? Did it first fall as rain on the San Bernardino or Angeles National Forest? Just as likely it fell in the high mountains of Wyoming on the Bridger National Forest, the Manti-LaSal in Utah, the Carson in New Mexico, or the Apache in Arizona. Or perhaps it was skied upon while on the Routt or Uncompahgre Forests in Colorado. It could have come from any of these or from many other National Forests. There is sound fact for a sign posted in a pass east of Silverton on the San Juan National Forest of Colorado. This sign reads, "You are now standing on a watershed which supplies water to the City of Los Angeles." So, you see, you have a vital interest in how we protect and manage National Forest resources in much of the West. They play an important part in sustaining southern California.

In order to place southern California's forest fire problem in perspective, let's first take a broad look at the national picture. Last year 115,345 forest fires burned 4,078,894 acres in the United States. This despite the fact that the National Forests were blessed with their smallest burn (85,457 acres) since records were started 57 years ago. Also, the State of Alaska contributed only 29,000 acres as compared with an average yearly burn of over 800,000 acres. Great forest fires of historical record have swept enormous areas in virtually every portion of this country. There are accounts of fires exceeding a million acres in such scattered locations as Maine, Oregon, Wisconsin, Idaho, Michigan, Montana, Kentucky, and West Virginia. As recently as 1957 forest fires on public lands in Alaska blackened over 5 million acres in a month, causing a Bureau of Land Management fire man to state, "Here, we contend with no lookout towers, very few roads, vast distances, long hours of daylight, high temperatures, strong winds, bad terrain, frequent lightning strikes, very little manpower, and next to no equipment—it's really a tough show."

It can be, and has been, a "tough show" in most forested areas when the weather dries the vegetation to a point where fires spread rapidly and conditions are unfavorable to control. Numerous areas have such factors.

There are sections of the country where we can point to rugged, inaccessible mountains, or to great volumes of forest fuels. There are areas with dry climates, having periods of severe fire weather. There are places where masses of people and their activities complicate the control of fires. But there is no single area in this country where factors favoring forest fires combine so frequently and last so long as here in southern California. Also I doubt there is a place more dependent on maintaining balance among elements of environment, such as soil and water. Certainly there is no place where this balance has been more often and disastrously upset by fire. Southern California's place in the Nation's forest fire problem, while small geographically, is large indeed measured by fire's effect on 7 to 8 million people and indirect effect on the Nation as a whole.

Yes, the problem and potential is of national recognition and concern and can be indicated in many ways. Expenditures through the Department of Agriculture and the Forest Service have increased from $886,000 in F.Y. 1955 to $2,711,811 in F.Y. 1963. This year an additional $300,000 has been added. Unbudgeted emergency funds for fighting forest fires have totaled $20,691,100 in the last 5 years.

Two of eleven flood prevention projects are located in the Los Angeles and Santa Ynez Rivers. Here, through 1962, $12,900,000 have been spent on improvements and fire protection measures. Under authority of the National Flood Control Act, money is made available to rehabilitate fire-damaged lands where life or property is threatened. Fifty-five southern California watersheds have been treated at a cost of $1,715,000.

Single fires on these National Forests have cost a million dollars or more to suppress, despite strong cooperative support given by State, county, and city fire units.

Men who have fought fire in southern California are acutely aware of a greater stake in these mountains. More than 50 firefighters, many from other States, have lost their lives dealing with intense, fast moving fires—typical of these precipitous watersheds. Yet I have never heard a fireman suggest we resign from the southern California fire team.

Some people, though, wonder aloud "a quarter of the protection money spent on 2 percent of the National Forest area?" Others have added, "Yes, but we are not moving ahead fast enough; losses are unacceptable; we need more research, more equipment development, more hazard reduction, more access roads, more firebreaks; more of everything." I agree and share concern with these people. But for a moment let's view southern California's place in the national fire picture from the inside looking out.

This area has been called a great outdoor fire laboratory, an advanced school for firefighters, a crystal ball in which to view future land management under stress of fires, floods, and population pressures. Certainly it has been a proving ground for firemen and their equipment. Large fires in recent years have names familiar to hundreds of men from many National Forests in a dozen States. Big Dalton, Devils Peak, Refugio, White Mountain, Fish Fork, Barrett, Monrovia, Woodwardia, Waterman Canyon, Stewart, Palomar, Inaja, and many more.

Innovations and progress usually occur closest to the need. Certainly this has been true throughout the southern California area. I think, of course, of the great potential of the new Fire Research Laboratory, but also of many other signs of progress and accomplishment:

The Arcadia Equipment Development Center, soon to move to expanded facilities.

The pioneering at the San Dimas Research Center on effects of fire on watersheds.

The hazard reduction and fuel modification studies called "Fuelbrake" and their application.

Research in human behavior aspects of fire prevention.

Preattack planning involving the construction and mapping of great nets of firebreaks, and facilities, and recording of knowledge needed should a fire start.

Organizing men and equipment for large fire control and interagency coordination.

The procession of new firefighting techniques that evolved from Operation Fire Stop—a most significant interagency effort.

The first use of a helicopter for firefighting and the adaption of techniques learned in the Forest Service smokejumper program to a subsequent fast attack, hard-hitting helitack program.

Major contributions in the use of air tankers and in chemical mixing and loading bases to support them.

Advances in the design and use of fire trucks, for mountain firefighting.

Development and use of mobile, power flamethrowers for backfiring.

Less spectacular, but very significant, studies that led to new land management direction.

In summary, southern California's place in the Nation's forest fire problem is an important and critical one—as a recipient of help from the rest of the Nation, and as a major contributor to fire problem solutions everywhere.

Whereas much progress has been made, there is a long way to go before we can feel we are not living too close to disaster.

All elements favoring fire are here, but so are all the elements we must look for for solution.

All agencies concerned are pulling together to a near unique degree. The disciplines of research and development are serving the men responsible for application.

Lastly, and most important of all, is public understanding and support. These elements combined are destined to solve southern California's fire problem, and in doing so, to establish a lasting place in fire control pioneering.

Presented by Mr. Nelson at a fire meeting sponsored by California State Chamber of Commerce at Riverside, Calif., Sept. 11, 1963.

LIGHTNING DAMAGE TO DOUGLAS-FIR TREES

ALAN R. TAYLOR, *Research Forester,*
Northern Forest Fire Laboratory

Lightning causes more than 10,000 forest fires annually in the United States by igniting snags, live trees, grass, and duff. Field observations have long shown that the lightning may not ignite trees even though it damages them structurally. It is of interest to know why some fuels are ignited while others only receive various degrees of damage from lightning. The author started gathering background information on this problem by studying lightning-caused structural damage to trees that were not ignited. The study was conducted on a portion of the Deerlodge National Forest near Philipsburg, Mont.

About 1,000 lightning-damaged Douglas-fir trees were observed in the 10,000-acre survey. Detailed descriptions of damage were written for 53 of the most recently damaged trees. This note describes some of the special damage features.

Nature of Damage

Visible damage to the 1,000 trees ranged from a superficial bark scar along the bole to nearly complete destruction of the tree. Figure 1 shows intermediate damage, with loss of top and a deep spiral scar where wood and bark were blasted from the tree. Most trees had shallow, continuous scars averaging 5 inches in width along their boles. About 25 percent of the 1,000 had two or more scars, 10 percent had severed tops, and about 1 percent had been reduced to slabs and slivers.

Damage was estimated for each of the 53 recently damaged trees by measuring scar width and depth at the 17-foot height on the bole. Lightning scars on Douglas-fir tend to be uniform in width and depth, except for slight taper, from about 10 feet above the ground to the upper end of the scar.

Scar Alinement

The 53 observed scars were classed according to whether they were straight, oblique (tending to spiral, but making less than one revolution around the bole), or spiral. It is interesting that:

1. All scars followed the grain of the outer layers of wood.

2. Only 7 scars were classed as straight. Twenty-four were oblique, and 22 were spiral.

3. The straight scars were twice as wide as the oblique and spiral scars. Average widths were 10 inches, 5 inches, and 5 inches, respectively.

4. About one-half of the spiral scars ascended to the right, and one-half to the left. Trees with right-hand spirals averaged 260 years of age and those spiraling left averaged 140 years.

Scar Length

Although lightning travels the entire distance between cloud and ground, lightning scars are seldom found along the entire length of a tree. The following points are noteworthy:

1. The average scar extended along 80 percent of the tree height.

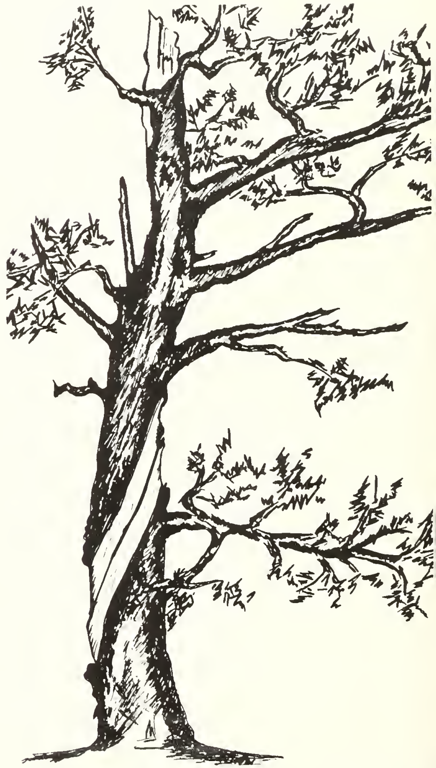


Figure 1.—Douglas-fir showing loss of top and spiral scar with crack along its axis.

2. None of the observed scars extended to the tops of the trees. Distance between the upper end of the scar and tree tip ranged from 3 to 22 feet, with average distance of 10 feet.

3. One-half of the scars extended to ground level. The others reached to within 6 feet of the ground.

4. Upper ends of scars were not tapered to a point, as one might expect, but terminated squarely.

The Lightning Track

Lightning sometimes leaves a narrow strip of inner-bark fibers along the middle of shallow bark-depth scars. This strip was observed on 12 of the 53 trees and usually ran the full length of the scar, adhering to the newly exposed wood surface. Scraping the shredded fibers away revealed a smooth shallow groove about $^1/_{16}$-inch wide. The groove was previously reported by McEachron,[1] who concluded that it marked the path of the discharge, which turned the wood along the path into gas.

Perhaps closely related to the groove is a narrow crack, found on 40 of the trees (fig. 1). The crack

1. occupied the same position as the bark strip and groove did on the other trees;
2. separated the two parallel slabs of wood that were blasted from the tree;
3. penetrated to the pith in some trees, as revealed by boring cores taken at right angles to the scar;
4. is a probable result of internal pressure created by the discharge current. It is frequently widened by exposure to the weather, but may eventually be closed or covered as the wound heals.

Bark-Loss and Wood-Loss Damage

On 38 of the trees lightning removed only a narrow strip of bark; on the other 15 it gouged out deeper and wider furrows, causing loss of wood (fig. 2). From 12 of the wood-loss trees lightning blasted the wood in two parallel strips (fig. 2*B*), separated along the crack described above. Several trees lost considerable wood in this manner; for example, from one the lightning ripped a pair of straight slabs, each 8 inches wide, 3 inches thick, and 44 feet long.

Scar dimensions (see tabulation) were, on the average, greater on wood-loss trees than on bark-loss trees.

	Length (feet)	*Width (inches)*	*Depth (inches)*
Wood-loss trees	54	11	3
Bark-loss trees	46	4	1

Wood-loss trees measured in this study were usually older than bark-loss trees and usually of greater height and diameter. For reasons unknown, the larger, older trees apparently were more susceptible to wood-loss damage than the smaller, younger ones.

Based on the author's M.S. thesis, "Lightning Damage to Douglas-Fir Trees in Southwestern Montana," Montana State University, 1962. The study was financed by the U.S. Forest Service under cooperative agreement with Montana State University and the Northern Forest Fire Laboratory, Intermountain Forest and Range Experiment Station, from May 1961 to June 1962.

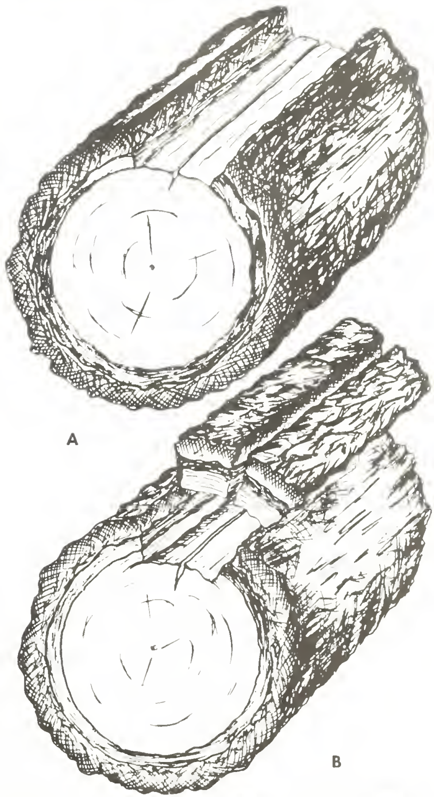


Figure 2.—*A*, Typical bark-loss scar; *B*, wood-loss scar, showing wood and bark removed in two slabs of nearly equal dimensions. Each bole has a crack along the scar axis.

[1] McEachron, K. B. Playing with lightning. 231 pp., illus. New York: Random House. 1940.

FIRE PREVENTION THAT WORKED

JOSEPH COUCH, *Forester, Division of Fire Control*
Southern Region

This article from the South affirms again the principle that specific problem identification in fire prevention is essential for productive results. It proves that effective fire prevention is not beyond the reach of the established field professional who can achieve the determined support of a community.

Although we've made progress in fire prevention nationwide, few of us are satisfied with the present level of knowledge and accomplishment. Who could be when, in 1962 for example, 94,000 man-caused fires burned almost 2 million acres of public and private forest lands under organized protection in the United States?

Experienced fire people know that the formidable number of variables and unknown factors involved in man-caused fires rules out categorical explanations for upward or downward trends. Nevertheless, some examples of successful prevention action may add valuable ideas to fire prevention work everywhere.

USE OF A SPECIALIST

A Ranger District in the longleaf belt was beset by an intolerable annual rate of 193 man-caused fires per 100,000 acres protected. Of the 368 fires that the Ranger tallied for one calendar year, 342 were incendiary! The fires were being set for the usual reasons—such as improvement of open-range grazing; "opening the woods"; reduction of snakes, ticks, and other pests; resentment; ebullience while drunk.

People resent what they don't understand

Careful analysis convinced the Ranger that his prevention program was only nibbling at the problem. The covert defiance of Forest Service authority to manage the land and the neglect of civic responsibility indicated the indifference and hostility often associated with misunderstanding. The Ranger concluded that more man-to-man contact—to increase mutual understanding between local residents and the Forest Service—would accomplish the most in the shortest time.

Finding the right man

Although increasing the amount of contact work done, especially by himself, the Ranger also got authorization to set up a new Fire Prevention Aid position. The man hired was a natural for the job. A likable, rural personality, with the gray-templed dignity of late middle age, this man was a native of a neighboring county, a former sheriff, physically powerful, and unafraid of toughs singly or in groups.

After a period of training that qualified him to explain Forest Service programs, the new man went to work in the District's hottest spot. He didn't miss a single family. By getting acquainted with each adult and many of the children, showing movies and giving talks at the rural school, getting on a first-name basis with the preacher, school bus driver, grocer, and justice of the peace, he gradually built a bridge of understanding and personal regard. People began to ask him questions and to talk out their complaints instead of expressing them with matches. The Forest Service and the National Forest became something they understood.

Understanding works both ways

To the forest officers who'd been fighting the long strings of incendiary sets, backfiring plowed lines all night after a day's work on timber sales, wading around in fire and smoke all day Saturday and Sunday and every holiday when the forest was dry enough to burn, staking out on cold nights to catch a firebug, some of the residents had seemed like hardened criminals, to be dealt with harshly. However, the communication finally established with these people brought deeper understanding and a chance to further apply persuasion and salesmanship.

Result

By the end of the following spring fire season the worst hot spot was totally free of incendiary fires. Man-caused fires on the entire District were down 8 percent. Occurrence the following year was down to 81 man-caused fires, a figure which amazed all forest officers in the Region familiar with this District. Except for normal fluctuations this initial success was never lost.

REDUCING SIZE OF ADMINISTRATIVE UNIT

To intensify management on a District plagued with an annual occurrence of 110 man-caused fires, the Forest Supervisor divided the unit and established a new ranger station in the town that was shopping center and county seat for the hotter localities.

The new office—handy for obtaining permits, buying timber, and hiring local men—increased community interest in the National Forest. The proximity of the hot spots allowed the new Ranger to give them personal attention, to get acquainted with the people, to study the fire problems in detail, and to devise specific measures against the heavy incendiary occurrence.

Following through, District personnel established a small lake and recreation area with the cooperation of county officials and worked with (1) the Extension Service—the County Agent, Home Demonstration Agent, Extension Forester—and the State forest service to create an annual forestry field day for rural adults and children alike, (2) stockmen's associations on grazing problems, and (3) farmers on safe methods of debris burning. Close surveillance in trespass-prone areas quickly turned up many violations. Firm, impartial law enforcement was applied to timber thefts, dishonest and erroneous land line surveys, land occupancy trespass, property damage, and intentional and accidental fire cases.

Result

In 7 years, annual man-caused fire occurrence dropped from an average of over 100 to 19. The following year the total was eight. The occurrence level to date has stayed low.

INTENSIFIED LAW ENFORCEMENT

On another District about 80 percent of the near 100 annual man-caused fires were incendiary. Concluding that the prevention program had successfully reached all residents whom his organization could teach or persuade, and that a small, hard core remained which would respond only to law enforcement, the Forest Supervisor brought in a Ranger who had had professional investigative training and experience.

Regular fire prevention activity was maintained, with emphasis on individual contacts. In addition planned personal acquaintance with possible witnesses and potential violators, before anything happened involving them, placed the new Ranger in an excellent position to cope with subsequent cases. While caution was exercised to avoid the appearance of persecution or of punishment and retribution rather than positive help, the Ranger nevertheless initiated a criminal or civil case for every fire on which sufficient evidence could be found.

Results

The percentage of fires for which cases were initiated rose from 15 to 22 the first year, and at the end of 2 years stood at 54. During the above period man-caused fire occurrence dropped from 91 to 22 annually. Occurrence has remained low.

PERSONAL PERSUASION BY RANGER

Man-caused fire occurrence had been averaging 40 fires annually, mostly from carelessness—in burning debris and in clearing thickets around residences without taking proper fire precautions. By visiting every land occupant prior to the fire season, the Ranger sold the idea of responsibility for guarding one's own burning, and taught safe methods of handling fire.

Results

The next year ended with a total of three man-caused fires. Furthermore, the next 2 years were entirely fire-free!

THE CONFERENCE TABLE

The change from steam locomotives to diesels on the major railroad lines in the Region during the 40's and 50's seemed to end the difficulty with right-of-way fires. The internal combustion engines of the new locomotives were not considered fire risks.

In 7 to 10 years, however, right-of-way fires began to reappear and multiply. Technical explanations pointed to aging equipment. As engine efficiency decreased, carbon accumulated in the exhaust stacks and was ejected as glowing flakes, sometimes as large as a quarter, when the engines labored under heavy loads or climbed steep grades. Attempts by some lines to economize by burning lower-quality fuel increased the carbon deposits, and heavier loadings of freight trains increased the ejections. Also, occasional fires were caused by hot brakeshoe slivers thrown off on steep downgrades or on curves.

To solve this problem by spark arrestors is not simple. Modifications which restrict free passage of exhaust gases tend to cut engine efficiency. The development and improvement of spark arrestors as well as braking systems has continued, but in the meantime the risk of a major railroad fire is ever present.

Cooperating with the State forest service, one Forest Supervisor arranged conferences with high officials of the major railroad traversing parts of his forest. He described the potential fire disaster, if right-of-way fires continued along inaccessible mountain grades, and the company's moral and legal responsibility to take preventive action.

The company's attitude was first skeptical and defensive. However, when a complete analysis of fire data, collected over a 10-year period for the area, was unveiled with maps, charts, and other visual aids, the railroad was convinced. They agreed to act.

The Forest Service and the State suggested that the company annually burn a protective strip along tracks in areas of high fire occurrence. They also offered to furnish technical advice and to help locate qualified men who might contract with the company to do the burning. The State offered to keep the contractors currently posted about the suitability of the weather. The fireproofing job began.

Results

During the two fire seasons the operation has been in effect, no fires have occurred on the treated sections of right-of-way—despite a particularly severe 1963 spring season. Company officials are convinced that much time, trouble, and money were saved by fireproofing critical rights-of-way.

CONCLUSIONS

Our records contain many other case histories in which aggressive, concentrated, prevention action cleared up bad fire occurrence situations. Taken together, the histories have convinced us that detailed study of a specific fire occurrence problem, careful prescription of approaches and remedies, and hard work in carrying out the plan will get real results.

IMPROVED LUNCH FOR FIREFIGHTERS

Equipment Development and Testing Center

Missoula, Mont.

Furnishing firefighters with enough food to sustain them during initial attack is a major problem in fire suppression planning. The usual sack lunch prepared for the field by local restaurants or mess halls and containing sandwiches, fresh fruit, canned juice or fruit, and candy bars has several disadvantages. Backlogs of lunch orders accumulate during severe outbreaks, and special trips are often made to send lunches after men have been dispatched. Sometimes there are long delays in deliveries and the lunches become stale and less palatable in transit. In some cases the lunches spoil, and firefighters have suffered severe cases of food poisoning.

The Missoula Equipment Development and Testing Center has started a project to provide a more satisfactory lunch. The primary objective is an improved sack lunch that can be prepared and stored at the beginning of the fire season and issued as needed. Other qualities sought for are (1) palatability, (2) enough calories to sustain a firefighter during initial attack, (3) readily obtainable items, (4) easy preparation, (5) food that will remain safe and palatable for a reasonable time, and (6) a container that is easily carried and will not smash like regular sack lunches.

An experimental lunch meeting these qualifications is described in the figure and table. Since the typical firefighter expends approximately 400 calories per hour while fighting fire, the lunch (see table) should sustain him for 12 hours—about twice as long as would the old sack lunch. The carrying case permits firefighters to pack the lunch in comfort, leaving both hands free.

Although the lunches can be refrigerated (not frozen) to extend

Components of firefighters' lunch with box and carrying case.

shelf life, the packing date should be plainly marked on each. At the end of the fire season lunches should be unpacked and items that are approaching their recommended shelf life should be discarded or eaten.

An initial supply of 1,200 experimental lunches was well received by firefighters and used up early in the 1963 fire season. Final specifications will be prepared after firefighters return their questionnaires.

Firefighters' lunch, menu 1

Food item	Package	Weight	Calories	Approximate price per package	Estimated shelf life		
					40° F.	70° F.	90° F.
		oz.			*Months*	*Months*	*Months*
Cheese and crackers	Plastic (2)	1½	296	$0.05	6-12	6-12	6-12
Hot cocoa mix	Plastic (1)	1	80	.05	60	24	12
Spaghetti with cheese	Can (1)	6½	750	.08	48	36	24
Jam, assorted	Plastic (6)	3	164	.08	18	18	10
Catsup	Foil (2)	1	27	.02	48	24	12
Mustard	Foil (2)	1	4	.02	36	18	9
Raisins	Box (2)	3	233	.08	24	12-15	6-9
Caramels, vanilla and chocolate	Cellophane (2)	2	296	.08	12	9	4
Deviled ham	Can (1)	2¼	250	.15	60	48	30
Pears	Can (1)	9	173	.16	48	24	12
Beef goulash	Can (1)	8	320	.15	60	48	30
Sardines	Can (1)	1	384	.19	48	12-24	6-12
Cookies	Cellophane (4)	3	375	.15	18	24	12
Bread, brown	Can (1)	16	1,289	.29	48	24	12
Totals		4 lbs.	4,641	[1] 1.88			

[1] Actual cost of 1,200 units for field testing: $1.56 each, including accessory packet and fiberboard box. Canvas carrying case costs $1.62. A more economical carrying method is being devised.

A TECHNIQUE IN TOWER ORIENTATION

James E. Mixon
State Forester, Louisiana Forestry Commission

Obtaining accurate cross outs on fires has presented a problem since the early days of fire detection. Several things can contribute to inaccurate cross outs of fires. One is the incorrect orientation of the fire tower from using the wrong magnetic declination for its longitude. Another is any error in the preparation of the cross out or district maps. However, since the same map with its errors is common to all towers within a parish and district, the greatest contributor to error is the difference between the azimuth circle of the tower table and those of the cross out maps.

To eliminate these causes of error, the Louisiana Forestry Commission has devised and instigated a program of tower orientation by districts. The program, by chain reaction, will result in correlation of all towers of the State. A brief explanation follows.

From the tower cross out map for the parish a known point, such as a section corner or a road intersection, is selected between two or more towers. From this point a balloon 6 feet in diameter, filled with a mixture of air and helium, is released. It is controlled from the ground by a light nylon line and allowed to rise to a height of from 200 to 300 feet. Because of its yellow or orange color it can be detected from 5 to 7 miles away, depending upon weather and keenness of sight. The towerman is told of its approximate location by radio and asked to get a reading on it. The cross out readings from the towers have previously been recorded by the orientation crew. When tower alidade readings have been reported, any difference between the alidade reading and the map cross out reading is readily noted; and the table azimuth circle can be corrected to coincide with the cross out map azimuth circle.

When the difference is sufficient, correction is made by having the towerman take another close reading and pinpoint or mark the point of his alidade just off the edge of his table azimuth circle. He then loosens the screws of the azimuth circle and rotates it to make the reading coincide with that of the cross out map.

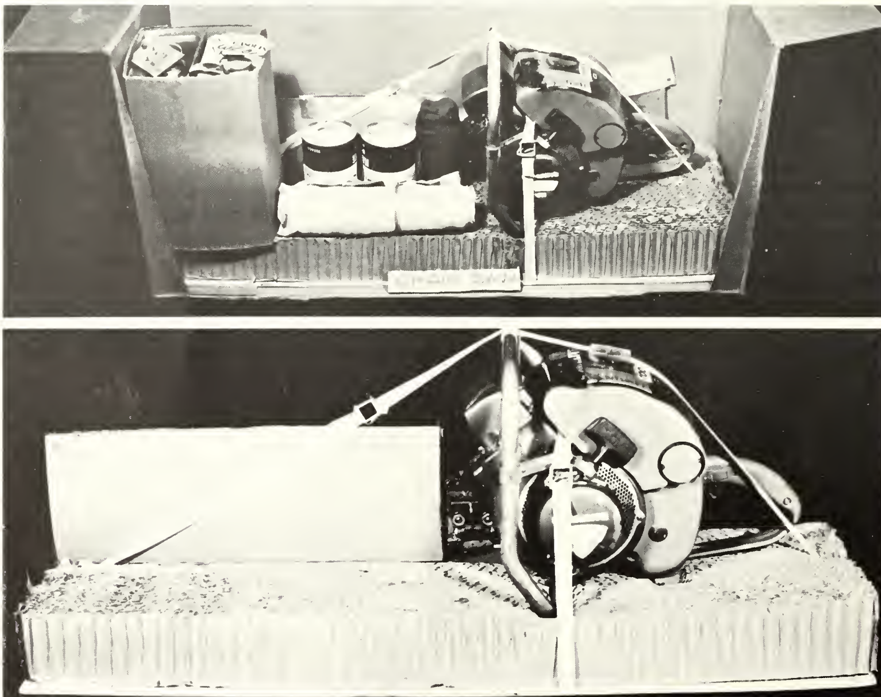
PAPER PACKAGING FOR AIRDROPS

Division of Fire Control
U.S. Forest Service

Smokejumper Dale A. Crane, working on the Carabou Ridge Fire on the St. Joe National Forest, reported an unexpected result of an airdrop malfunction. A power saw dropped by parachute broke loose when a cargo ring failed during opening shock. The free-falling package hit a 15-foot western larch, removing all the branches from one side prior to impact with the ground. Expecting the worst, Crane retrieved the package and found the power saw intact with no damage to accessories. Oil and gas cans had not ruptured. Luckily the box landed right side up and the honeycomb paper absorbed the free fall impact.

The saw was packed in a multiwall fiberboard box and protected with paper honeycomb cushions. Similar parachute failures in the past have resulted in complete loss of the saw, fuel, and accessories. The fiberboard container for this saw was developed by the Missoula Equipment Development and Testing Center under a special project to explore the use of low-cost energy-absorbing materials for protective packaging of cargo. In this instance a $2 box saved a $350 piece of equipment. Usually power saws are packaged in comparatively expensive handmade, heavy, cleated wood boxes. The latter weigh more than the saw and are frequently damaged beyond repair.

A report from cargo droppers at the Redding Air Attack Base in northern California states that a single experimental fiberboard box of the same type has been used five times in dropping power saws to fires; however, the parachute opened on each drop.



Box and honeycomb cushion for airdropped powersaw.

THE LARGE TANKER—EXTENDING ITS USE

JOHN A. ANGUILM, *Assistant Regional Supervisor, Region 1*
Michigan Department of Conservation

The large water tanker, primarily used to supply smaller units on the fireline, can serve an additional purpose if equipped with a simple water boom and adequate pump.

In 1962 Al Jackovich, Region 1 mechanic, fabricated such a water boom assembly on our 2,000-gallon semi-trailer tank unit. The purpose of this addition to the normal uses of a large tanker is to permit application of a large volume of water quickly to a planned control line in the path of a fire.

Fire behavior studies, field experience, and table-model demonstrations have shown that even minor variations in temperature and humidity have a surprisingly great effect on fire ignition and movement.

Water-dispensing boom mounted on 2,000-gallon tanker (photo courtesy of Michigan Department of Conservation)

This understanding triggered a method of creating, along a control line, a microclimate that might bring crown fires out of the treetops. Then effective attack with conventional control equipment would be possible.

In situations where advance deployment of forces can be made, some lessening of the intensity of the fire head may result even when complete success is not achieved.

Crown fires moving in natural or planted stands of red, white, and jack pine constitute an immediate and growing fire control problem in the Lake States. Openings of 50 to 150 feet wide provided by roadways, power lines, and fire lanes provide little hindrance to progress of such fires if the cover burns to the border of the opening. Flaming brands of cones and branches blow freely across the open; updrafts carry burning materials for substantial distances across the openings. Many of these brands rise vertically from intensely burning fuels and are carried aloft and over the tops; however, many more are cast horizontally and only short distances.

Using components on hand, a 200-g.p.m. pump powered by an 80-hp. industrial motor was installed. The boom was fashioned from 2-inch black pipe, and nozzles were attached with orifices of 1/4, 1/2, 1/2, and 5/8 inch from bottom to top. In position, the boom reaches 22 feet above ground and provides an even water coverage to a depth of 80 feet against a light wind. Facing a strong wind, the water breaks into a mist and approximately 50 percent drifts downwind across the line of travel, resulting in lesser coverage in the direction of discharge. The tank capacity (2,000 gal.) is dispensed in 12 minutes at a rate of 170 g.p.m. through the four nozzles. Experience indicates effective coverage can be gained over 140 rods of control line at vehicle speeds of 2 to 3 m.p.h.

Experiments to date with the described unit encourage us to seek more maneuverable vehicles with enough water capacity for effective water applications to openings other than roadways. Heavy-duty, multidrive vehicles available from time to time from the Federal Excess Program provide opportunities heretofore unavailable for such developments.

We believe such efforts offer a good chance of success under conditions less than extreme, and on areas where the stand is without firebrand material of the white birch and hemlock stub fuel variety.

SUMMARY OF FIRE LOSSES IN ALASKA

BUREAU OF LAND MANAGEMENT
U.S. Department of the Interior
Anchorage, Alaska

Year	*No. of fires*	*Acreage burned*
1946	130	1,436,597
1947	159	1,429,896
1948	134	33,676
1949	53	17,933
1950	224	2,057,817
1951	271	219,694
1952	136	73,801
1953	285	466,748
1954	262	1,389,920
1955	190	23,582
1956	225	467,721
1957	403	5,034,554
1958	196	288,616
1959	286	586,535
1960	157	85,240
1961	116	5,440
1962	102	38,923
Total	3,329	13,656,693
Average	191	815,094

Since 1940, the Bureau of Land Management has been responsible for protecting 225 million acres of public land from forest, range, and tundra fires in Alaska. This area now includes the 8 million acres recently selected by the State of Alaska.

There are no lookout towers in Alaska—and very few roads, bulldozers and fire trucks. Here, firefighting is mostly a job for aircraft and men on foot. Vast distances, long hours of daylight, high temperatures, dry fuels, frequent lightning strikes, bad terrain, limited equipment and manpower, all combine to make BLM's task of protecting the public lands from fire one of the toughest assignments of its kind in the United States.

FIRE CONTROL NOTES

Information for those who bind Fire Control Notes: A cumulative index for the period January 1956 through October 1963 will be printed in the old style size and format and distributed to subscribers in the near future.

REPORT ON AERIAL FIRE DETECTION STUDY

Louis L. Davis
Forester, Ouachita National Forest

Early in fiscal year 1963, the Ouachita began investigating the possibility of establishing a ground-air detection system. The present system consists of 26 primary and secondary lookouts on a gross area of 2,541,000 acres of which 1,543,413 acres are National Forest land.

Several factors prompted the investigation:

1. The topography makes ground detection difficult. In spite of the large number of towers 22 percent of the area remains unseen. This is due to the system of long narrow ridges, uniform in height, with few prominences high enough to overlook adjoining ridges. Many towers would be necessary to adequately cover the protected area.

2. Public use of the forest is booming and the corresponding risk increasing. Land values, already high, are increasing.

3. Each year it becomes more difficult to find competent men to replace the lookouts that are retiring, and costs of training and actual manning are high.

4. Maintenance of lookout towers is expensive, and most of the towers need rehabilitation to bring them to standard.

Study Plan

It was decided to make a study before coming to a decision. Past records were researched and a study plan made. The object of the study was to determine (1) if air patrol could effectively eliminate enough tower manning to be economically practical and (2) the effect on control time standards. The following organization was used: dispatcher, observer, communications technician, and pilot. The study was to be carried out for 1 year on approximately 1 million acres of the east part of the Ouachita National Forest.

Operations

The study occurred during the second year of drought. Fire occurrence in 1962 was twice that of 1961, and the trend continued through the period. Rainfall was approximately one-half of normal for the period and the previous 4 months. Chances to fly on low danger days in lieu of primary tower manning did not materialize. Due to high buildup primaries were manned on all class 2 days. The plan became active on January 10, 1963, with the letting of a contract for rental of aircraft and pilot based at Hot Springs, Ark.

From March 13, after preliminary flights to determine patrol routes and time required, to June 30, 1963, 85 flights were made on 66 days. Altitudes varied from 1,500 to 2,500 feet above terrain. Two flights were cancelled on notice from FAA of extreme turbulence, and two were cancelled because of low ceilings. Almost all flights encountered low to moderate turbulence, but none were aborted due to airsickness. Visibility from the towers was poor during most of the period. Visibility from the air proved better from just above the haze layer than at lower elevations.

Smokes were scouted from as low an altitude as considered safe by the pilot. Forty-four smokes that probably would have required false alarm runs by ground personnel were checked out. In fact, no false alarm runs were made while the observer was airborne. This was important to rangers, as they were engaged in APW work with deadlines to meet.

Residents soon learned that any burning they started would be checked closely from the air. Observer and pilot made three reports of circling unattended meadow fires until the farmer came and waved them on. This year the number of land clearing and meadow fires in the patrol area is less.

Results

Results thus far indicate that one plane with skilled pilot and observer and 5 lookout towers provide better detection at reduced cost than an all-ground system of 14 towers. Additional, uncalculated savings result from prompt scouting and reduced attack and control time through accurate location with nearest access route. Significantly, the largest of 74 fires in the patrol area burned 177 acres. On the other half of the forest there were several class E fires during the same period.

Air operations

Days flown	66
Flight totals:	
Number	85
Hours	254
Fires detected:	
In flight	[1] 24
By lookout and others	57
False alarms checked in flight	44

[1] Includes seven State and Corps of Engineer fires.

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

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF AGRICULTURE

AERIAL STUDY—*Continued*

Supplementary Data

Air unit operating costs

Airplane and pilot	$4,089.33
Observer	1,324.13
Radio technician	68.00
Mileage	373.61
Total	$5,855.07

Lookout costs

Primary	$5,389.41
Secondary	54.20
Total	$5,443.61

Estimated savings

9 secondary towers, not manned, 42 days	$4,868.00
Travel, 30 miles per tower per day	1,134.00
Communications maintenance, 9 towers, 2 trips each [1]	288.00
Inspection, training, and supervision; $37 each	333.00
6 months maintenance	300.00
44 false alarms	1,100.00
Total	$8,023.00
Less air unit cost	5,855.07
Net savings	$2,167.93

[1] Includes only such mileage as could be estimated from regular schedule. No special trips from base. No dollar value is given for scouting, guiding crews, etc.

TABLE 1.—*Number of fires and fire days by class of day*

[March 13–June 30, 1963]

Time of origin	Fires Class of day—					Total
	1	2	3	4	5	
0001–0800	2	1	4	4	1	12
0801–1000	1	1	1	3	2	8
1001–1200	1	1	4	7	0	13
1201–1400	0	0	3	3	0	6
1401–1600	1	0	2	0	2	5
1601–1800	1	1	2	5	2	11
1801–2000	0	1	2	4	0	7
2001–2400	0	0	4	4	4	12
Total fires	6	5	22	30	11	74
Total fire days	30	32	26	17	5	110

Number of fires by size class and cause

Size class:	
A	7
B	41
C	23
D	3
E	0
Cause:	
Lightning	14
Recreation	4
Smoking	6
Land occupancy	6
Incendiary	42
Forest utilization	1
Miscellaneous	1

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FIRE CONTROL NOTES

U.S. Department of Agriculture
Forest Service

FIRE CONTROL NOTES

A quarterly periodical devoted to forest fire control

CONTENTS

INFORMATION FOR CONTRIBUTORS

Please submit contributions through appropriate channels to Director, Division of Fire Control, Forest Service, U.S. Department of Agriculture, Washington, D.C. 20250. Articles should be typed in duplicate, double 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 organization.

Authors are encouraged to include illustrations with their copy. Illustrations, whether drawings or photographs, should have clear detail and tell a story. Only glossy prints or India ink line drawings are acceptable. Captions for illustrations should be typed in the manuscript immediately following the paragraph in which the illustration is first mentioned, the caption 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 caption 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.

COVER—TBM air tanker making drop in open test area. (Photo courtesy of Monsanto Chemical Company)

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EFFECT OF OVERSTORY ON GROUND DISTRIBUTION OF AIRDROPPED SLURRIES

RAGNAR W. JOHANSEN, *Research Forester,*
Southern Forest Fire Laboratory

Overstory crowns and understory vegetation affect the success of an aerial retardant drop by intercepting much of the material before it reaches the ground. Miller and Reinecker[1] reported there was considerable interception of dropped retardant slurries by heavy brush and timber canopies in California. In Georgia,[2] pine canopies with closures ranging 63–69 percent in stands 25–55 feet in height intercepted 40 percent of the kaolin slurries released from a TBM air tanker owned by the Georgia Forestry Commission. Therefore, to obtain desired ground coverage, more material had to be dropped into a fairly heavy pine canopy than in open areas.

Further tests were deemed necessary to acquire a quantitative estimate of retardant interception by different types of vegetative cover. In a mature bottomland hardwood stand 90 feet tall, located on the Oconee National Forest in Georgia, drops were first made while the trees were in full leaf and again when they were bare. Results from these tests were compared with data obtained from drops into a 22-year-old, 15 by 15-foot spaced slash pine plantation 60 feet tall on the George Walton Experimental Forest, near Cordele, Ga. Crown closure exceeded 60 percent in all of the forested areas. For comparison, drops were also made in the open.

Dropping procedure was standardized as much as possible to minimize sampling error. Only 220- and 440-gallon loads were used; airspeed at time of drop ranged 100–110 knots; and altitude was maintained 75–90 feet above the highest obstruction.

Former studies have shown that large tank gates and quick release are best. Thus, when the pilot trips the tank latch, he virtually opens the bottom of the tank. This produces an elliptical ground pattern concentrated at the center and tapering off to the sides and ends. By effective pattern length, we mean end and side limits of one-half gallon per 100 square feet, or in certain heavier fuels 1 gallon per 100 square feet—which are considered minimum for extinguishing fires in the Southeast.

To aline the air tanker with the drop area and to designate the proper drop altitude, helium-filled weather balloons were raised in a prearranged pattern immediately prior to each test (fig. 1). Plastic ½-gallon cups spaced 20 feet apart in rows 25 feet apart were used to make a ground grid covering an area 150 by 500 feet. Slurry in the cups after a drop gave us an estimate of amounts and distribution on the ground.

Results from this study (table 1) indicate that for drops over open areas (see cover) 220-gallon loads are almost equal in effectiveness to 440-gallon loads, provided ½- to 1-gallon application rates are adequate to stop a fire. Either drop load will generally result in an effective line at least 200 feet long.

Where fairly heavy pine canopies exist in the Southeast, drops in excess of 220 gallons are needed to produce a 200-foot line at the minimum required application rate of one-half gallon per 100 square feet.

Only 78–79 percent of the slurry dropped over open areas could be accounted for. The remaining

Figure 1.—TBM air tanker lining up with helium-filled balloons that mark the test drop area.

[1] Miller, H. R., and Reinecker, H. P. Air tanker report, California, 1957. U.S. Forest Serv., Fire Control Notes 19: 53-56, illus. 1958.

[2] Storey, T. G., Wendel, G. W., and Altobellis, A. T. Testing the TBM aerial tanker in the Southeast. U.S. Forest Serv., Southeast. Forest Expt. Sta. Paper 101, 25 pp., illus. 1959.

TABLE 1.—*Relation of drop load*[1] *to length of slurry pattern in open and forested areas*

Drop type and number	Pattern length at: ½ gal./100 sq. ft.	Pattern length at: 1 gal./100 sq. ft.	Slurry reaching grid
	Feet	*Feet*	*Percent*
220-gallon, open			
1	240	200	85
2	280	240	74
3	180	180	75
Average	233	207	78
440-gallon, open			
1	260	260	83
2	200	180	73
3	280	280	82
Average	247	240	79
220-gallon, pine forest			
1	120	100	54
2	180	120	39
3	140	120	52
Average	147	113	48
440-gallon, pine forest			
1	220	220	42
2	240	160	54
Average	230	190	48
220-gallon, full hardwood canopy			
1	25	0	9
2	25	25	11
Average	25	12	10
440-gallon, full hardwood canopy			
1	0	0	17
2	50	50	10
Average	25	25	14
220-gallon, bare hardwood canopy			
1	260	(2)	(2)

[1]Kaolin slurries were used to simulate thickened retardant mixtures.

[2]Too much of the slurry load fell outside cup pattern to permit this computation.

material (21–22 percent) was apparently lost from the drift of very fine particles out of the drop area. When drops were made over pine canopies, only 48 percent of the slurry could be accounted for on the ground underneath. This indicates that the canopy intercepted about 30 percent of the dropped material.

The penetration of 220- and 440-gallon kaolin slurry drops through a mature, well-stocked, fully leafed hardwood stand was extremely poor compared with the amount of material striking ground fuels from drops made over open areas. The 10–15 percent of material that did reach the grid area was concentrated under canopy openings. Because of the high interception rate, the longest line made in the fully leafed hardwood drop series with application rates exceeding one-half gallon per 100 square feet was 50 feet.

During the winter, two 220-gallon drops were made over the previously used bottomland hardwood canopy. Although neither drop fell completely within the confines of the measuring grid enough data were usable to indicate that the bar

Continued on page 1

AERIAL SURVEY OF TOWER SITES

C. F. Platt, *Assistant Senior Superintendent, Forest Protection Branch, Alberta Forest Service*

An aerial survey program for the selection of forestry tower and lookout sites in Alberta was begun in 1956. Its characteristics were dictated by the following factors:

1. The rate of expansion in Alberta's forest service demanded that a large number of sites be established within a relatively short period of time.
2. Complete topographic and contour mapping was unavailable.
3. Large areas and great distances were involved (forestry administration covered more than 42,000 square miles at the time, the majority being boreal region).
4. The need for a consistent standard in lookout site evaluation required a single, simplified site selection routine.

The final method adopted was a combination of earlier procedures and new methods suited to the territory and topography involved.

Preliminary Survey

Objective.—To select a large number of heights of land for possible tower sites for further evaluation and final selection.

Method.—Fly a series of grid flights by fixed-wing aircraft, at [illegible],000 feet above ground level, on grid lines spaced at 12-mile intervals. The altitude is specified to provide the airborne selector with topographic definition; at higher altitudes ground contours begin to flatten out. Visual comparison of heights of land are made in flight and locations plotted.

By this means large areas are quickly appraised, and the most likely sites plotted to simplify final selection surveys. Preliminary surveys should be conducted well ahead of actual lookout construction planning. A 2-year interval and backlog of possibilities are considered adequate.

Final Survey

Objective.—Selection of a final construction site, within a specific region, from among possible sites plotted on preliminary surveys.

Method.—A helicopter flight is made directly to the plotted sites in the area. Each is evaluated in turn and the final selection marked from the air by dropping two rolls of red plastic marking ribbon; one roll for air location is laid along the tree canopy, and one for ground location is allowed to drop through the canopy to the ground. Following selection, a series of horizontal photographs are taken from the aircraft, at approximately tower cupola height above the selected site (fig. 1). The photographs provide "seen" area illustration through a complete circuit made at the point of location. Film is exposed at intervals based on time of complete circuit divided by 16 (the number of exposures required by camera lens angle to give proper exposure overlap).

Oblique photographs are then taken from an altitude of approximately 1,000 feet above ground. These illustrate the overall site, viewed from several directions, and include landmark tie points for future location references (fig. 2).

Timber stand heights and estimates of required site improvements, access routes, and specific ground survey needs are noted during final survey flight.

Following final survey, photographs are interpreted by a photogrammetrist who plots "seen" areas on a map. Areas of doubt may be checked by ground survey and engineering opinions sought before any final construction program is laid on.

Equipment

Fleet helio courier airplane.—260-hp. Lycoming motor,[1] model GO–435–2C. Flight characteris-

[1]The identification of commercial products is solely for information purposes and does not imply endorsement by the Forest Service, U.S. Department of Agriculture.

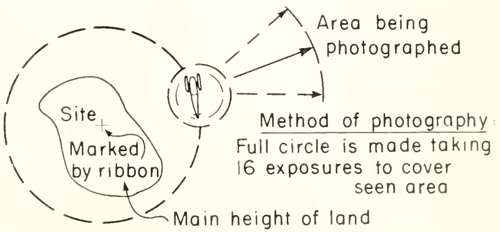


Figure 1

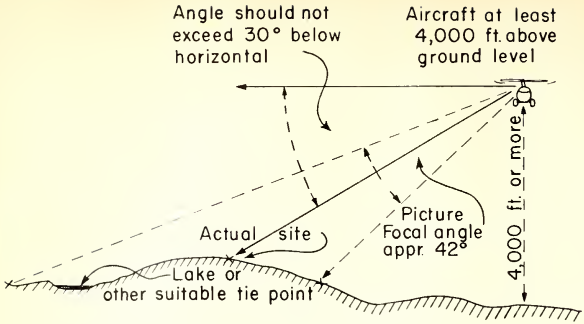


Figure 2

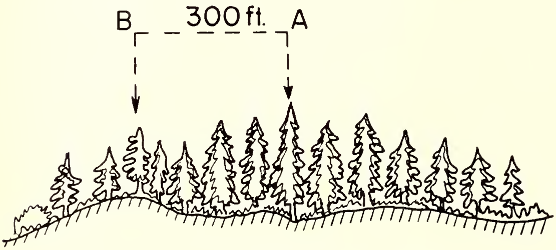


Figure 3

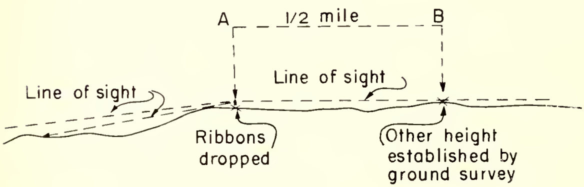


Figure 4

tics: slow speed, short takeoff and landing distances.

Bell 47J2 helicopter.—305-hp. Lycoming motor, model VO–435–A1B. Flight characteristics: service ceiling 12,000 feet with load of 1,000 pounds.

Fairchild K20 hand-held aerial camera.—Lens: f4.5, 161-mm., focal length 6⅜ inches. Filters: minus blue wratten 12 combined with haze #1, series 6. Film: modified infrared aerographic roll type, 50 exposures per roll, exposure index 100. Light meter.

Problems

Timber heights may vary at a site summit, and in such cases ground-level checks should be used for a final decision (fig. 3).

Plateau-type sites should be checked carefully for land shoulders that may seriously reduce the total "seen" area from this location (fig. 4).

Helicopters are used for final site selection because of their safety factor. However, helicopters lack some of the lateral flight stability featured in fixed-wing aircraft maneuvers, and constant correction of camera angle is required during circuit if winds are encountered.

Film selection is important if haze and variations in light and shadow are to be surmounted, particularly in "seen" area exposures. The film used in Alberta is reasonably satisfactory; however, cloudless days should be selected for photography, if possible. Broken cumulus imposes heavy black shadows on landscape which may limit photogrammetry. Vibration through helicopter rotor blade flutter requires shutter speeds of over 1/250 of a second; good lighting is essential for quality results.

Checklist

An observer may find a survey data sheet useful to almost eliminate the need for writing during flight and to provide checkoff reference for future observations. Suggested references for such a checklist are:

Location, date, weather, hour of photography, camera settings and meter readings, camera filters, type of film, number of exposures and shutter speed, orientation points (lakes, streams etc.), landing possibilities, land access routes, height of tower required, altitude of site, and (in writing) miscellaneous characteristics.

FIRE RETARDANT FOR GROUND ATTACK

R. M. Coy, *Forester,*
Pennsylvania Department of Forests and Waters

Much has been written in recent years about the use of various retardants in fighting forest fires. Most of the work and use of retardants has been with air attack as a support action to ground attack.

The air attack arm of the Division of Protection, Pennsylvania Department of Forests and Waters, has been developing into an essential attack unit in the control of forest fires. Its successes or failures have been tied to the presence or not of direct ground attack on the fire within minutes of airdrops. For the most part, the ground action has been by "smokechaser" crews.

The smokechaser crews are not new to Pennsylvania. For 20 years or more they have been an extremely important part of the control organization in the anthracite coal region of eastern Pennsylvania. The theme of their operation has been "Hit 'em quick, your next fire may have already started." These crews generally consist of two men supplied with a small pumper unit of 100-gallon tank capacity, a live reel with several hundred feet of ¾-inch booster hose, fusees, assorted small handtools, mobile radio, and transportation suitable to carry all this into rough country. Once at the fire, their main attack tool has been the 5-gallon backpack tank.

The accomplishments with this 5-gallon tank by one who knows how to use it and has faith in his ability are amazing; yet no one has been more concious of the limitations of this attack system. In the search for the "equalizer," experience has proved that laying fire hose for more than short distances is not a practical solution because of the nature of forest cover, topography, and water supplies. Rather, attention has been focused on any material that, as an additive to water or in pure form, could increase the effectiveness of the backpack tank. Many such materials have been tested, but none has had wide acceptance.

One material which might be the "equalizer" is Pyro 11–37–0,[1] manufactured as a commercial liquid fertilizer by TVA but also marketed as a fire retardant.

Six thousand gallons of Pyro were purchased for the spring fire season of 1963 to be used by air-attack and ground crews. The initial results brought approving reports.

The manufacturer recommended a mixing ratio of 5 parts water to 1 part Pyro, and we have attempted to maintain an approximate 5 to 1 mix for our airdrops. However, I have witnessed a series of successful airdrops by a helicopter (100-gallon drops) in which ratios of 5 to 1 and 10 to 1 were used indiscriminately with no apparent difference in effect. Ground crews have been using a 10 to 1 ratio in their backpack tanks with results apparently equal to stronger mixes.

At this time the most effective method of attack by ground crews equipped with backpack tanks seems to be a direct one of playing a narrow spray of the mixture to the base of the flame and directly ahead of it. When intensity of the fire is such that men cannot approach for a direct attack, a line several feet in width has been sprayed a safe distance in front of the fire. This has sufficiently slowed the fires to allow men to move in for direct attack. Back fires have been allowed to burn out against retardant lines and occasionally have burned under the retardant lines. Motorized pumper units using 10:1 mixtures have been successful in establishing lines for indirect control, owing to the greater volume discharge and the greater width of the resulting line. No major problem in equipment maintenance has developed from the use of this retardant.

Some of the characteristics of Pyro and possible solutions to some of the problems encountered in its use are:

1. May cause "fertilizer burn" to living plants. This has never been found on forest vegetation, but has been disastrous on lawn grass.

2. Nontoxic to humans or animals.

3. Excessive contact with skin has caused slight dermatitis, although Pyro is easily rinsed or washed away.

Continued on page 15

[1]Pyro is made of the following components: 49 percent ammonium phosphate, 28 percent ortho phosphate, 17 percent tripoly phosphate and 6 percent other (primarily tetrapoly phosphate).

USE OF AIR PRESSURE POWERED WATER TANKS IN WEST TENNESSEE

MICHAEL H. STANFORD, *Assistant District Forester, Tennessee Department of Conservation, Forestry Division*

Because of easy access to fires, owing to an extensive road net and flat terrain, water can be used extensively in direct fire suppression in west Tennessee. Because of budget limitations the required number of commercial slip-on pumper units could not be purchased, so a cheaper method of getting water to the fire was looked for.

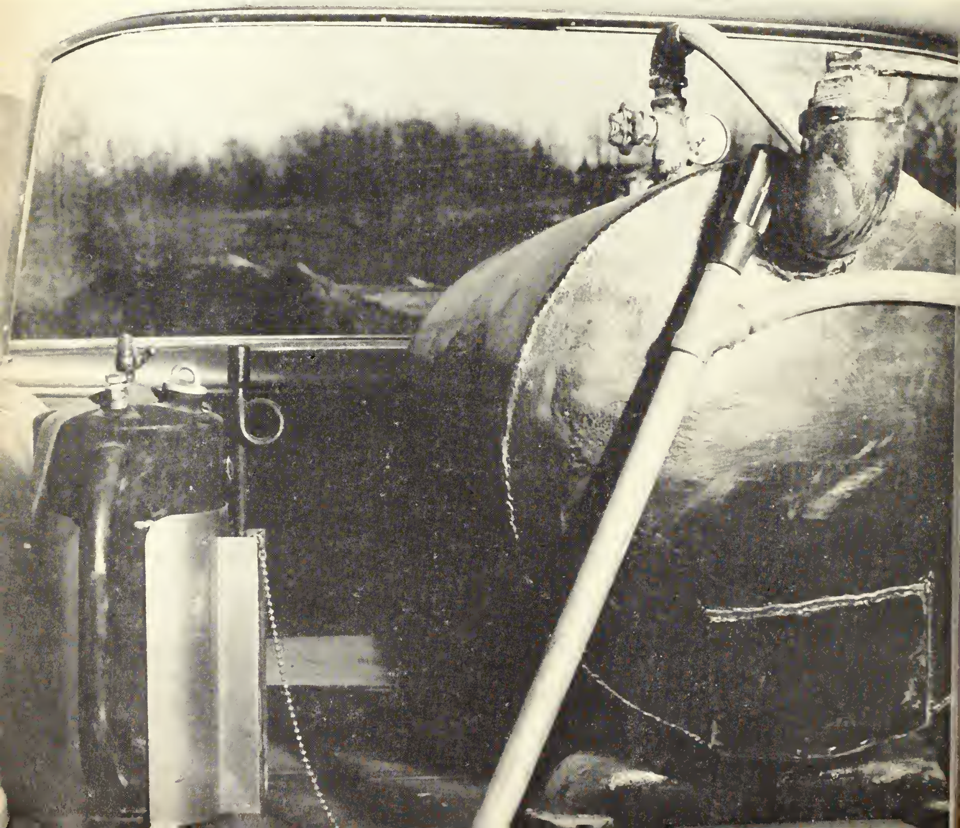
The answer is a 30–60-gallon pressure tank fitted with an air gage, air valve stem, a 2-inch filler hole, 500–100 feet of ⅝-inch rubber hose and a nozzle (see figs.).

The tank is filled to the ¾-level with water, with or without fire retardant or wetting agent added, and 100–150 p.s.i. of compressed air is put into the tank, the amount depending on the pressure capacity of the tank. Hot water heater tanks, for example, have a pressure capacity of 125 p.s.i.

Two kinds of nozzle have been tested, a regular garden hose nozzle and a low-volume, fog-type crop spray nozzle. A 40-gallon tank at 100 p.s.i. will spray an effective stream for approximately 45

Continued on page 16

Figure 1.—Forty-gallon air pressure water tank mounted in rear of station wagon.



THE FOREST SERVICE SPECIFICATION PROGRAM FOR FIRE EQUIPMENT

CARL BURGTORF, *Forester,*
Division of Fire Control

Firefighters need and expect good performance from the fire equipment and supplies they use on firelines. Fire equipment must be dependable, and safe to use.

In the early days firefighting Rangers learned to select certain brands of fire tools which experience had shown would meet their exacting requirements. Many of the tools were handpicked and maintained or sharpened by the men who used them. Today, fire equipment may be purchased in large quantities by a procurement officer with only a written description and specification for guidance. However, the objective of the program is to continue to meet the exacting needs of the firefighter. The procedure is different, but the field still has a voice in the development of specifications for fire equipment.

At one time the Forest Service maintained warehouses stocked with fire equipment and supplies. In 1956 the Forest Service signed an agreement with the General Services Administration which provided for procurement and stocking of fire equipment and supplies by the Federal Supply Service. While this gradually reduced the Forest Service Warehouse stocking of fire items, the Forest Service has the responsibility to provide GSA with suitable specifications for the equipment and supplies needed for fire control activities. It is especially necessary to develop specifications for all new items of fire equipment as they come into use.

Forest Service Specifications

The Forest Service specifiation is a technical detailed description of a material, product, or service. Inspection and testing procedures, performance requirements, preservation needs, packaging and packing instructions are usually included in the specification. The end purpose of the specification is primarily to meet the needs of the user by providing fire equipment of uniformly acceptable quality. Several steps are necessary to accomplish this.

First, use of the equipment is examined, and the field is canvassed to determine if a specification is needed. Comments are invited from field people in determining requirements for the item being considered. When needs are known, a search is made to find commercial products that are on the market. These are examined by engineering or equipment specialists who choose special qualities and devise testing and inspection procedures to include in the final specification.

Next, a proposed specification is written and circulated to field units, to interested suppliers, and to industry for review and suggestions. This information is carefully weighed and often results in desirable corrections to the proposed draft. This work is usually done at the Forest Service Equipment Development and Testing Centers located at Arcardia, Calif. and Missoula, Mont., or at the Electronics Center at Beltsville, Md.

The Division of Fire Control reviews and coordinates preparation, processing, and distribution of fire equipment specifications. After review and acceptance by the Division of Fire Control, the specification is usually printed initially as an Interim Specification and remains in use for 1 or 2 years to allow personnel time to find and report on weakness in material or design.

Procurement problems are often found and corrected during this period. After this "debugging" period, appropriate revisions are made and a USDA-Forest Service Specification is written. The Division of Fire Control is presently maintaining 85 active specifications for fire equipment and supplies. There are 38 specifications currently in various stages of development at the Forest Service Equipment Development and Testing Centers. The Centers also amend and rewrite specifications to incorporate different materials or performance requirements. It is estimated that over 200 Forest Service specifications are needed for all fire control items.

Qualified Products Lists

Qualification tests are used to determine the acceptability of some fire equipment. After these tests a list is compiled of the products that will meet rigid field performance requirements, for example, the engine-driven pumpers used in fire control which are tested according to Forest Service Specification 5100–273a. Exhaustive tests are made of various pumper models and types, and those that qualify are listed as acceptable for their designated purpose. Manufacturers submit their models to the Arcadia Equipment Development and Testing Center for qualification and often witness the testing operation. This service enables manufacturers to eliminate weaknesses in their equipment to qualify for Government bidding.

Forest Service Standards

Forest Service standards are used as detailed descriptions of materials, processes, methods, designs, drafting room and other engineering practices. The standard is written to achieve the highest practical degree of uniformity of materials or products, primarily for ease of handling and interchangeability of components.

Standards are used in specifications, invitations for bids, proposals, and in contracts. A good example is Forest Service Interim Standard 5100–0070, which is a checklist of components for a complete kitchen and mess outfit. The standard includes instructions for assembly, with pictures and illustrations of special containers in the outfit.

In addition to providing guidance for procurement officers, there are many benefits from the Forest Service specifications and standardization program, such as:

1. Reduction in variety of sizes, types, and grades of items needed in fire control operations.

2. Procurement of greatest practical uniformity of dimensions to promote interchangeability and replacement of parts.

3. Uniformity in production, inspection, testing and processing which also helps in training personnel to use fire equipment.

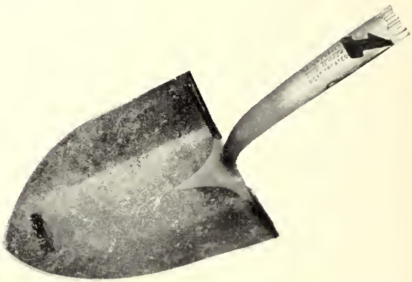
4. Adoption of uniform terminology and definition of technical, engineering, and supply practices.

5. Utilization of work done by industry, technical societies, and other agencies to avoid duplication of testing and research.

6. Aids in selection of commercial products that meet our acknowledged performance requirements.

7. Standardization of purchasing. Specifications may be used by General Services Administration as purchased descriptions for procurement.

The development of the firefighting shovel, size 1, is a fine example of the progression from the employee improvement suggestion to the development project assignment to Arcadia Equipment Development and Testing Center which finally resulted in manufacture of the shovel under the new Forest Service Specification 5100–00326. Manufacturers and Forest Service field personnel made their comments throughout the specification development. General Services Administration has been instructed to purchase pilot quantities, and the next step will be to include firefighting shovel, size 1 in the GSA Forest Firefighting Equipment and Supply Catalog.



Firefighting shovel size 1, Forest Service Specification 5100-00326

In the final analysis firefighters, crew bosses, and Rangers will decide whether this shovel meets their needs. Specifications and standards are obtainable upon request to the Chief, Forest Service, U. S. Department of Agriculture, Washington, D. C. 20250.

FIRE POWER.—Conservation Department records show that the diesel locomotive was the leading cause of Wisconsin forest fires in 1962.

FIRE HAZARD ON TOBAGO

Merrill E. Tester, *Forester,*
Division of Fire Control, Missoula, Mont.

Mr. Tester, Fire Control Specialist from Missoula, Mont. went to Tobago in October 1963 to assist the Trinidad-Tobago Government with the fire hazard created by Hurricane Flora. This article reports on the problem and remedial plan developed.

Throughout the United States, fire hazard in timber areas is a common situation. Hazard is always present but the degree may vary. Few foresters realize that fire hazard can also exist on the tropical islands of the West Indies. This article deals with the fire hazard created on Robinson Crusoe's island of Tobago by Hurricane Flora.

Tobago is a small island of some 114 square miles and is 26 miles long by 7½ miles wide. It is located about 26 miles north of Trinidad and is part of the Trinidad-Tobago nation. The island was discovered by Columbus in 1498, with the first European settlement taking place in 1632. From 1814 to 1962 it remained under British rule. In August 1962, Trinidad and Tobago became an independent nation and a member of the Commonwealth.

The island of Tobago is situated roughly on a NE-SW axis with a main range of mountains running lengthwise along its middle. Most of its terrain consists of steep hills and sharp draws with elevations ranging up to 1,890 feet above sea level. Topography is generally young with highly erosive soils. Typical of many of the islands in the West Indies, Tobago is favored with a very pleasant climate. Prevailing wind is the NE trade, which blows with considerable constancy and force. Winds probably exceed 6 m.p.h. at any time, being higher in the dry season. Mean annual temperature is 78°, varying between 65° and 90°. Relative humidity seldom is below 60 percent. Annual precipitation varies from about 56 inches along the coast to about 150 inches in the higher country. There are distinct wet and dry seasons, with March and April being the driest part of the year.

Situated astride the main ridge running lengthwise of Tobago is a 9,770-acre forest reserve. This reserve is one of the oldest in the Western Hemisphere, having been established by the English in 1765. The reserve is about 10 miles long and 1½ miles wide. Until 1958 no roads penetrated the reserve. Since then an access road has been partially completed across its middle, but most of the reserve is still inaccessible.

Hurricane Flora struck her first devastating blow on Tobago on Sept. 30, 1963, with no warning (fig. 1). In fact two blows were struck, with the first coming about 12:45 p.m. for 30 minutes, and the second and heavier blow about 2:00 p.m. for about 2 hours. Winds reached a high of 140 m.p.h. When Flora departed, curving upward to continue her havoc in Haiti and Cuba, she had turned Crusoe's smiling, unspoiled isle into a whimpering shambles. Twenty-four lives were lost, some 20 villages were wiped out, and more than 50 percent of the island's 38,000 population was rendered homeless. Agriculture was almost no more. The extent of the damage was estimated at $150 million.

Prior to the hurricane, the entire reserve was covered with a dense, primeval rain forest with very few trees of merchantable value. Slopes are steep with many ridges and draws. Elevation of the reserve ranges from 800 to 1,890 feet. Very little management of the forest has taken place, with only about 200 trees having been removed for commercial purposes during the past 10 years. The primary value of the reserve is watershed protection.

Damage to the reserve was heavy. Approximately 75 percent of the stems were blown over or broken off (fig. 2). The remaining stems had almost all of their crowns removed. Many of the standing stems were damaged so severely they will not survive. The resultant accumulation on or near the ground of trunks, limbs, and leaves caused a vast change in the fire hazard.

Prior to the hurricane the reserve had never known a fire problem. The entire area was well shaded with a solid canopy. Ground temperatures were low, surface moistures high, and flash fuels nonexistent. In a matter of hours, Hurricane Flora completely reversed this picture. The canopy was completely destroyed, thereby creating the potential for higher ground temperatures, lower surface moisture, and a vast amount of flashy fuels. In effect, the Trinidad-Tobago government was confronted with a brand new fire problem of rather serious proportions. Coupled with this was the lack of experienced firefighting personnel and suppression equipment.

Fortunately, the fire hazard is of a short, transitory nature. High humidities, coupled with heavy precipitation, will tend to reduce the hazard quite rapidly through decomposition. It will further be alleviated by the rapid growth of new vegetation. It was agreed locally that the greatest risk would occur during the dry season of March and April 1964. After that, it should not be great enough to cause any serious problems.

The primary concern of the Trinidad-Tobago government was how to cope with this fire problem. Arriving at a solution was complicated by lack of access, erosive soils, lack of trained and experienced personnel, lack of suppression tools and equipment, short amount of time before the next dry season, and the transitory nature of the fire hazard.

Through the assistance of the Agency for International Development, I was assigned to help develop a plan of action. The final plan was prepared in late October and early November 1963. At the same time, members of the forestry and fire departments were given fire suppression training which covered organization, line construction methods, snagging, line location, burning out, and use of tools, dirt, and water. Basic recommendations of the plan were:

Figure 1.—View of forest reserve on Tobago after Hurricane Flora struck. (Photo courtesy Trinidad-Tobago Government.)

Figure 2.—Detail view of the reserve, showing many broken trees and heavy ground debris. (Photo courtesy Trinidad-Tobago Government.)

Prevention

1. Develop and implement a strong, effective fire prevention program.

2. Restrict public entry on government lands during the dry season and smoking by work crews.

3. Require burning permits for all open fires during the dry season.

4. Strengthen government organization on Tobago to facilitate accomplishment of the prevention program.

Continued on page 16

FIRE HAZARD MANAGEMENT

John Morrison, *Forester,*
Bitterroot National Forest

About 100 years before Lewis and Clark passed through western Montana in 1805, a large fire or a series of large fires burned about 1 million acres that later became portions of the Bitterroot, Deerlodge, and Beaverhead National Forests. In this burn a lodgepole pine stand became established and eventually flourished. The stand became overmature and in the late 1920's was struck by a bark beetle epidemic which killed between 65 and 90 percent of the stems. Most of the snags have fallen down in subsequent years (fig. 1).

When the snags were standing and the first few years when they were on the ground, the fire hazard was not greatly increased. However, in recent years decomposition has greatly increased their combustibility. A tangle of reproduction, mostly alpine fir, became established under the opened stands (fig. 2). This was the setting for the Sleeping Child Fire which started from a dry lightning storm on Aug. 4, 1961. In spite of rapid initial attack, this fire enveloped 145 acres in 2 hours and spread to 9,000 acres in 24 hours (fig. 3). The fire continued to spread until August 13, when it was controlled at 28,000 acres.

Fires such as the Sleeping Child Fire are very costly to control. However, a conflagration-type fire such as this must be controlled as quickly as possible because of its destructive potential to forest resources and improvements. Such a conflagration in these fuels could spread with force to hundreds

Figure 1.—Lodgepole pine high hazard area showing the heavy ground fuel accumulation.

Figure 2.—High hazard area. Trees killed by bark beetle infestation in the late 1920's are mostly on the ground.

Figure 3.—Sleeping Child Fire, Aug. 9, 1961.

of thousands of acres and destroy all that is on them. Reduction or elimination of these fuels, at the cost of controlling one conflagration, would reduce the hazard on an area many times the size of the conflagration. The Sleeping Child and Saddle Mountain Fires reemphasized this need.

There are still over 200,000 acres of these high-hazard fuels on the Bitterroot National Forest. This area is producing little or no valuable timber, owing to dwarf mistletoe in the lodgepole pine understory and the poor potential and low quality of the alpine fir. It has not been developed because of its present low value, and roads generally stop on its perimeter.

In the fall of 1962, the Bitterroot National Forest started development of a hazard management plan for these areas. Objectives of the plan are to (1) minimize the possibility of conflagration-type fires; (2) salvage all available merchantable material; (3) reduce the fire hazard; (4) bring timber production to or near full potential.

Before field work was started on the plan, work maps were made for the general high-hazard area. Two-inch-to-the-mile timber management plats were used. The lodgepole pine pole and sawtimber types were shaded on the plats so that they could be readily checked in the field. Ridges were also shown. Two observers field-checked the area by helicopter. The heavy fuel types were readily discernible. The aerial base timber plats were invaluable in delineating the high-hazard areas which, as well as possible helicopter spots and natural firebreaks, were recorded on the maps.

After the field check, boundaries of the high-hazard areas were outlined on a ½-inch forest map. They were then subdivided into 16 units where drainages or natural firebreaks were used as unit boundaries. These units vary in size from 5,000 to 26,000 acres. Two-inch-to-the-mile base maps were prepared for each unit showing hazard and major timber types. An improvement overlay was made for each unit showing (1) planned roads, (2) planned helispots, and (3) planned firebreaks. A written section was made for each unit which shows (1) estimated volume of commercial timber by species and (2) estimated cost of proposed roads, helispots, and firebreak construction.

The units were further broken into blocks which are being used as work units and for which intensive on-the-ground plans will be made.

In implementing the plan, first consideration is given to a transportation system of roads and helispots needed to provide better protection until fuel reduction can be accomplished. Helispots in the very heavy fuel areas are given highest priority. These will be used by helitack to speed up initial action on fires. Roads are also assigned construction priorities. Second consideration is given to harvesting merchantable timber, and third to reduction of the fire hazard and establishment of a new timber stand. Establishment of a new timber stand will, in most cases, be accomplished by leaving seed trees on the areas which are prepared for prescribed burning.

A start was made in 1963 toward implementing the plan. Fifteen helispots were constructed, and a construction contract was let for 5 miles of the highest priority road. In addition three areas totalling 160 acres, where merchantable timber had been salvaged, were prepared for prescribed burning. In preparing the areas, from 10 to 20 lodgepole pine seed trees per acre were left to help establish a new timber stand. The remaining trees and snags were felled to provide flash fuels to carry the fire and ignite the heavier fuels. The seed trees will be killed by the fire, but their cones will open and reseed the areas to lodgepole pine.

Preparation of the areas was accomplished by the interregional fire suppression crew stationed on the Bitterroot Forest at Trapper Creek. The flash fuels had not dried sufficiently to ignite and carry fire in the fall of 1963. Plans are to burn the areas in the fall of 1964 (fig. 4).

Figure 4.—Area prepared for burning. The seed trees will be killed when the area is burned.

The areas to be burned were selected for their potential to serve as firebreaks or barriers to keep wildfires from becoming conflagrations. Eventually the hazard on the entire area should be reduced to a level that will not be conducive to large fires. This will be done in conjunction with intensive resource management.

Airdropped Slurries—*Continued from page 4*

crowns did not materially impede the slurry passage to the ground. The length of the ground pattern exceeding one-half gallon per 100 square feet through the bare hardwood crown was about equal to that for an open area. Application rate zones exceeding 2 gallons per 100 square feet were lacking in these hardwood drops, but were present in both the open and pine drops. Thus, while the open and hardwood patterns were comparable in size, less slurry actually reached the ground through the bare hardwood canopy.

Nevertheless, a 220-gallon drop should effectively retard the advance of a low-intensity fire in the understory. If a hardwood stand is in full leaf, however, not even a 440-gallon drop will penetrate the crown canopy sufficiently for fire retardant action.

Ground Attack—*Continued from page 7*

4. Corrosive to most metals. A corrosion inhibitor which makes possible long-term storage in steel containers can be added by the manufacturer.

5. Mixture of Pyro and water begins to freeze at temperatures slightly less than 32 F.

6. Pyro will leak through joints and seams that were considered watertight.

7. Equipment used only periodically may tighten or freeze up from dried deposits of Pyro.

   a. Complete flushing with water is good preventive maintenance.

   b. Small, premeasured containers of pure Pyro can be carried in vehicles for use in backpack tanks.

8. Pyro's retardant effect appears to remain on vegetation until leached or weathered away.

9. Use of various ratios, including pure Pyro, in a powered, backpack mist blower proved unsuccessful.

10. Penetration appears to exceed any retardant we have used to date.

Water Tanks—*Continued from page 8*

minutes using the low-volume nozzle. By changing to the higher volume garden nozzle the effectiveness of the stream is increased somewhat, but the spray time is cut to approximately 15 minutes. We have found that the increased spray time usually outweighs the advantage of a greater volume of water.

By using a surplus or discarded pressure tank, the cost of the unit should not exceed $20 including the hose and nozzle.

The air pressure powered water tanks used through one fire season have already proved their worth. In many instances one man was able to stop a hot, fast-moving fire, thus saving the expense and time involved in dispatching a fire plow unit.

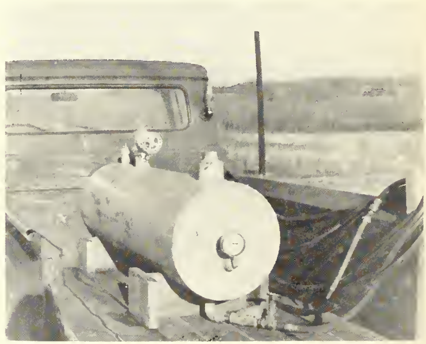


Figure 2.—Sixty-gallon air pressure water tank mounted in rear of truck.

Tobago—*Continued from page 12*

Presuppression

1. Supplement firefighting equipment with tools designed to fight fires in heavy fuels.

2. Organize and train selected groups of cooperative smokechasers.

3. Establish tool caches at locations of cooperating smokechasers.

4. Use a small fixed-wing aircraft for supplemental detection.

5. Organize and train cooperative detectors.

6. Develop a map of all transportation routes, both road and trail.

Suppression

1. Develop and implement a fire training program for government employees and selected cooperators.

2. Specialized equipment such as helicopters, large aircraft, radios, and retardant are not needed.

3. Additional mobile firetrucks are not needed.

4. No attempt should be made to construct firebreaks throughout the reserve.

5. No attempt should be made to construct more access roads in the forest reserve before the next dry season.

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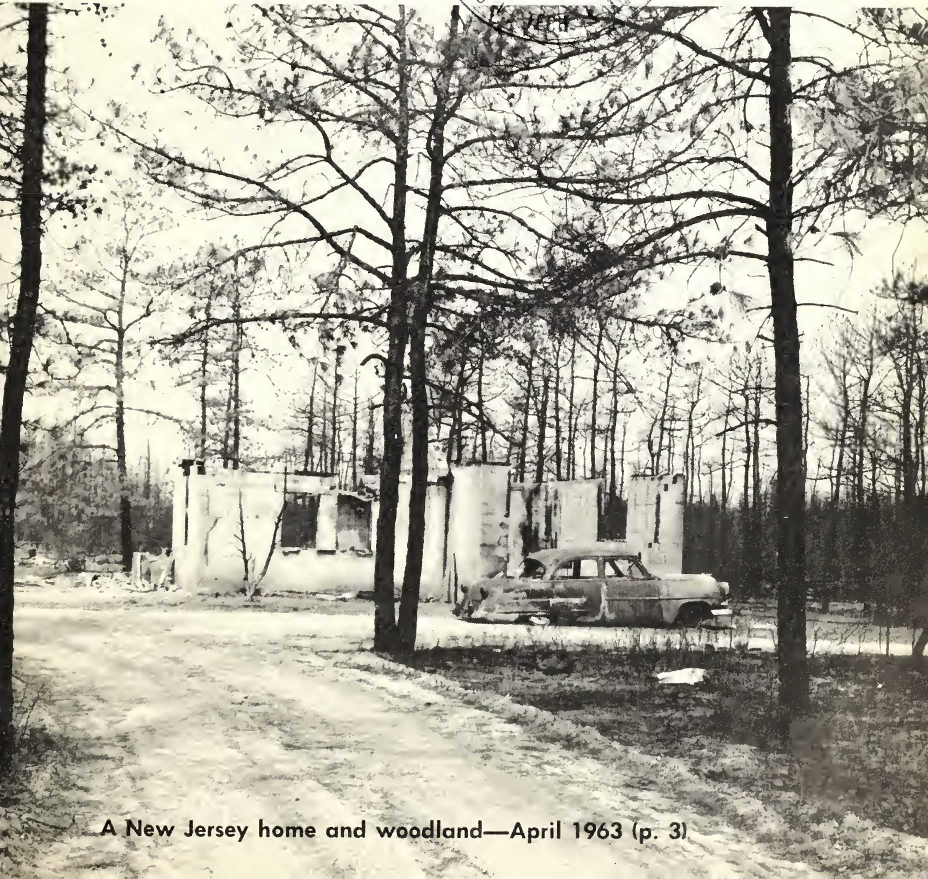
FIRE CONTROL NOTES

U.S. Department of Agriculture
Forest Service



A New Jersey home and woodland—April 1963 (p. 3)

FIRE CONTROL NOTES

A quarterly periodical devoted to forest fire control

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INFORMATION FOR CONTRIBUTORS

Please submit contributions through appropriate channels to Director, Division of Fire Control, Forest Service, U.S. Department of Agriculture, Washington, D.C. 20250. Articles should be typed in duplicate, double 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 organization.

Authors are encouraged to include illustrations with their copy. Illustrations, whether drawings or photographs, should have clear detail and tell a story. Only glossy prints or India ink line drawings are acceptable. Captions for illustrations should be typed in the manuscript immediately following the paragraph in which the illustration is first mentioned, the caption 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 caption 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.

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THE FOREST FIRES OF APRIL 1963 IN NEW JERSEY POINT THE WAY TO BETTER PROTECTION AND MANAGEMENT

Wayne G. Banks *and* Silas Little, *Research Foresters, Northeastern Forest Experiment Station*

In the spring of 1963, conditions conducive to severe forest fires prevailed rather generally throughout the Northeastern States. Scant rainfall, low humidity, and high winds combined to produce high and extreme fire-danger ratings for prolonged periods. On April 20 fire danger reached a peak in several areas. As a result, fast-moving fires of unusual intensity burned out of control.

The New England States were fortunate in escaping really large fires; the largest was approximately 700 acres in northern Maine. However, New England did have many small fires. Massachusetts, for example, had 4,861 forest fires in April, a record for that State and possibly for any State.

Fire disasters made the headlines of many newspapers. In New Jersey, newspapers reported more than 200,000 acres burned and 458 buildings destroyed (fig. 1). These reports listed 7 persons dead, many injured, and 2,500 evacuated—of whom 1,000 were left homeless. New York newspapers reported that a brush fire on Staten Island covered 10 square miles and destroyed 100 homes. In the suburbs of Philadelphia, and elsewhere in Pennsylvania, homes were threatened by numerous woods fires. Fast-moving fires were reported in Maryland. West Virginia, Virginia, and Kentucky were also hard pressed to control their many fires.

Whether these newspaper statements were correct in all details is probably not very important. But what should be important to foresters and the general public are the reasons for these disasters, the ways of preventing them, and the probability of similar conditions occurring again. The second seems particularly important because on April 20, when most of the damage occurred in southern New Jersey, fire suppression techniques and presuppression measures proved woefully inadequate.

Weather Conditions

April 1963 was the driest April on record in New Jersey. Only 0.31 inch of rain fell during the first 29 days of the month, and 0.52 inch on the 30th. On 22 days, maximum wind velocities at Trenton were 20–40 m.p.h. In the 30 days prior to April 20, precipitation deficiency amounted to 3 inches. Relative humidity on that day dropped from 50 percent at 6 a.m. to 23 percent at 10 a.m. and remained between 20 and 23 percent until nearly 5 p.m. Temperature was 80° F. at midday, dropping to 53° at midnight. Fuel moisture indicator sticks at two fire-danger stations showed 3.5 and 4.1 percent fuel moisture at 2 p.m. At both stations the buildup index was 100 and the burning index was 200 on the 8-0 meter.

The estimated average wind velocity for April 20 was 20 m.p.h. The average of the maximum wind velocities reported from the three nearest Weather Bureau offices was 33 m.p.h., and gusts were probably as high as 50 m.p.h. Turbulence prevailed at low levels, and many small whirlwinds developed. Prevailing wind direction veered during the day from northwest to west, then back to northwest, and to almost north late at night.

Comparable Conditions in the Past

Because April was such a black day for fire protection in New Jersey and in sections of neighboring states, we attempted to determine the past frequency of such weather conditions. Weather Bureau records for the previous 49 years indicated that the spring fire weather was never quite so bad as in 1963. During that half century only four spring days had conditions that approached those of April 20, 1963. In early May 1930, when fires were rampant in South Jersey, surface burning conditions on two days approached those of April 20. The chief difference was that, in the 30 days preceding April 20, 1963, there had been an inch less precipitation than in the 30 days preceding May 2 and 4, 1930.

However, previous seasons have had conditions comparable to April 20 in both wind velocity and drought. Since 1913 there have been six fall days of apparently similar conditions, and one summer day and four fall days when conditions approached those of April 20. However, because of less wind within stands in summer and early fall, the shorter days of fall, and less fresh leaf litter, we doubt that any of these days actually provided burning conditions as critical as on April 20, 1963.

On several other days of that April there were high winds. Fuel moisture was low, and at one danger station the buildup index registered 100 on 10 days. But at no time did all the elements of fire danger combine to create conditions so severe as those on April 20, although April 29 was fairly close.

Fire Behavior

Because of the drought, low humidity, and high winds, some of the fires of April 1963 started and spread in fuels so light that normally they are considered insufficient to maintain a fire. Owing to intensity, rapid spread, and ability to carry across very light fuels, suburban fires were difficult to suppress, and many buildings were lost.

In the heavier and more flammable fuels of the New Jersey Pine Region, the wind-driven fires burned with great intensity and caused severe damage to both oaks and hard pines. Fires spread rapidly across upland sites where there was relatively little fuel, as on areas where prescribed burning had been done 1 or 2 years earlier. On such sites a very light cover of pine needles was sufficient to maintain a fire. Oak leaves, where present, were blown across bare spots so that fires advanced rapidly even in scattered fuels.

Because fuels contained so little moisture and winds were so strong, the rate of spread of fires on April 20 was extreme almost regardless of fuel type. One of the larger fires, which started just north of the Lebanan State Forest, advanced about 3½ miles in 2 hours and 9 miles in 6 hours. Probably the rate of spread on April 20, 1963, has been matched or even exceeded by other fires for short periods. However, foresters and wardens with many years' experience in fighting South Jersey fires could recall no case where the sustained rate was as high as on April 20. The Forest Fire Service of the New Jersey Department of Conservation and Economic Development provided data from 1924–63 that showed only 1930 to be comparable to April 1963 in number of large fires and their rate of spread. The two fires with the greatest area burned per hour were in 1963 and covered about twice as much ground per hour as any of the much-publicized 1930 fires for which complete data are available. The data also emphasize the importance of April and May in local protection problems.

Suppression Difficulties

The New Jersey Forest Fire Service uses a combination of suppression techniques and several kinds of machines. The latter include trucks of various sizes up to 500-gallon tank trucks equipped with 4-wheel drive; aircraft equipped to drop 150–200 gallons of retardant; and tractor and plow units. Backfiring and handtools are also used, and backfiring plays a large part in stopping head fires and tying in flank fires.

On April 20 none of the suppression methods proved effective. For example, only one of the three pilots employed for firefighting was willing to fly, considering the 40-m.p.h. winds and the low-level turbulence. Effectiveness of tractor and plow units on April 20 was confined to areas with no more than 1 year's accumulation of litter, and that mostly pine needles. Tank trucks and handtools were useful in controlling spot fires in 1-year needle litter, but in oak leaf litter neither was enough. For example, at about 1:45 p.m. between New Lisbon and Route 70, a spot fire started along a road within 50 feet of a tank truck, its crew, and several men with handtools. At that particular moment, a small whirlwind spread this fire for 100–200 feet. High winds forced the abandonment of suppression attempts, even though the area had only a year's litter since the last prescribed burn.

The extremely dry and windy conditions caused much difficulty in backfiring. Attempts to backfire and hold the line along sand, gravel, and even blacktop roads had to be done slowly and carefully to prevent the backfires from jumping the road. Backfires along a State highway crossed the road even though the cleared strip in that area ranged from 75 to 120 feet wide. In some places head fires arrived before backfiring could be completed.

Effectiveness of Prescribed Burns

Prescribed burning in the winter to facilitate suppression of fires in the South Jersey Pine Region has long been advocated. However, this measure too proved less effective on April 20, 1963, than in previous wildfires.

In general, prescribed burning 1 or more years before the wildfires of April 20 did not facilitate suppression appreciably, especially where oak litter was an important component of the fuel complex. In these areas the 1963 fires were not stopped under fuel conditions that had permitted the suppression of earlier wildfires.

More recent burns that left some surface fuel remaining only reduced the damage, and others that removed nearly all the fuel did not stop the fire. On one firebreak where the 1962–63 winter burn had consumed only the top litter, the fire burned with sufficient intensity to kill many of the oaks and severely scorch the crowns of the pines (fig. 1).


Figure 1.—The stands on both sides of this road had been prescribe-burned in the winter of 1962–63. A good burn had been obtained on the left side, and here the fire of April 20, 1963, burned only a few scattered patches. On the right side, only the top litter had been burned by the winter fire, and much damage was done in April.

Rapid combustion of wind-tossed dry fuels in the April 20 fires created extreme temperatures and greater damage on prescribed burn areas than in other years. On areas with 1 year's accumulation of litter after periodic burns, head fires killed most of the oaks but not the overstory pines. Strong flank fires on such areas killed about half of the overstory oaks. Damage to oaks in areas with 2 or more years' accumulation of litter was usually about as severe as in stands with no previous prescribed burning. However, any reduction of fuel was apparently effective in reducing damage to pines.

Preventing Similar Disasters

Prevention.—One of the major fires of April 20–21 reportedly started where a debris burner had a permit for night burning. The fire held over in a brush pile and broke out on April 20. At the nearest fire-danger station the buildup index had reached 59 on April 12, climbed steadily to 100 on the 17th, dropped to 97 on the 18th, but was back at 100 on April 19th.

We suggest that no burning permits, for either day or night, be issued when the buildup index is 60 or more according to the system now in use in the Northeast. Any permits issued when the buildup index is less than 60 should be so limited in time that they will expire before the index reaches 60.

Camping should be prohibited at remote sites when the buildup index reaches 60, and at all areas when the index is 80 or more. Prohibiting camping may meet resistance; yet such a measure is needed as much for the safety of the campers as for fire prevention. On April 20, 1963, a large group of Boy Scouts were camped in the Lebanon State Forest, where only a slight shift in wind direction would have brought a head fire, quite possibly before they could have been evacuated.

Another important prevention activity is reduction of fuel through prescribed burning during the winter in types where these burns are silviculturally desirable. Earlier recommendations for the South Jersey Pine Region appear to remain sound:

1. For maximum protection of improved property, burns at 1- or 2-year intervals be used.

2. For extensive forested properties, barrier zones be prepared by the prescribed burning of belts of upland sites, which would reinforce swamps or other natural firebreaks.

3. Eventual development of a checkerboard pattern on upland sites in the larger unimproved holdings, i.e., a pattern of young unburned stands and of older, periodically burned stands. Prescribed burns at 4- or 5-year intervals are considered essential in a protection program.

In years like 1963, only recently burned areas will be effective barriers against fire. But in view of the rarity of such extreme fire danger, an annual and more costly fuel reduction seems justified only near buildings or other improved property.

Management for pine over oak, besides favoring the production of timber, can facilitate fire control under certain conditions. Periodic prescribed burning in areas with few oaks results in less rapid combustion of the rather compact needle litter. In April 1963 the burning needles were not carried long distances by the wind as oak leaves were. Suppression was therefore easier in stands that had few oaks.

Presuppression.—What can be done in presuppression to help ensure initial-attack success under fire conditions such as had developed in April 1963? We suggest broadening the scope of the working agreements between the New Jersey Forest Fire Service and other State agencies, companies, and individuals to furnish equipment when it is needed. Needed equipment from outside sources should be on standby whenever the fuel and weather conditions indicate a conflagration threat.

Protection agencies might also consider providing tanks of 500-gallon capacity or larger and equipped with their own pumping units. These tanks could be strategically located, and stored in such a way that they could be mounted on flat-bed or dump trucks and put into operation quickly.

The responsibilities of most forest fire protection agencies today extend to much more than protecting woodlands alone. The extension of residential building and industry into rural wooded areas, the reversion of farmland to forest, and the development of forest recreational areas are now making high-value improvements and even lives dependent on the efficiency of forest fire suppression. Public recognition of these increasing responsibilities must be encouraged if protection agencies are to receive the financial support that they need.

Suppression.—What can be done to control fires under conditions such as prevailed in New Jersey and other parts of the Coastal Plain in April 1963? When the high winds eliminated the small airplane as a working tool, suppression forces found themselves back to conventional weapons—tanker trucks, plows, and hand crews—which were inadequate. Perhaps larger aircraft, carrying heavier loads and effective under windier conditions, and larger tanker trucks with multiple pumping units might be feasible. Although the latter might not be adequate for such fires as occurred in April 1963, they should prove effective against many fires that cannot now be attacked directly. They could also be a valuable aid to backfiring.

Also the use and coordination of equipment could be improved. Much difficulty was experienced in holding backfires, even along wide cleared rights of way. Could tanker units of the type available, supported by large tank trucks for refilling them, adequately fireproof the fuels on the opposite side of the roadway to permit rapid and safe backfiring from such roadway? This type of operation might require planning and practice. It might very well resemble the "one-lick" method used by hand crews, with several tankers proceeding in tandem at a reasonably good speed, each one spraying a designated portion of the fuels. Studies to determine the feasibility of this approach should be initiated.

FOREST FIRES AND FIRE WEATHER CONDITIONS IN THE ASHEVILLE, N.C., FIRE WEATHER DISTRICT—SPRING SEASON, 1963

EARNEST A. RODNEY, *Meteorologist in Charge, Weather Bureau Office, Asheville*

The Asheville Fire Weather District comprises an area of some 257,000 square miles with 78,550,000 acres of forest land under national, State, and private protection. The acreage and fires occurring on the nine national parks in the District were not available for inclusion in this summary.

In the District there are 117 administrative units of Federal, State, and private forest lands. During the spring season from February 15 through May 15 fire weather forecasts are forwarded to approximately 100 of these units six days each week. Four-day outlooks are included on Mondays, Wednesdays, and Fridays. Owing to the critical forest fire conditions existing in 1963, some routine forecasts were continued into June. From March 30 through May 19, 1963, 91 special forecasts were issued for "going fires" for various units in the area. The spring fire-weather season of 1963 was probably that of the most devastation since spring of 1942. In the 4-year period 1959 through 1963, 968,073 acres of forest were destroyed by fire in the District, an average annual loss of about 242,018 acres or 0.3 percent of all forest land under protection. In the spring of 1963 (table 1) three times as much of the forests burned, compared with the annual average for the previous 4 years.

Precipitation

Most of the District had below-normal rainfall in three of the four months from January through April. South Carolina is possibly the only area with near-normal precipitation for the 4-month period. Most of the heavy precipitation was over by March 15-20, setting the stage for the dry (fig. 1), warm weather of April. On April 6 and 7 there was some heavy rain in North and South Carolina, but in general there were no beneficial rains until the end of the month. This deficiency of rainfall had its effect in keeping the forest fuels dry during the later part of March and all of April.

Temperature

Temperature over the entire District averaged from 4 to 10 degrees below normal in January and 6 to 8 degrees below normal for February. After the first few days in March, temperatures were above normal, and the month averaged 4 to 6 degrees warmer than normal. April also was about 4 to 6 degrees above normal and can be characterized as warm, dry, windy, and dusty.

TABLE 1.—*Summary of fires on protected forest areas, Asheville, N.C., Fire Weather District, by States, Jan. 1–June 30, 1963*

State	State and private				National Forests			
	Forest area	Number of fires	Average size	Area burned	Forest area	Number of fires	Average size	Area burned
	Acres		*Acres*	*Acres*	*Acres*		*Acres*	*Acres*
Ky.	9,854,000	3,351	65.6	219,975	575,000	94	18.1	1,706
N.C.	17,279,000	3,449	76.3	263,000	1,485,000	151	33	4,987
S.C.	11,175,000	3,856	14.6	56,173	621,000	133	21.7	2,892
Tenn.	10,119,000	3,371	11.2	37,890	937,000	128	46.2	5,909
Va.	14,033,000	2,369	16.3	38,542	1,709,000	149	16.1	2,403
W. Va.	9,007,000	1,552	45.2	70,121	906,000	15	1.5	22
Ga.	.....	.....	.....	.....	850,000	53	14.8	786
Total	71,467,000	17,948	.....	685,701	7,083,000	723	.....	18,705

Upper Air

Figure 2 shows the mean circulation existing in April 1963 and gives the average height, isotherms, and resultant winds at the 700-mb. surface. The flow is also representative of that which prevailed during the latter part of March. During this time mean troughs were located off both coasts of the United States and a ridge over the Central States. Thus the general flow over the Asheville district was from the west and west-northwest. Not only does this type flow restrict the northward and eastward transport of moisture, but also the anticyclonic nature of the circulation tended to inhibit precipitation.

When the flow of air was from the Gulf of Mexico, the frontal systems moved through so fast that the warm air did not attain sufficient moisture content for much precipitation before being forced off the east coast. Also, because of the general upper-air circulation, any of the lows developing to the west moved from the southwest to the northeast. This resulted in only the trailing cold fronts passing through the District. This type of front seldom has much precipitation associated with it as it passes through the southeastern states.

Surface

On April 3 at 1:00 p.m., e.s.t., a front was oriented northeast-southwest in the vicinity of Chicago, Peoria, Little Rock, and southwest into Texas. Temperature readings in the District were in the 80's to low 90's with dewpoints 55 to 60 degrees. Winds were generally light southwesterly. During the following 24 hours the front moved 25 to 30 m.p.h. to the coastal areas of North and South Carolina. To give some idea as to how dry this frontal passage was, *Climatological Data* for the States of North Carolina, South Carolina, Virginia, and Georgia lists a total of 0.08 inch of rainfall.

At this time forest fires were burning in many states of the District, and foresters faced great difficulties in fighting the head and flank fires as the dry, cold frontal system moved through.

April 4, 1963, was one of the most critical fire-weather days during the spring season. In North Carolina this date is referred to as "Black Thursday." Then, over 127 fires burned throughout the State. At least 43 class E (over 300 acres) fires were reported, with one fire of over 30,000 acres and another of 23,000 acres. A total of 185,000 acres burned in North Carolina on April 4. Air-

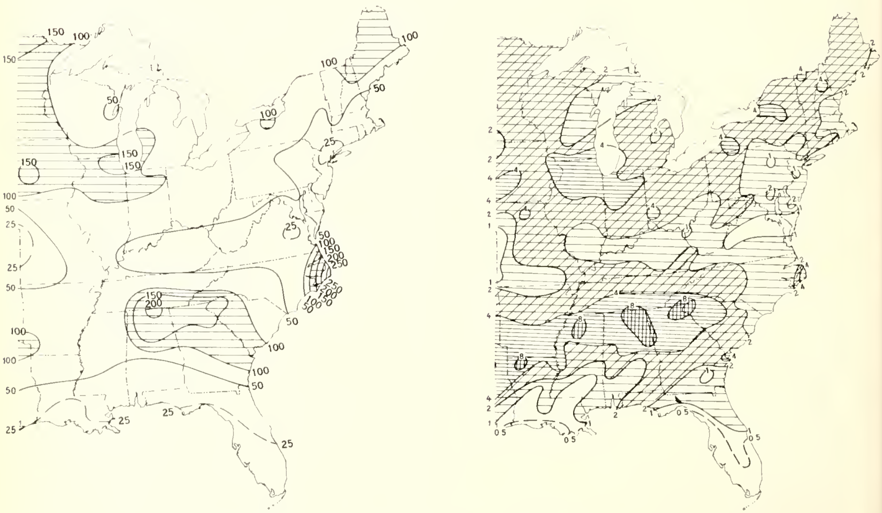


Figure 1.—Precipitation, April 1963: *Left,* Percent of normal; *right,* total (inches).

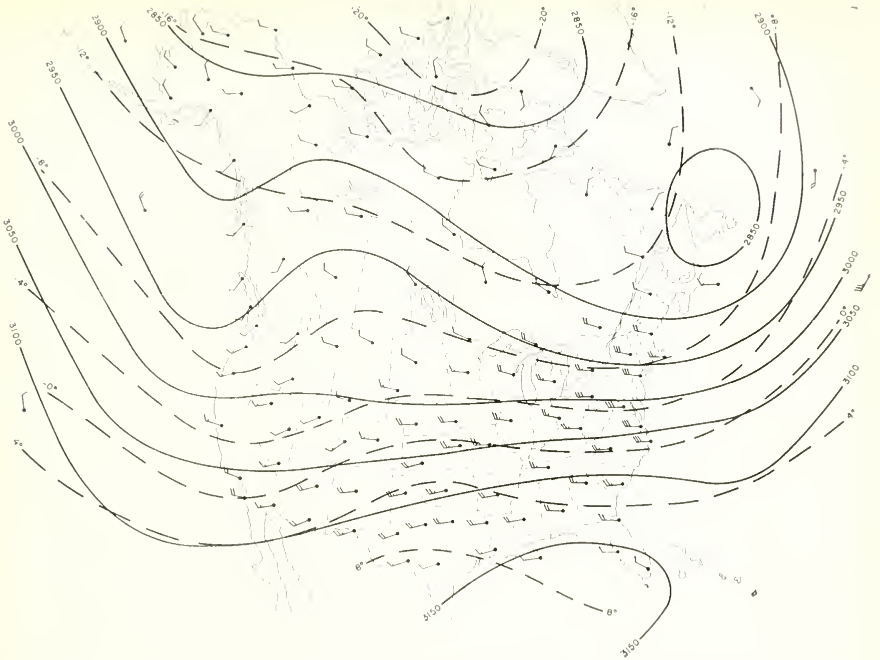


Figure 2.—700-mb. surface, 1200 G.m.t., April 1963: average height (geopotential meters) and temperature (° C.), and resultant winds. (Windspeeds in knots; flag represents 50 knots, full feather 10 knots, and half feather 5 knots. Wind data based on rawin observations.)

craft, chemicals, and ground attack were used during this critical situation, but the control organization was hampered by the size and number of fires.

Fuel Moisture, Buildup Index, and Classes of Fire Days

The fuel moisture is the moisture content of fine dead fuels, such as the surface layers of hardwood leaves or pine needles on the forest floor. The buildup index is a number on a 100-point scale that is directly related to the dryness of the layer of litter-type fuels (approximately 2 inches deep) that lies immediately beneath the surface layer. It is computed by cumulating daily factors according to the surface fuel moisture as reflected by the fuel moisture indicator sticks.

A day may be designated as one of five classes of fire danger. The fuel moisture, buildup index, windspeed, and condition of lesser vegetation are integrated by means of a fire-danger meter (Southeastern Station Meter, Type 8) to give a Burning Index. The range of Burning Index is divided into five classes for planning and operational purposes. Class 1 indicates low fire danger, and class 5 indicates extreme fire danger. With the buildup index already high, combined with a dry cold front, wind, etc., all areas except northern West Virginia experienced a class 4 or class 5 fire danger day on April 4.

Summary

1. The temperature was above normal in March and April.

2. Precipitation was below normal for the most part in all but March. After March 15 most of the precipitation fell on a few days through April.

3. The combination of lack of precipitation and above-normal temperature and sunshine caused the forest fuels to be very dry and brought about the most critical spring fire-weather season since 1942.

Continued on page 15

THE EMERGENCY BACKPACK KIT

GERALD F. EWART, *Supervisory Fire Control Aid,*
San Bernardino National Forest

The emergency backpack kit illustrated provides a radio for communication, first aid kit adequate for a 25–30-man crew in case of multiple injuries, and fusees to be used for emergency escape, burning out and firing. This pack was used extensively during the 1962 and 1963 fire seasons by the Del Rosa suppression crew and proved to be very practical. It provides for the crew's safety so many times overlooked because these items were not available when the crew began work. Previously the items were handcarried to the fireline, which resulted in their not being readily available when needed.

The contents of the pack are mounted on a canvas backpack board. A piece of nylon cord secures the radio, two small blocks of wood keep it level, and a short length of aluminum angle keeps it from sliding down. The first aid kit is mounted just below the radio with four small bolts. The fusees are mounted at the bottom of the packboard with heavy elastic. A cover is need to protect the radio and first aid kit from dirt and scratches. This can be made at any canvas shop for about $10. Other crews should also find this pack useful and easy to make up.

Emergency backpack kit.

A PORTABLE FIRE-WEATHER FORECAST UNIT FOR USE ON BACK-COUNTRY FIRES

Howard E. Graham, *Meteorologist,*
Division of Fire Control, Pacific Northwest Region

A portable fire-weather forecasting unit, developed by the Forest Service in cooperation with the Weather Bureau, will make local fire-weather forecasting available to firefighters in unroaded back country. This information has been unavailable because meteorologists were unable to take conventional mobile fire-weather forecast units into remote areas. The new unit contains all items needed for forecasting by the meteorologist at the fire and can be taken wherever horses can walk or helicopters can land.

The portable fire-weather forecast unit is compatible with Weather Bureau mobile units and other Weather Bureau communication equipment, and contains all items needed by the fire-weather forecaster for receiving weather data and compiling a forecast. Not included are topographic maps of the fire area and personal needs. Included are (fig. 1)

1. Radio for receiving current weather conditions from observers around the fire, and long-distance radio for receiving worldwide weather data from a special Weather Bureau transmitter.
2. Tent, worktable, chairs, and weather plotting charts.
3. Instruments for sampling weather conditions near the fire.
4. Small items such as paper, pencils, erasers, envelopes, and antennas for long-distance radio.

The equipment is packed for shipment in five wooden boxes (fig. 2). Total weight is 720 lb. Upon arrival at the fire camp, the equipment must be unpacked and assembled before the meterologist can begin forecasting.

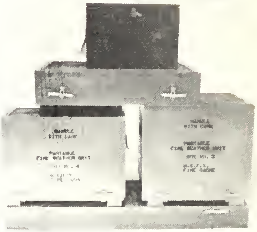


Figure 2.—Portable fire-weather forecast unit ready for dispatch when needed.

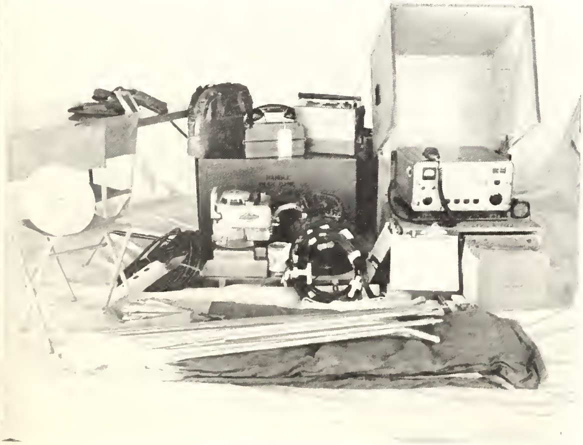


Figure 1.—Components of portable fire-weather forecast unit.

Once assembled, operation will be similar to regular Weather Bureau mobile units. By agreement, Weather Bureau fire-weather meteorologists will operate the portable forecast unit whenever they are available. Therefore, although the unit will be ordered by the fire control agency, the decision for its use should be made jointly by fire control officials and Weather Bureau meterologists. One, possibly two, meterologists will operate the equipment. They will need to be assisted by one or two weather observers provided by the fire boss.

The portable fire-weather forecast unit is available for use anywhere in the country. It is stored in the Region 6 Fire Cache at Portland, Oreg. Dispatching will be handled like any other firefighting equipment. If the unit is needed, the Regional Dispatcher should be contacted to arrange transportation and other details.

AN UNUSUAL POTENTIAL CAUSE OF FOREST FIRES

G. S. Chester, *Research Officer*, and E. J. Hopkins, *Technician*,
Forest Research Branch, Ontario District Office, Canada

Stories of forest fires caused by focusing the sun's rays on a suitable fuel by pieces of broken glass or water in bottles are usually discredited as highly improbable or merely imaginative. Occasionally, though, one finds firsthand an ignition source that adds credence to the stories.

In April 1963, as part of a silvicultural project, small greenhouses (6.5×6.5×5 feet, sloping to 4 feet at rear) were erected in an aspen stand located in Essa Township near the town of Barrie. The greenhouses, of light frame construction, were covered with polyethelene sheeting.

On June 17, Department of Forestry personnel detected the smell of something burning and, on investigating, found a strip of charred and smoldering duff approximately 12 inches long in one of the greenhouses (fig. 1). Close examination revealed that rainwater had collected on the roof of the shelter, and the resultant pool was acting as a burning lens. The pool was dumped and the smoldering material extinguished.

Figure 1.—Charred strip in duff.

At the time of discovery the pool was approximately 2½ inches deep and contained an estimated 1½–2 gallons of water (fig. 2). No information is available on how long it had been there. The shelter was in full sunlight from about 7:30 a.m. (e.s.t.) on the morning of June 17. The smoldering duff was discovered at 2:35 p.m. and according to calculation had been smoldering for approximately 50 minutes.

Conditions inside the greenhouse at the time of the incident were as follows:

Drought.—The duff layer was extremely dry, having received no moisture since the greenhouses were erected in April.

Air temperature. — The maximum air temperature on the day of the incident was 102° F. inside the shelter and 86° F. outside. Inside and outside minimum temperatures the night before were 38° F. and 36° F. respectively.

Relative humidity. — The relative humidity inside the shelter was approximately 25 percent; outside it was 23 percent. The higher relative humidity inside the shelter was probably due to transpiration and restricted air movements which prevented this moisture from being readily carried away.

Wind.—Ventilation of the greenhouses was by means of small vents located just under the roof. Air movements inside were thus minimal.

Duff.—The floor of the shelter was covered with partly decomposed aspen leaves, bracken fern fronds, and other herbaceous ma-

Continued on page 15

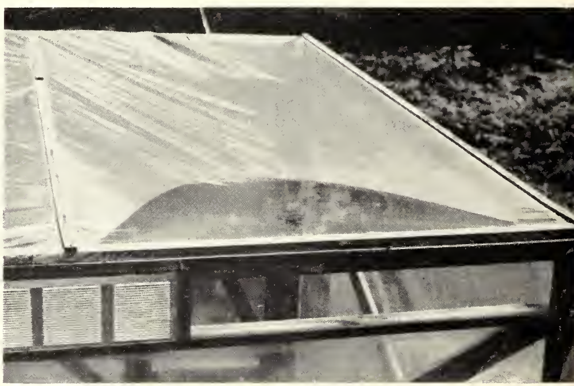


Figure 2.—Pool of water on greenhouse roof.

DEER HUNTERS ARE CAREFUL WITH FIRE WHEN PROPERLY APPROACHED

David D. Devet, *Forester, National Forests in South Carolina*

What would you do if 9,000 deer hunters descended on your Forest and scattered over 800,000 acres during the driest October in 22 years? This was the problem facing the South Carolina Forestry Commission and the Sumter National Forest in the piedmont area of South Carolina in October 1963. Personnel of the South Carolina Wildlife Resource Department went "all out" to help.

A series of planning and strategy meetings with representatives from the Wildlife Resource Department resulted in many procedures to make the hunters conscious of fire prevention. Game wardens contacted and registered every hunter and asked their cooperation. Posters reminded hunters to be careful. Newspaper articles invited hunters to participate in organized hunts and requested their help in preventing fires. The South Carolina State Forestry Commission conducted a series of TV and radio programs about the dry forests and hazards of fires.

James W. Webb, Director of the South Carolina Wildlife Resource Department (left), receives citation from Forest Supervisor Ray W. Brandt of the National Forests in South Carolina for outstanding cooperation in fire prevention during the drought of October 1963, when 9,000 hunters visited the Sumter National Forest.

Carolina for outstanding cooperation in fire prevention during the drought of October Forest, contacting a group of deer hunters in October 1963.

U.S. Forest Service personnel conducted an intensive hunter contact program. The theme was: "You are welcome—come and enjoy yourself—this is your forest—the woods are extremely dry—please help us in preventing fires—we are confident you will be careful." Information concerning roads, hunter camps, and deer concentrations was provided. Game wardens helped organize drives and provided guidance and direction. The dry weather practically eliminated stalking.

Continued on page 15

NEW SPARK ARRESTER LEGISLATION IN CALIFORNIA

The California State Legislature passed Senate Bill No. 643 at its 1963 session, and Governor Brown approved it on July 23, 1963. The sections pertaining to spark arresters follow:

Section 20. Section 4167 of said code is repealed. (Public Resources Code)

Section 21. Section 4167 is added to said code, to read:

4167. Except as provided herein, no person shall use or operate any internal combustion engine which is operated on hydrocarbon fuels on any forest, brush, or grass-covered lands without providing, and maintaining in effective working order, a spark arrester attached to the exhaust system. For the purposes of this section, a spark arrester is a device constructed of nonflammable materials specifically for the purpose of removing and retaining carbon and other flammable particles over 0.0232 of an inch in size from the exhaust flow of an internal combustion engine that is operated by hydrocarbon fuels. Motor trucks, truck tractors, buses and passenger vehicles, except motorcycles, are not subject to the provisions of this paragraph provided the exhaust system is equipped with a muffler as defined in the Vehicle Code.

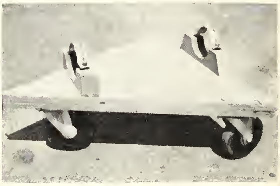
Provided, further, that spark arresters affixed to the exhaust system of engines or vehicles, as described in this section, shall not be placed or mounted in such a manner as to allow flames or heat therefrom to ignite any flammable material.

Provided, further, that all mobile equipment, including trucks, tractors, bulldozers, and other mobile equipment engaged in lumbering, logging, and other industrial operations in any forest, brush, or grass-covered land, shall also be equipped with and carry at all times a serviceable shovel for use in the prevention and suppression of fire, except that mobile equipment used in the business of a common carrier or railroad does not have to be equipped with or to carry a shovel for use in the prevention and suppression of fire.

RETARDANT HOSE SKATE

George Carberry
Wenatchee National Forest

At a retardant base, up to three men are required to drag charged hose from aircraft to aircraft without hose skates. A hose skate which eliminates excessive wear on retardant transfer hose for filling air tankers was developed for the Wenatchee Air Tanker Base. (See photographs.) With skates placed about 7 feet apart, one man can move a hose line easily. The cost of construction and materials is soon repaid in reduction of manpower and hose wear. One sheet of 4 by 8-foot plywood will make eight complete hose skates.



List of Materials

Item	*Quantity*
¾-inch outdoor plywood, 24×24×24 inches	2 pieces
Lumber, 2×4×8 inches	2 pieces
5-inch ball-bearing rubber-tired casters	3
3-inch conduit clamps	2
5/16×7-inch bolts	4
¼×2½-inch bolts	12

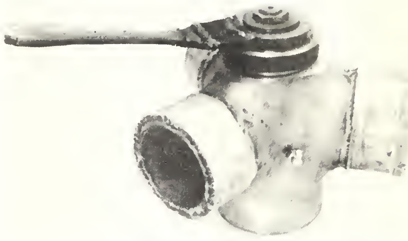
MODIFICATION OF 3-WAY VALVE ON RETARDANT PUMPS

HORACE G. COOPER, *Fire Equipment Engineer, Pacific Northwest Region*

Here's how Region 6 solved a problem involving 3-way valves used on retardant handling pumps at air tanker bases. The 3-way valve is used on both the suction and discharge sides of retardant pumps. This valve permits adjustment of the nuts that attach the handle to the rotating plug. It is necessary to tighten the adjustment in the suction line to prevent air leakage. On the discharge side, the pressure often wedged the plug so tight that the valve became very hard to turn. As originally designed, the valves were hard to operate.

One manufacturer developed a modification of the valve so they could space the plug. This made the valves easier to work, but the plug attachment was still critical. If it was loose, it leaked air; if a little tight, it turned hard. Corrosion between the aluminum casting and the brass plug presented a problem.

We have installed a grease fitting in the valve to lubricate the plug, with a waterproof lithium-base grease. The grease fitting is placed about midway between two of the outlets and about midway between the top and bottom of the valve (see photo).



With the grease fitting installed, the grease is forced in as the plunger is turned. Thus, the aluminum face of the casting and the brass face of the valve plug are coated with the waterproof grease. The treatment is effective in making the valves work easily, in stopping minor leaks of both air and retardants, and in preventing corrosion and sticking of the aluminum and brass parts of the valve.

Forest Fires and Fire Weather—*Continued from page 9*

4. Approximately 10 frontal systems passed through the District in April. Generally the fronts were lacking in moisture content.

5. The surface winds associated with these dry frontal passages in April made the work of controlling fires more difficult.

6. The high temperatures and low dewpoints and relative humidities caused fuel moisture values to be as low as 3 percent on many days in April.

Acknowledgements

We wish to thank the U.S. Forest Service Regional Offices at Upper Darby, Pa., and Atlanta, Ga., and the Southeastern Forest Experiment Station, Asheville, N.C., for furnishing the data in table 1, and the National Weather Records Center, Asheville, N.C., for most of the information in the figures.

Unusual Cause of Fire—*Continued from page 12*

terial. The surface of the duff had been lightly disturbed by raking, and the light litter removed before the greenhouses were erected.

Herbaceous plants.—Scattered bracken ferns up to 23 inches high were the dominant vegetation in the shelter. Also found were aspen suckers, wintergreen, and bindweed. Density of the plant cover was never sufficient to provide heavy shading of the duff.

Deer Hunters—*Continued from page 13*

This outstanding cooperation among the hunters, State organizations, and the Forest Service resulted in an almost perfect record. Only one small fire occurred during the entire season, and it was quickly extinguished by hunters and game wardens. Thus, intensive personal contact, use of cooperating agencies' personnel, mass media appeals, and welcoming the hunters and expressing confidence in their care with fire paid big dividends.

The April '64 Fire Control Notes contained an article, "Use of Air Pressure Powered Water Tanks in West Tennessee," which described a simple low-cost slip-on forest firefighting tanker. It has been called to our attention that industrial safety codes in some states prohibit the use of certain types of water tanks in air-pressure discharge systems. Persons contemplating construction of pressurized water tanks should follow local industrial safety codes to ensure that proper tank types and appropriate pressure relief valve systems are used.

PROPANE GAS INSTALLATION FOR LOOKOUT TOWER

Howard Burnett, *District Ranger, National Forests in North Carolina*

Provision of utilities at isolated lookout tower installations has long been a "bugaboo" for fire control supervisors. Albert Mountain Lookout on the Wayah Ranger District of the National Forests in North Carolina presented such a problem. Heating and cooking were done with wood stoves, lighting was by means of kerosene lamps, and there was no refrigeration.

When modernizing this tower, the decision was made to convert to a propane gas system. For a total charge of $701.90 a local propane gas company furnished and installed a 500-gallon propane tank; gas piping, valves, etc., to the tower cab; two 50-watt equivalent gas lights; a 60,000 B.t.u. vented heater; and a 2-cubic-foot refrigerator and 3-burner gas stove combination unit.

An alternative to the gas installation was to run a powerline about 5 miles cross-country, and provide a complete electric installation, at an estimated cost of $10,000. A gas installation is by far the less expensive of the two. In addition to the cost savings compared with electric power at this location, other advantages over wood or coal fuel are compactness; cleanliness, no ashes or wood chips; faster and easier cooking; refrigeration; and elimination of cutting, hauling, and storage of fuel.

The gas is purchased from a local propane supplier for 20¢ per gallon. We use about 500 gallons of the gas per year, costing us about $100. The 500-gallon tank requires only one refill trip per year. Because of the rough road to Albert Mountain, passable in dry weather, it may be feasible to locate the tank some distance from the tower.

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Forest Service

FIRE CONTROL NOTES

A quarterly periodical devoted to forest fire control

CONTENTS

INFORMATION FOR CONTRIBUTORS

Please submit contributions through appropriate channels to Director, Division of Fire Control, Forest Service, U.S. Department of Agriculture, Washington, D.C. 20250. Articles should be typed in duplicate, double 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 organization.

Authors are encouraged to include illustrations with their copy. Illustrations, whether drawings or photographs, should have clear detail and tell a story. Only glossy prints or India ink line drawings are acceptable. Captions for illustrations should be typed in the manuscript immediately following the paragraph in which the illustration is first mentioned, the caption 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 caption 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.

COVER—This flail trencher is being used to quickly build a fireline.

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DEVELOPING A NETWORK OF FIRE-DANGER STATIONS

JOHN J. KEETCH, *Research Forester (Fire), Division of Forest Protection Research, Washington Office (located at Asheville, N.C.)*

Editor's Note: The future availability of automatic weather observation systems will permit the selection of fire danger station locations which were previously not practical. It will be possible to place observation stations at midslope and in critical fuels; they will not be restricted to valley floors or ridgetops. To meet the increased need for guides on spacing between stations, a summary and suggested minimum standards for spacing of fire-danger stations is presented.

Introduction

There is no clear-cut answer to the spacing of fire-danger stations (fig. 1). This article summarizes a few references and a discussion with research personnel at the National Weather Records Center, Asheville, N.C. Because of the complexity of the problem, even the broad agreement in recommended spacing is rather surprising and encouraging.

Recent Opinions

In writing under the heading "*How Many Stations?*" Nelson made the following statement.[1]

"There can be no specific answer to the question, 'How many danger stations should I operate?'. Differences in topography, weather, fire occurrence, size of administrative divisions, and patterns of land use are the major variables that have to be evaluated before a sound decision can be reached. Basic to such evaluation are maps of administrative units differentiated into zones of weather, fire occurrence, and danger measurements from well located and operated stations.

". . . In USDA Handbook No. 1, one station was suggested for 150,000 acres in the mountains and one for 300,000 acres in rolling or flat country . . ."

Use of these acreage figures would result in a *desirable* spacing of about 17 miles between stations in mountains and about 25 miles between stations in flat or rolling country. Nelson also suggests that a *fair* network of stations would still be provided if the spacing were about 30 miles in mountains and about 42 miles in flat country.

The results of investigations in Canada on the reliability of danger ratings with distance from station give a little more leeway. In an analysis of fires in New Brunswick, Beall[2] concluded as follows:

a. Within a radius of 25 miles the danger index is highly reliable.
b. At distances between 25 and 100 miles the danger index may be useful, but is not highly reliable.
c. At distances greater than 100 miles weather conditions are apt to be so different as to make the danger index quite unreliable.

Similar conclusions were drawn by Williams[3] in a study conducted in the plateau region of British Columbia. In another recent report Williams[4] states the case as follows:

Figure 1.—Fire-Danger Station at Hungry Horse, Mont. (Flathead National Forest).

[1] Nelson, R. M. How to measure forest fire danger in the southeast. U.S. Forest Serv. Southeast. Forest Expt. Sta. Paper 52, 22 pp. 1955.

[2] Beall, H. W. Forest fires and the fire danger index in New Brunswick. Forestry Chron. 26(2). 1950.

[3] Williams, D. E. Fire danger rating and fire experience in the Cariboo. Brit. Columbia Lumberman 47(3): 12, 14, 16, 18. 1963.

[4] Williams, D. E. Forest fire danger manual. Canad. Dept. Forestry Pub. 1027, 28 pp. 1963.

". . . If the earth were as flat as the top of a table, as indeed it is in some areas of our country, a single weather station would provide weather data representative of a relatively large area. On the other hand, in mountainous country, fire weather varies from valley to valley, from one elevation to another, and from one aspect to another. In certain parts of eastern and central Canada, where topographic conditions fall somewhere between these extremes, it has been found that fire danger ratings from a given station are reliable for a *radius* of about 25 miles. For points 50 to 60 miles from the station, ratings, although less reliable, have still proved to be useful. In general, then, each fire-weather station should not be expected to cover an area having a radius of more than 25 miles, and in mountainous country the number and extent of individual valleys will be a better indication of the number of stations needed.

Since rain is the weather factor most likely to vary from place to place within the area to be served by the station, it is often advisable to measure rainfall at one or more auxiliary locations and to use these rainfall records, together with other required weather readings from the main station, in working out the danger index for additional localities."

Thus, Williams believes that stations spaced 50 miles apart will give adequate coverage in average country and that the network should include additional measurements of the more variable factors, such as precipitation.

The 1960 *Guide to Climatological Practices*,[5] prepared by the Secretariat of the World Meteorological Organization, is of greater interest. The relevant parts are the section on "*Climatic Elements and Their Observation*" and the subsection on "*Networks*." The "ideal" network of stations is described as follows:

"Ideally, the number of stations at which any particular climatic element is observed should be large enough to permit a complete analysis to be made, without resorting to doubtful hypotheses, of the geographical distribution of mean values, frequencies, extremes, and other characteristics of this element.

". . . A sparse network may be sufficient for the study of the atmospheric pressure reduced to sea level but, on the other hand, a fairly dense network will normally be required for the study of the wind regime (exposure) and such elements as maximum temperature, amount of precipitation, and number of days with snowfall, and a very dense network may be required for the study of minimum temperature, frequency of frost, and frequency of fog."

The *WMO* report recognizes the marked tendency for isolines of the values of most climatological elements to be parallel to the major broad-scale geographic boundaries, such as coastlines or mountain chains. A similar but smaller influence is noted in hilly country. For an adequate study of these relationships, the report recommends climatological stations 1 to 6 miles apart if they are alined perpendicular to the coastline, mountain range, or valley bottom, and 12 to 31 miles apart if they are alined parallel to such boundaries.

The report further specifies that in areas where the geographical conditions are fairly uniform, a station per 1,000 square kilometers will normally be sufficient for most climatological purposes. This means a station per 625 square miles, one per 400,000 acres, or one 30 miles from the next station.

I believe that these requirements presented by the World Meteorological Organization are somewhat more rigid than those usually needed in fire control planning. In table 1 I have indicated the minimum stations that I believe are necessary.

Table 1.—*Minimum standards for spacing and density of fire-danger station network*[1]

Terrain	Average distance between stations	Average density per million gross acres
	Miles	*Number*
Flat to gently rolling country....	40–50	1
Broken and hilly country..........	30–35	2
Mountainous terrain...........	20–25	4

[1] Depending on local needs, additional stations may b necessary in certain areas, or additional measurements of selected fire-weather factors may be needed.

The station-spacing problem was discussed early in 1964 with Dr. Gerald Barger, Director, National Weather Records Center, and four members of his

Continued on page

[5] World Meteorological Organization. Guide to Climatological Practices. No. 100. TP 44. 1960.

EXPERIENCES WITH THE ONE-MAN FLAIL TRENCHER

Francis B. Lufkin, *Aerial Project Officer, Okanogan National Forest*

Editor's Note. Fire control men are constantly looking for new and better ways of doing their work. For example, mechanized fireline trenchers have been developed, discarded, and redeveloped during the past several years. In this article, Mr. Lufkin writes of his personal experiences with the one-man flail trencher. An interim specification, No. 5100-00370, was adopted by the U.S. Forest Service for this trencher in June 1964. The specification is available on request from the Chief, U.S. Forest Service, Washington, D.C.

The size of our aircraft (Twin-Beech[1]) limits our basic mechanized line building crew to four men. One man is the chain saw operator, the second man cleans up behind the saw, the third man operates the trencher (fig. 1), and the fourth man cleans up, finishes the fireline, and maintains the supply of gasoline, water, and chain oil for the crew. The chain saw man is the most important man in the operation because he sets the pace for the line building operation. However, all of the men should be trained to work at all of the positions.

Mechanical equipment does not have a place on *all* fires, but it should be ready and available for use as needed. Mechanized equipment can be integrated into any size of crew without difficulty. The amount and type of equipment varies with topography and fuel type.

[1] Use of trade names is for information purposes and does not imply endorsement by the Forest Service.

Figure 1.—The flail trencher in operation.

Trenchers have also been valuable in mopup and in cooling hotspots. Exposed fire on logs and stumps is knocked down much quicker with a trencher than it is knocked down with a shovel or chopped off with a pulaski (fig. 2).

CASE HISTORIES OF TRENCHER USE

1. Found Creek fire—Mt. Baker—1959

Our first mechanical trencher was used on this fire. It was equipped with a star blade head of our design. The eight-man crew used it in their mopup. The crew boss said that "although it only lasted 20 minutes, it was doing as much work as the rest of the crew." This was encouraging, so we built an improved head for the machine.

2. Beaver Lake fire—Okanogan—1960

This was a Class E fire which had a heavy lodgepole fuel type, with excessive down lodgepole. We had an 18-man initial attack crew, with four chain saws and one trencher equipped with an improved star blade head. We used 15 men out front to remove the heavy lodgepole downfall. One man using the trencher did nearly all the trench digging, with two men cleaning up behind. The

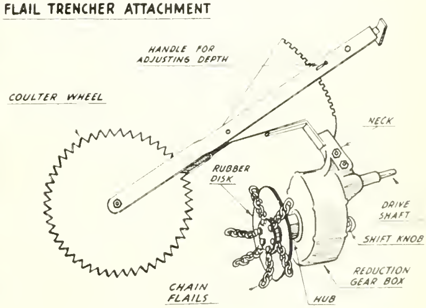


Figure 2.—A diagram of the flail trencher attachments.

crew built about one-fourth mile of fireline the first afternoon and night that the fire burned.

3. Lightning Creek fire—Okanogan—1961

This was a grass fire with scattered pine and fairly rocky topography. We dropped a four-man crew with two trenchers, equipped with the first chain type of flail heads. These four men built more than 160 chains of fireline in about 10 hours. They found that operating the machines in tandem provided the best efficiency.

4. Ortell Creek fire—Okanogan—1962

This fire burned in scattered pine, with a pinegrass cover. The soil was perfect for the flail trencher. We had an eight-man crew with trenchers and one chain saw. We had an excellent line around the 1-acre fire in 30 minutes. We then plowed up the whole burned area. We used the flail to beat the fire off the logs, and then we threw a dirt covering over everything. The fire was reduced to a few smokes in about 2 hours. The trenchers speeded the mopup immensely.

5. Baldy fire—Okanogan—1962

We dropped 19 men on this fire, which was controlled at 100 acres. The fuel type was heavy lodgepole, stacked head high in places. We used four chain saws and two flail trenchers. We built a line approximately two-thirds the way around the fire (approximately 10 acres at this time) before it blew up. The trenchers could be operated by just two men. This was important because the remainder of the crew were free to do the extensive sawing and clearing. Using the dirt-throwing action of the flail, we ran across the top of the fire, cooling it and holding it for some time.

6. Volstead Creek fire—Okanogan—1964

We dropped four men on this 1½-acre fire, along with one chain saw and one flail trencher. The fuel type was scattered pine and pine grass, and the topography was quite rocky. In 1 hour the trencher had gone around the fire twice, and a very good fireline had been built. While the trencher operator built the fireline, the other three men knocked down hotspots and cut snags.

OTHER USES

We have used the flail trenchers on other jobs. We obtained fairly good results by using them to scalp ahead of tree planting crews. We used them in erosion control to cut small drain ditches in skid trails.

Flail-trenchers are effective for building control lines around cutting units prior to burning. Many people on the Okanogan National Forest feel the hand trench has application in prescribed burning because use of the "cat line" causes so much erosion on the steeper areas. These extra projects enable our smokejumpers to obtain good training in handling mechanized equipment while performing useful work.

Fire-Danger Stations—*Continued from page 4*

staff. Dr. Harold Crutcher, Chief of the Science Advisory Staff, reported, as an example, that monthly average temperature correlations rated against Miami, Fla., dropped to 0° F. at 600 miles, but maintained a 95-percent correlation for as far as 100 miles. In the Central United States the 95-percent level was maintained up to 95 miles. However, these limits should be used only where the primary interest is obtaining statistical data, such as broad approximations of seasonal severity. Stations spaced up to 200 miles apart might be useful for this limited purpose, but they would not satisfy daily operational needs.

Personnel of the National Weather Records Center knew of no reports that would provide better clues as to optimum fire-danger station distribution; however, they propose to look further. They thought that the 25-mile radius suggested by Williams was a reasonable first approximation in certain terrain, particularly if supplemented by additional rain-measuring stations.

Conclusion

We have only an approximate answer to the question of fire-danger station distribution. The development of a station network for a fire control organization is largely a rule-of-thumb procedure. The suggested minimum standards should be helpful, but they are not the best answer. Analyses of weather records combined with the results of local climate studies now underway at several experiment stations should eventually provide a sound basis for the optimum spacing of fire-danger stations.

THE NEW BOWLES HELITANK

Ralph A. James, *Assistant Regional Coordinator, Northern California Service Center, Redding, Calif.*

Editor's Note: The Bowles Helitank is designed to attach to the "H" frame adapter developed at the Arcadia Equipment Development Center.

Description

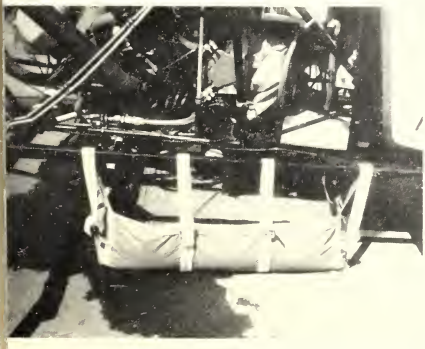
The new Bowles helitank[1] is square, open topped, and constructed of heavy-duty coated fabric. Its capacity is approximately 90 gallons of liquid for small helicopters (Bell G3B or Hiller 12E[2]) without leg extension or 100 gallons of liquid when attached to the above helicopters with leg extension. Recommended gross weight limitations must be followed for each helicopter make and model (fig. 1).

Rigging

The helitank is suspended on the rails of the bomb shackle adapter assembly by parachute webbing. The webbing straps are lashed around the rails of the adapter assembly, and attached by hooking the parachute snaps at the end of the straps into the V-ring sewn to the bag (fig. 2).

[1] The helitank was developed by William Bowles, Supervisory Smokejumper and Master Parachute Rigger, and Ralph Johnston, Helitack Specialist, of the Northern California Service Center, Region 5. Bert Train, Helicopter Operator, and Charles Burgans, Helicopter Pilot, assisted with the development and testing of the helitank.

[2] Use of trade names is for information purposes and doe not imply indorsement by the Forest Service.



igure 1.—Bowles helitank attached to bomb shackle adapter assembly on Bell helicopter with leg extension.

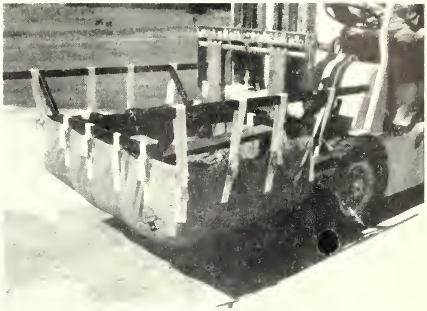


Figure 2.—Bowles helitank showing rigging to bomb shackle adapter assembly.

Dropping

The pilot may release the contents of the tank electrically or manually (fig. 3). When the helicopter is over the target, the pilot hits the release switch which supplies the current from the helicopter's electrical system to the electric solenoid mounted on the bomb shackle. The solenoid opens the bomb shackle, releasing the spout. The tank empties in 3 seconds.

Flying at 30 miles per hour and 50 feet high, the drop pattern with water is 30 feet wide and

Figure 3.—Static tests of dropping time with Bowles helitank.

100 feet long (fig. 4). After the drop is completed, the tank remains snug against the bomb shackle adapter assembly at cruising speed. Pilots report no adverse effects on flight characteristics before or after dropping.

Advantages

The Bowles helitank has the following advantages over helitanks now in use:

1. *The exchange of equipment.* When helitacks with rigid tanks are made, it is necessary to remove the helitank and attach the bomb shackle adapter assembly if the fire manager decides to use other helicopter accessories such as a helipumper, sling load, or hose tray. This is a 20- to 30-minute job. With the Bowles helitank, the bomb shackle adapter assembly is already in position for attaching other helicopter accessories.

2. *Easier handling and transportation.* One man can easily attach or detach this tank and fold it into a small bundle. It can be kept on the cargo rack of the helicopter. The rigid aluminum helitanks now in use require at least two men to mount or demount and a pickup to move the equipment.

The Bowles helitank weighs approximately 15 pounds, compared to approximately 50 pounds for aluminum tanks. This reduced weight allows an increase in the helicopter payload.

3. *Less expensive.* The cost of the Bowles helitank is about $60, compared to $500 to $1,200 for rigid aluminum tanks. It is also inexpensive to replace.

4. *More adaptable.* The Bowles helitank can be attached to a Bell or Hiller helicopter adapter assembly regardless of leg height. Metal tanks are not interchangeable without major modifications and resulting expense.

5. *Easier maintenance.* The Bowles helitank is easily repaired if damaged on the fireline.

6. *No certification.* A Supplemental Type Certificate is not necessary for the new helitank since it is attached to the bomb shackle adapter assembly that is certificated by the Federal Aviation Agency.

Figure 4.—Drop pattern made with Bowles helitank; it is 30 feet wide and 100 feet long.

Material lists, plans, and specifications are available from the U.S. Forest Service, Northern California Service Center, Airport Road, Redding, Calif.

MATERIALS LIST

Tank

- Material, Herculite 80 coated fabric
- Physical properties:
  - Total weight, 18.1 sq. yd.
- Tensile strength:
  - Warp, 332 lb. per in. width
  - Fill, 338 lb. per in. width
- Tear strength:
  - Warp, 103 lb.
  - Fill, 108

Webbing

- Nylon webbing straps, white
  - Spec. Mil W 4088, type 8, 1¾-in wide
- Condition (untreated) natural
- Tensile, 3,600 lb.
- Price per 100 yd.
  - Natural, $22.58

Snaps

- Parachute snaps tested to 2,500 lbs.

BRUSH CLEARANCE FOR STRUCTURAL PROTECTION

HARVEY T. ANDERSON, *Division Assistant Fire Chief*
Los Angeles County California Fire Department

Many structures have been lost in brush fires in southern California in 11 of the last 35 years. However, homes amid the worst brush fire can be saved if the surrounding brush is cleared.

Brush fires classified as major conflagrations repeat the same burning pattern on about a 20- to 30-year cycle. While fires of such magnitude constitute less than 3 percent of the total fires occurring in the watershed, they do by far the most damage. These fires can and do occur during all seasons.

Firefighters have worked on the flanks of these fires, reduced the acreage burned, and saved many structures in the paths of the fire, but until the extreme wind decreased or the fires consumed all available fuels, it was impossible to build control lines around them. Most of the structures lost had little or no brush clearance.

One hundred acres of fire in heavy brush releases the same B.t.u.'s as one atomic bomb, Hiroshima size. Nature could hardly have designed a more explosive mixture than the half-dead, oil-filled, finely divided leaves and stems of the vast brush fields of southern California chapparal. Add to this a carpet of dry grass for a fuse, and there is a potential conflagration from any one of a dozen causes.

The Indians put their tepees in the open grass meadows and let the children and dogs wear the ground bare. When the fires approached, they did not burn their homes.

American homeowners have been slow to realize that when the brush is too close to the house, the house is very likely to burn when a brush fire occurs. The Topanga fire of 1958 demonstrated this fact convincingly. In Fernwood in Topanga, 50 homes burned in a dense brush area, while on Big Rock Mesa, where the brush had been removed from around the homes, not one home was lost. This does not mean that homes need not be protected from flying embers or that fire engines are not necessary. It does mean that firemen and their equipment can certainly do a better job of saving homes if the house is not buried in flammable brush.

The fire problem on the average summer day has been solved in most of southern California. With the abundance of pumpers, patrol pickups, bulldozers, airplanes, and manpower, the average fire does not usually get out of control.

It is the fire that starts during high winds and low humidities and becomes large that greatly damages watersheds and homes. This conflagration runs until it consumes all available fuel or the wind abates. Nothing can be done about the wind, so what can be done about the FUEL? For effective fire control under conflagration conditions, reduction and modification of the fuel is needed.

In 1956 there were three big fires in Malibu, all driven by high winds in rough country. These fires occurred in a 6-day period and burned some 37,000 acres. All three practically duplicated fires that burned in 1930, 1935, and 1943.

Civic organizations became incensed and insisted that the fire department do something. The Chambers of Commerce of Topanga and Malibu insisted that the fire services recommend a solution. Interested parties met in 1957 in Los Angeles County Supervisor Chace's office, and as a result of this meeting, the Los Angeles County Brush Clearance Ordinance was adopted.

In 1959, clearing of lots was begun. The County Fire Department tries to get the property owner to make his own 100-foot brush clearance, but if he does not, the County crews clear his property and add the cost to the owner's tax bill. The average cost per lot cleared by County crews has been $100. When the owner can be contacted, an average additional cost of $5 is charged for chemical spraying. These sprays eliminate the need to cut the brush back the following year.

To remove the brush hazard, the Los Angeles County Fire Department uses the authority given by the 1961 Weed Abatement Act, State Health and Safety Code Section 14875-14921. In January, the County Board of Supervisors declares that certain lots are fire hazards and must be cleared. Weed Abatement Section personnel post brush hazard removal signs on these lots, and fire station captains and patrolmen try to obtain voluntary action. If the brush has not been cleared by August, a 30-day notice is sent to the owner, and if the work is not done by September 15, the County crews start cutting. Hand crews burn the piled brush, or if the weather is unfavorable, the brush is run through a chipper and distributed on top of the soil as a mulch.

The Brush Clearance Ordinance has been declared constitutional when owners have tested the law in court. Insurance companies have required up to 400 feet of clearance in some brush areas to prevent a brush insurance surcharge. The insurance companies have helped greatly in getting people to meet the requirements of the Brush Clearance Ordinance.

Instead of telling citizens to clear all the brush off his property, the slogan "Landscape with the native vegetation" is used to promote individual effort.

Some owners have found, after clearing off brush, that they owned more valuable land than they thought. After the 1961 Topanga fire, many personally thanked the Fire Department for making them clear the brush around their homes.

The effort is to reduce the fuel by separating bushes so that fire will not readily travel from one to the other, and to create a pleasing parklike effect. The use of local shrubs, such as manzanita, sumac, holly, scrub oak, or lilac, all native to the dry southern California climate, simplifies the plant problem. The remaining plants will have deep root systems and along with the grass and weeds that will come in will give the erosion protection that is needed.

The use of bulldozers for clearing brush in steep terrain is not advised. Hand clearing is necessary so that the duff and leaf mold will be left to protect the soil. No soil erosion was found after a heavy rain in the first brush area cleared in Fernwood in Topanga Canyon. Where water is available, low-lying iceplants and ground cover plants can be used to protect the soil and beautify the area. The department has a list of suitable plants.

Controlling Regrowth

The new 6- to 8-inch spring growth is treated with a mixture of 50-percent concentrate composed of 1½ oz. 2-4-D, 1½ oz. 2-4-5-T, and 3 gal. of water. Twice this strength was used on 3,000 acres on the Temescal Ranch, and an 85-percent brush kill was obtained. The cost was approximately $14.50 per acre. This figure included the expense of application by helicopter. One good mix for the treatment of 1 acre is 3 lb. of 2-4-D, 3 lb. 2-4-5-T, and 1 gal. of diesel oil; water is added to make 10 gal. of mix.

For sagebrush, 3 lb. of 2-4-D, 1 gal. of diesel oil, and enough water to make 10 gal. of mix is effective. The cost is approximately $7.65 per acre when the mix is applied by helicopter. Application of sprays around houses or cultivated areas must be done with extreme care under conditions of no wind to prevent damage to other plants.

Prescribed burning has been advocated by some as a means of breaking up the large brush areas, but it is not feasible in southern California. It is not possible to both do it safely and obtain a good burn.

However, advantage should be taken of the burns that do occur and the areas treated to prevent regrowth of the brush on main ridges in selected areas. We need to perfect regrowth control methods. Some erosion may have to be tolerated, but it is better to have some erosion than to permit the repetition of the 30-year cycle of devastating conflagrations, the loss of valuable watersheds and homes, and the subsequent disastrous floods and accompanying erosion.

References

The following pamphlets and bulletins may be of help in further investigation of this subject.

Los Angeles County Fire Department.

1960. Can your home survive a major brush fire?

1964. Chemical control of brush around the home.

Murphy, J. L.

1963. Conflagration barriers. Pacific Southwest Forest and Range Expt. Sta., 12 pp.

Pacific Southwest Forest & Range Experiment Station, California Division of Forestry, and Los Angeles County Fire Department.

1963. Guidelines for fuel breaks in So. California. Fuel Break Rpt. 9, 25 pp., illus.

Plum, T. R., Bently, J. R., and White, V. E.

1963. Chemical control of brush regrowth on fuel breaks.

Pacific Southwest Forest and Range Expt. Sta., 41 pp., illus.

HELMET RACK

PHILIP E. CLARKE, *Supervisory Smokejumper*
Bureau of Land Management, U.S. Department of the Interior, Fairbanks, Alaska

The Alaska smokejumper unit was established in 1959, on a trial basis, to increase the efficiency of forest and range fire control in Alaska.

In growing from a 16-man contingent in surplus quonset huts to a well-equipped 50-man fire suppression organization, we have encountered many problems, some *unique* to Alaska, some common to all growing smokejumping units. One problem which has plagued all loft foremen is how to store smokejumper helmets so they will be orderly arranged and safe from damage while in storage.

To meet this problem we have constructed a simple and efficient helmet rack. The helmets are placed on the rack; the ear vents are inserted onto a welding rod hook (fig. 1). The individual racks are spaced to allow easy accessibility to each helmet when the rack is fully loaded (fig. 2).

The racks are made of ¾-inch thin-wall conduit and 5-inch pieces of ⅛-inch steel welding rod. The racks consist of 5-inch pieces of welding rod placed at 10-inch intervals starting 12 inches from the bottom of the rack. The welding rods are bent upward to a 60-degree angle to give the helmets a stable resting position (fig. 3).

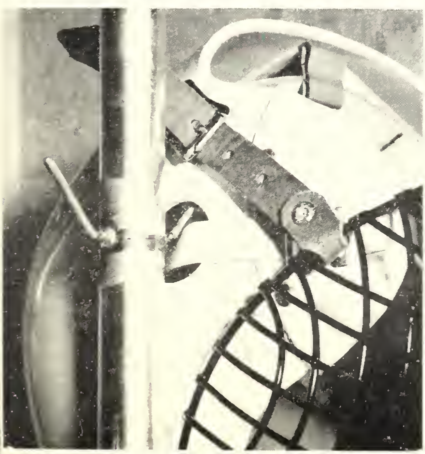


Figure 1.—Smokejumper helmet in storage on helmet rack. (Photo courtesy of U.S. Department of Interior, Bureau of Land Management.)

In addition to improving the appearance of the storage area and decreasing the storage damage of the helmets, use of the helmet rack has increased the available shelf space.

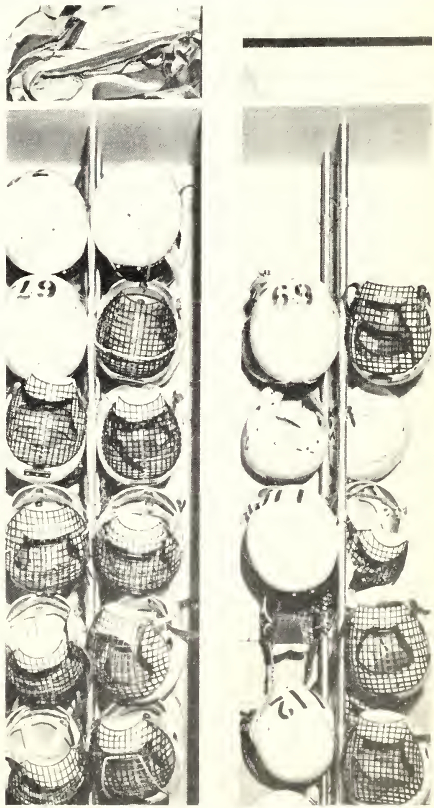


Figure 2.—Helmet rack installed in parachute loft. (Photo courtesy of U.S. Department of the Interior, Bureau of Land Management.)

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STABILIZATION OF SLASH FUEL SAMPLES

S. J. Muraro, *Research Officer*

Forest Research Branch, Department of Forestry

Victoria, British Columbia[1]

In fire research, sampling of highly diverse fuels such as slash is difficult, particularly if preservation of the spatial distribution is desired. One method of sampling such fuels is to stabilize them in their original state by using Vibrafoam.[2] It is a rigid polyurethane foam similar in appearance and physical properties to styrafoam.

Vibrafoam is marketed as a two-package viscose liquid; part A contains the prepolymer and part B, the cross-linking agent, catalyst, and blowing agent.[3] Combining the liquids in the ratio of 11 parts B to 10 parts A by weight or 8 parts B to 7 parts A by volume produces a foaming liquid which rapidly hardens to form a porous, white mass. Two quarts, one of part A and one of part B, yield approximately 3.3 cubic feet of foam at a cost of about $10. Larger quantities are available at lower prices.

Small quantities of the two liquids are combined in the appropriate ratios and mixed with an egg-beater or by rapid hand stirring in a polyethylene mixing bowl. (Polyethylene lessens adhesion of solidified foam to the mixing vessel.) Within 1 minute the liquid will expand to form a yellowish froth. This froth is poured through voids in the slash to form a mound of froth at the base of the fuel. Further expansion of the froth incorporates fuel components both vertically and horizontally until the action of the blowing agent is exhausted and hardening commences. This procedure is repeated until a mound of rigid foam incorporates the desired portion of the fuel complex. Safety precautions furnished by the supplier should be observed, especially regarding fume inhalation.

Within 30 minutes the foam solidifies, and a sample (fig. 1) may then be obtained by making four vertical saw cuts along the borders of the desired sample. The complex of Vibrafoam and entrapped slash is easily cut with a handsaw, but if the incorporated fuel components are large, a chain saw may be required. Attempts to cut similar samples of slash without the benefit of a stabilizing medium have been time consuming and difficult.

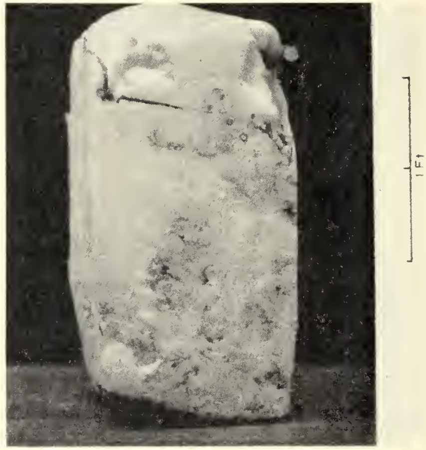

Figure 1.—Fuel sample stabilized with Vibrafoam.

The method of evaluating the incorporated fuels will depend on the fuel information desired. Average density of a fuel sample may be calculated by determining the difference between (a) the density of foam plus incorporated fuel components and (b) the density of an equal volume of solidified foam. The total weight of fuel is the product of the difference in densities and the volume of the sample.

If a finite description of the distribution of fuel sizes and types is desired, the sample may be sectioned to isolate specific zones. Figure 2 shows two facing sections cut from the sample shown in figure 1 and the larger fuel components which were later extracted from the sample.

[1] Department of Forestry, Canada, Forest Research Branch Contribution No. 462.

[2] Use of the trade name, Vibrafoam, is solely for information purposes, and endorsement by the Forest Service is not implied.

[3] Anonymous. Naugatuck Chemicals Technical Data Bulletins, P_1, P_2, and P_5. Naugatuck Chemicals, Elmira, Ontario.

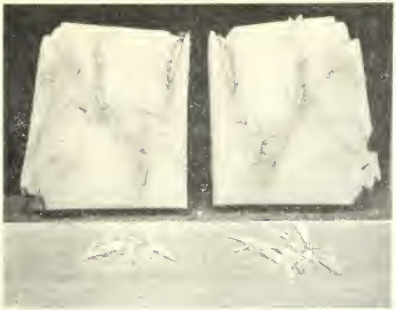

Figure 2.—Adjacent sections of the sample shown in figure 1. The larger fuels taken from each section are shown below.

To allow examination of the incorporated fuels, they must be separated from the foam by breaking the section and removing the larger fuel components by hand. Smaller fuel components, such as needles, grass, and fine twigs, may be separated by dissolving the foam in a solution of equal parts of acetone and dimethyl formamide or in methyl alcohol. Each fuel component can then be dried and weighed to permit a description of the fuel complex in terms of the spatial distribution of weight, or in terms of fuel surface area.

VIRGINIA HARD HIT BY '63 FOREST FIRES

Fires destroyed 44,744 acres of Virginia's forests last year, the State Division of Forestry reported. It was the worst year for forest fires since 1952, when 111,000 acres of forest land were burned over.

Hardest hit was the Northern Piedmont section of the State, where 545 fires burned 9,529 acres.

TRAGIC FIRE TOLL ITEMIZED AT MEETING

[From the DALLAS TIMES HERALD, *Dallas, Tex., May 19, 1964.]*

Percy Bugbee, general manager of the National Fire Protection Association, detailed the toll of human suffering and waste caused by fire in his report to the organization's 68th annual meeting in Dallas, Tex., in May 1964.

On an average day, 32 people will be killed by fire, more than 1,500 homes will be hit by fire, costing homeowners nearly $1 million. There will be fires in 14 schools, 17 farms, 3 hospitals, and 8 churches. Fire will disrupt operations in 135 factories and 120 stores.

"These are not just numbers," said Mr. Bugbee. "These are people and their possessions and their jobs—all casualties of needless fires."

He emphasized that practically every fire is needless.

"Dig into the story of every fire and there is some human failure or act of carelessness which allowed the fire to happen.

"Fire cost 11,800 lives and more than $1.7 billion in property damage in 1963 in this country, and it may appear we are losing ground.

"However, our growth in population during the past 25 years means there are many millions more people exposed to the hazards of fire. Likewise, there are tens of billions of dollars' worth of additional property available to burn. So actually we have made progress in holding losses to their present levels.

"But in the final analysis, it is people who cause fires. When all of us acknowledge that fires are not only wasteful but avoidable, and then go on to reform the habits and remove the hazards that cause them, we will see real progress," he concluded.

DRAFTING TABLE FOR FIELD PROJECTS

CLEMENT MESAVAGE, *Research Forester*
Southern Forest Experiment Station

A combination drafting and light table that can be placed on a desk prior to use or stored when not in use has been constructed (figs. 1, 2).

A 32- by 40-inch drawing surface is attached to a 28- by 36-inch base, 7⅜ inches high. The table's height is 9⅛ inches; this dimension can be altered to suit the user. A full-length piano hinge is installed at the front. This allows the user to tilt the table at various angles. Casement sash adjusters are used at the rear corners to lock the table in place at the desired angle.

A 24- by 30-inch frosted plate glass is recessed flush, centered in the surface of the top. Even illumination is provided by two fluorescent fixtures, each containing four 20-watt tubes. A sheet of chromed brass set under the tubes reflects light upward.

The tabletop was made from a solid-core veneered door, 1¾ inches thick, and faced with birch (maple or another close-grained hardwood would be equally suitable). An opening, 23¼ by 29¼ inches, was sawed out, and then a ⅜-inch ledge was routed deep enough for flush mounting of the glass. The glass was fixed in place with a glazing compound. A 36-inch parallel rule was attached.

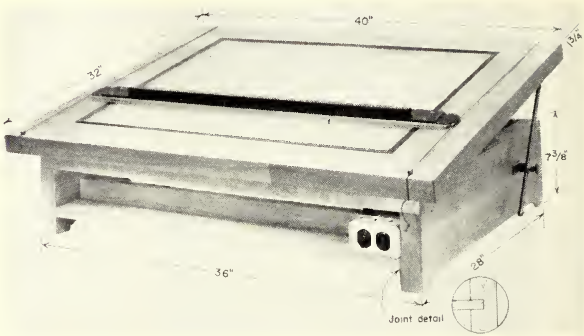

Figure 1.—Completed drawing table.

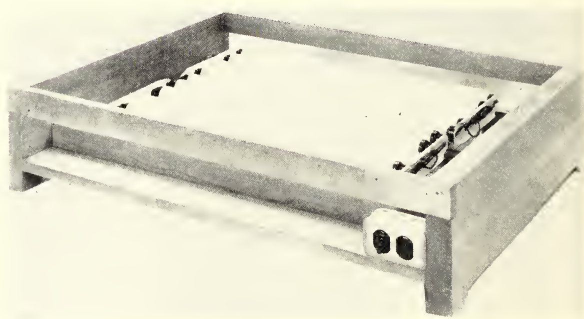

Figure 2.—Top removed to show installation of light fixtures.

Sides of the base were ripped from the material removed for the opening. The bottom is ¾-inch plywood, 28 by 34 inches, set in a groove ¾-inch deep in the sides of the base. This bottom piece provides a mounting surface for the light fixtures and full-length shelves at the front and back of the table. Exterior edges were banded with a veneer to improve appearance. The light fixtures were wired into a toggle switch attached at the front of the unit.

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

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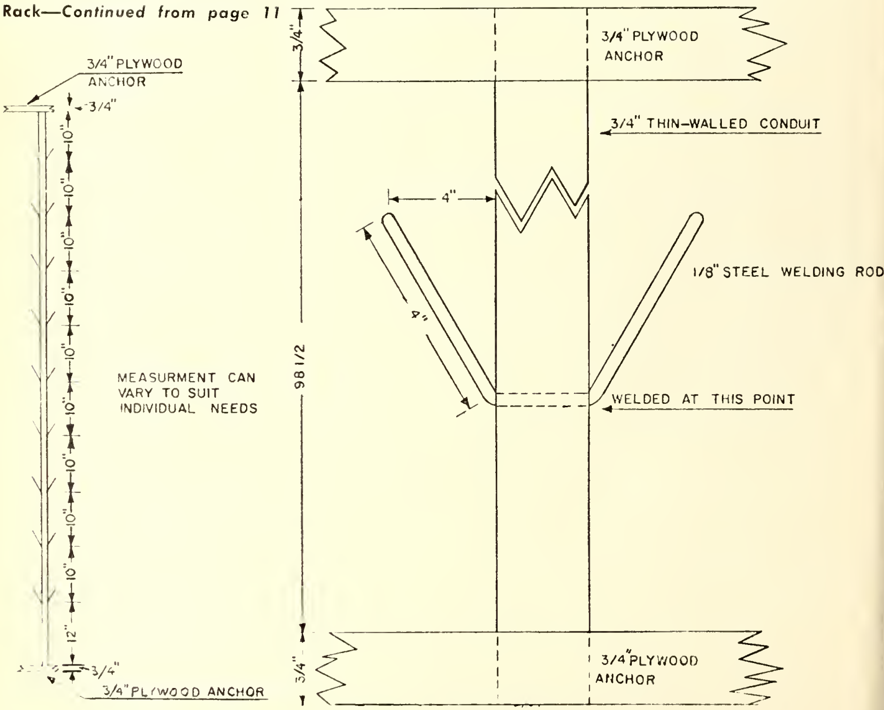

Figure 3—Specifications for smokejumper helmet storage rack. (Photo courtesy of U.S. Department of the Interior, Bureau of Land Management.)

January 1965 Vol. 26, No. 1

FIRE CONTROL NOTES

U.S. Department of Agriculture
Forest Service

FIRE CONTROL NOTES

A quarterly periodical devoted to forest fire control

CONTENTS

INFORMATION FOR CONTRIBUTORS

Please submit contributions through appropriate channels to Director, Division of Fire Control, Forest Service, U.S. Department of Agriculture, Washington, D.C. 20250. Articles should be typed in duplicate, double space, and with no paragraphs breaking over to the next page. Elite and pica copy should be 54 and 45 spaces wide, respectively.

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 organization.

Authors are encouraged to include illustrations with their copy. Illustrations, whether drawings or photographs, should have clear detail and tell a story. Only glossy prints or India ink line drawings are acceptable. Captions for illustrations should be typed in the manuscript immediately following the paragraph in which the illustration is first mentioned, the caption 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 caption 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.

COVER—The Redmond, Oreg., Air Center was dedicated on August 29, 1964, by the U.S. Forest Service. It is the hub of aerial firefighting operations for the Pacific Northwest. The Air Center is home base for smokejumpers, air tankers, air cargo planes, and an interregional fire suppression crew that may be flown anywhere in the West.

FIRE CONTROL NOTES is issued by the Forest Service of the United States Department of Agriculture, Washington, D.C. The matter contained herein is published by the direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. Use of funds for printing this publication approved by the Director of the Bureau of the Budget (Sept. 16, 1963).

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SIMULATING FOREST FIRES FOR RESEARCH

ROBERT C. HARE, *Plant Physiologist,*
Institute of Forest Genetics,
Southern Forest Experiment Station[1]

The effects of a forest fire on a single tree can be simulated by burning an oil wick encircling the tree near groundline. Some of the advantages of this method over the setting of fires in natural fuel include ease of replication, standardization of amount of heat, a saving of labor, and low risk of fire escape. Trees are also conserved, for only those needed are burned, whereas natural-fuel burns usually damage many trees not used in a study.

Figure 1.—Wick braided from wire-reinforced asbestos and saturated with SAE-30 motor oil in kerosene is wrapped around the trunk and ignited.

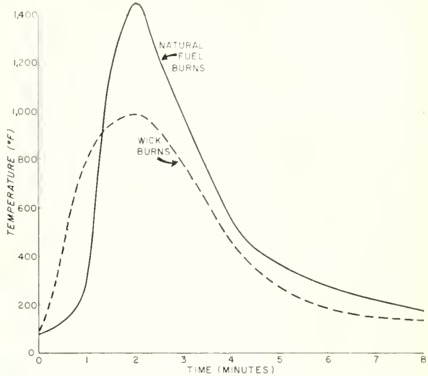

Figure 2.—Typical lee-side, bark-surface temperature curves 1 foot above the wick and in natural-fuel burns.

The wick, braided from wire-reinforced asbestos and saturated with SAE-30 motor oil in kerosene (1:3), is wrapped around the trunk about 1 foot off the ground, and ignited after litter is removed (fig. 1). Temperature regimes on and under the bark are recorded by thermocouples connected to a multiple recorder.

Wick flames, lasting about 7 minutes, give temperature histories on both windward and lee sides that are quite similar to those obtained in natural-fuel burns (fig. 2). Maximum cambium temperatures in a number of tests varied from 85° to 520° F. in wick burns, and from 85° to 500° in pine-litter burns.

Although the wick fire cannot reproduce a moving front, it responds to wind much as natural fires do. Because of a cooling effect on the windward side and a convection column buildup on the lee side, maximum lee temperatures in both types of fires are at least twice as high as windward maxima, and the difference increases with height.

[1] This research was conducted when the author was with the fuels and fire control project at the Southern Forest Experiment Station.

VORTEX TURBULENCE—ITS EFFECT ON FIRE BEHAVIOR

James B. Davis, *Forester,*
Pacific Southwest Forest & Range Experiment Station
and Craig C. Chandler, *Fire Behavior Specialist,*
Forest Fire Research, Washington Office[1]

"The fire wasn't doing much until the air tanker went over, and then it spotted all over the place," complained the fire crew foreman.

Such reports have caused fire control officers to ask, "Can air tankers really cause erratic fire behavior?" The answer is yes—under some conditions. The gremlin is "vortex turbulence," a pair of whirlwinds streaming out behind the wingtips.

What is Vortex Turbulence?

Vortex turbulence is a sheet of turbulent air that is left in the wake of all aircraft. It rolls up into two strong vortices, compact fast-spinning funnels of air, and to an observer on the ground appears to trail behind each wingtip (fig. 1). Because it moves out at right angles to the flight path, vortex turbulence can be distinguished from propeller wash, which is largely localized to a narrow stream lying approximately along the flight path. Unfortunately, however, vortex turbulence is usually invisible.

Under certain conditions the two vortices may stay close together, sometimes undulating slightly as they stretch rearward. The interaction between them tends to make them move first downward, then outward along the surface of the ground.

How Important are Vortex Wakes?

The Flight Safety Foundation, Inc., reports: "In recent years, there have been increasingly frequent reports by pilots encountering severe disturbances of another airplane even when separated from it by distances of several miles. There also are an increasing number of fatal accidents to lighter airplanes, resulting from upsets near the ground or structural failures which are being ascribed to encounters with wakes of large airplanes. It is now generally accepted that the only disturbance which an airplane can produce that is powerful and persistent enough to account for these incidents arises from the vortices which trail from the wingtips of any airplane in flight."

Ordinarily, vortex turbulence does not pose any difficulties to fire control forces. But under special circumstances vortex wakes may cause a fire to act most unexpectedly. Line personnel should become familiar with the vortex problem and the situations where it is likely to affect fire behavior.

What Causes Vortex Turbulence?

Vortex turbulence is a byproduct of the phenomenon that gives lift to an airplane. Air flowing the longer route over the top of the wing has to travel

Figure 1.—Low-flying spray plane. Note funneling effect of spray trailing behind each wingtip. This is vortex turbulence.

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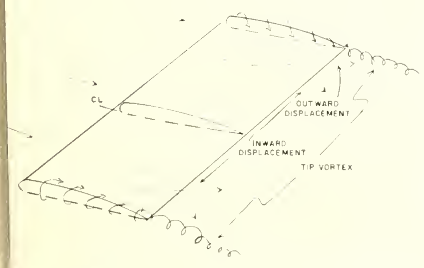
[1] The authors have received technical guidance from many sources but are especially grateful to Richard C. Rothermel, Aeronautical Engineer, Northern Forest Fire Laboratory; Herbert J. Shields, Supervisory Engineer, Arcadia Equipment Development Center; and Alan W. McMasters, Operations Analyst, Pacific Southwest Forest & Range Experiment Station.

aster than the air flowing across the bottom in order to reach the trailing edge simultaneously. The difference in speed causes a difference in pressure between the top and bottom of the wing with a resultant upward force, or lift. If you want to demonstrate this effect, hold the back of a spoon in a stream of water from a faucet. The spoon will be pulled into the stream as soon as the water touches it. However, here is where the trouble starts. Since the air pressure is greater on the under surface of the wing than on top, some air tries to flow around the end of the wing to the lower pressure area. Because of the flow around the tip, the main stream—instead of flowing straight back across the top and bottom of the wing—tends to fly inward toward the fuselage on the top of the wing and outward on the bottom. As a result, the air doesn't "fit together" at the trailing edge but forms a vortex sheet that rolls up into two large whirlwinds that trail from each wingtip (fig. 2).

Is Turbulence the Same for All Air Tankers?

Vortex severity and persistency vary with several actors. Most important are the type and size of he aircraft and the condition of the air. Vortex urbulence is greatest when produced by a large ircraft with a heavy wingspan loading. Thus, the eavier the aircraft or payload per unit of wing urface, the more severe the turbulence will be. The B-17 is a heavier airplane than the PBY. Thus, when the vortex wake immediately behind a B-17 is 29 m.p.h., the lighter PBY's vortex will be only 6 m.p.h. under the same flying conditions since both planes have the same wingspan.



gure 2.—Airflow over wing with distortion of flow and vortex formation.

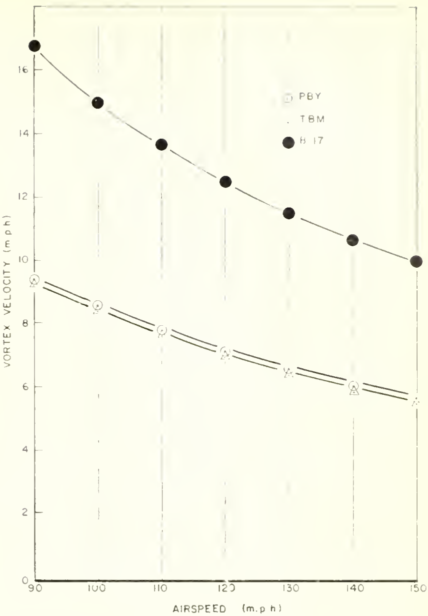


Figure 3.—Relation of vortex velocity to air tanker speed. The tanker's altitude was 75 feet; vortices took about 15 seconds to reach the ground, where their velocities were obtained.

How Does Air Tanker Speed Affect Turbulence?

It may seem surprising, but turbulence is inversely related to airspeed (fig. 3).

Other factors being equal, an aircraft with a high wingspan loading at slow airspeed is the source of the strongest vortices. In terms of air safety, one of the greatest hazards is a heavily loaded aircraft flying at slow speeds before landing or after takeoff. Essentially, this is the condition when an air tanker slows down for an accurate airdrop.

How Does Aircraft Height Affect Turbulence?

At high altitude, the two vortices remain separated by a distance slightly less than the aircraft's wingspan. However, the interaction of the two causes them to drop. As they approach within approximately a wingspan of the ground, they begin to move laterally outboard from each wingtip. The lateral motion may be better termed "skidding" than "rolling," for at the ground contact point the direction of rotation is opposite the core's lateral movement (see fig. 2). The downward movement may require only 10 seconds from a TBM flying at 50 feet, but a minute or more from the same aircraft flying at 150 feet. The time required for downward movement is important for two reasons:

1. Wind can blow the vortices away from the drop area. For example, a 10-m.p.h. wind can blow the vortices more than 800 feet in the short time required to drop from 150 feet.

2. Vortices weaken rapidly with time. Under average air conditions, the turbulence may lose its danger potential in less than a minute. In rough air, the funnels break up and weaken even more rapidly. Calm air is the worst situation because it permits the turbulence to persist for a longer period.

How Does Vegetation Affect the Vortex?

Natural surfaces are more or less rough and, therefore, cause frictional resistance to air movement above them. The rougher the surface, the greater the friction. Timber, for example, has a much greater slowing effect on wind than does open grassland. Whereas a vortex turbulence is more like a horizontal whirlwind than what we normally think of as a wind, the same frictional considerations apply. A heavy stand of timber would dissipate most of the force of a vortex; the same vortex would be only slightly weakened in grass or scattered timber.

How Do Vortex Wakes Affect Fire Behavior?

Although there are many observations on the effect of vortex wakes on other aircraft, we have

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Figure 4.—Wake from a DC-3 and pronounced vertical motion of the vortex.

LOOKOUT VISIBLE AREA—ILLUMINATED AND PHOTOGRAPHED

CLAUDE PHILLIPS, *Forester,*
Oregon Forestry Department

Because of changing fire detection systems there is recurrent need for lookout visible area charts. Office or field methods of charting seen area require tedious sketching.

The darkroom photographic method developed in the Oregon Forestry Department eliminates much of this effort and produces new features on the charts. Reference to flashing light on relief models is found in Davis (1959)[1] (photography is not mentioned). Modest exploration of the method's potential became possible only with the advent of plastic relief maps. This process was tested during a project requiring extended coverage for several lookouts on a district being considered for combination lookout and air patrol.

Concept

To illustrate the method, visualize taking a picture at night from a high altitude directly over the lookout while using a powerful flash at the lookout point for exposure lighting. The area illuminated and recorded in the picture would correspond to the area seen by the lookout. The area hidden from the lookout by ridges and canyons would be in shadow.

Utilization of Relief Maps

In practice, the same method is used on a miniature scale. Miniature terrain is provided by Army Map Service plastic relief maps with a horizontal scale of 1:250,000 and a vertical exaggeration of 2:1.

The tiny point source of light needed to match this miniature terrain might be difficult to obtain from light bulbs, lenses, or reflectors. Therefore, the flash from a small arc created at the lookout point on the map surface was used.

The map used in this project (fig. 1), which covered the Northwest Protection District of Oregon, was made by gluing together two of the "Wrinkle Quads." The main concern was over the accuracy to be expected of terrain impression and the effects of using the small scale of one-fourth inch per mile. On these relief maps with a vertical scale of 1:125,000, one-hundredth inch is equivalent to a tower height of 104 feet. The requirements of this project permitted the indication of slightly greater coverage than the ground surface really seen.

Figure 1.—Front of map used in darkroom method.

Measurement of the height of model terrain on the relief map with a surface gage revealed the map to be surprisingly accurate. Corrections of 0.01 to 0.03 inches were made by gluing balsa blocks to the back and trimming to support at the correct height before gluing the map to a ½-inch-thick fiberboard base. These blocks gave rigidity to the map when it was glued to the base for wiring.

Instrumentation

Holes were drilled through the map and the base at the lookout point, and wire electrodes were inserted until flush with the map surface. Under

[1] Davis, Kenneth P. Forest fire: control and use. 584 pp., illus. New York: McGraw-Hill. 1959.

the base the wires were bent flat (fig. 2), anchored with screws, and soldered to a common conductor. Map electrodes are made from number 18 copper magnet wire (0.040 inch diameter) with enamel removed. The arcing circuit was completed by a carbon electrode (penlight battery core) mounted on a slender adjustable support arm above the map (fig. 3). Current was supplied to the electrodes from 45- and 67½-volt B-type used radio batteries connected in a series to give 450 to 500 volts. The carbon electrode was connected positive through a momentary switch. Actual arcing was controlled by a fine adjustment screw in a leg of the stand supporting the overhead arm. The arm was lowered and raised to strike and break the arc as in welding. The switch protects against accidental flashes. Capacitors were tried successfully as a power source, but the arc created more sparks than the battery system and the recharging time was too long.

Figure 3.—Meeting of contacts showing map electrode slightly extended.

Application of The Method

Direct photography of the lighted area was the real expedient in this venture. It permitted a simultaneous record of geographic map, seen area, and composite coverage as desired. Pictures were made on Kodak Royal Pan film[2] by a 4 by 5 Speed-Graphic camera mounted on a tripod directly over

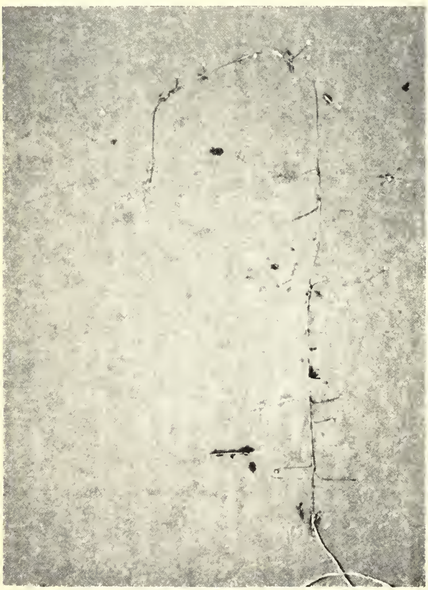

Figure 2.—Back of map used in darkroom method. Firtex backing and wiring detail is shown.

[2] Use of trade names is for information purposes and does not imply endorsement of products by the U.S. Department of Agriculture over other products not mentioned.

Figure 4.—Camera setup with map on darkroom floor; exposed portion of arcing circuit is shown.

the map in the darkroom (fig. 4). The aperture was f-8, and the exposures were made with an open shutter. Two to four flashes were used, depending on the quality and duration of the flash. Sustained arc with this power source can set the map on fire or overheat the wires. The shutter was closed for moving the contact on composite pictures, and a separate floodlight exposure was made at 1/150 second for map background lighting.

Light diminishes with distance at a rate somewhat comparable to visual perception, providing a gradual limit instead of the arbitrary 8-mile circle.

The seen area appears gradually darker farther from the lookout. This feature apparently helps in making a visual estimate of lookout potential. Also the recorded light is attenuated in the shadow of obstructions so that we have some representation of nearly seen surface. Areas slightly below the line of sight are only lightly shaded, indicating the area where it is possible to detect rising smoke.

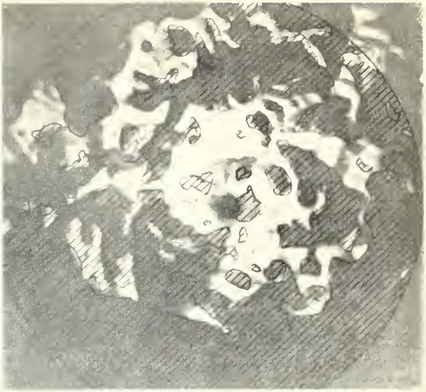

Figure 5.—King Mountain, Northwest District, showing overlay by profile method superimposed over photo. Unseen area of profile overlay is hachured. Discrepancies are partly due to slight scale differences and photo distortion.

Figure 6.—Point tried near the bend of Wilson River in Northwest District.

Comparison with Profile Method

Seen-area charts made by the profile method use 1-inch-per-mile topographic maps, and then the charts are reduced to a ½-inch-per-mile scale. The reduction method is subject to error and may account for much of the discrepancy between the photos and previously drawn charts done by the profile method (fig. 5).

It is not difficult to orient an overlay chart when

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Figure 7.—This composite photo shows seven selected points. There is attenuated but recorded light up to 15 miles. Background lighting brings out the printing detail of the map.

THE UNIMOG, A VERSATILE VEHICLE

SAMUEL S. COBB, *Chief, Division of Forest Protection, Pennsylvania Department of Forests and Waters*

The Pennsylvania Department of Forests and Waters has consistently sought better means by which its personnel could reach and control all forest fires as quickly as possible.

Although Pennsylvania is populous and highly industrial, most of its people and extensive road networks are concentrated in small areas. Except for the coastal piedmont region in the State south of the Appalachians, the western fringe along the Ohio border, and a few wide agricultural valleys, the State is heavily forested. There are many large, unbroken blocks of forest. Fifty-two percent of the land area is in woodlands, and more than half of the 67 counties have forested areas of 60 to 90 percent.

In these heavily forested counties the road networks are sparse, especially in the mountains. Even in areas with large population centers, there are sizable forested blocks without roads or with only very poor roads.

Over the years, particularly since the end of World War II, many types of vehicles have been tested for use in off-the-road travel into such inaccessible areas. Many conventional four-wheel-drive trucks and military surplus four-wheel-drive vehicles have been tried. However, when any of these vehicles were used to traverse rough terrain, expensive breakdowns or crippling "hang-ups" sometimes occurred.

In 1958, Horace B. Rowland, then Chief of the Department's Division of Forest Protection, became interested in a vehicle called the Unimog[1] (figs. 1-3). Manufactured in West Germany by the Mercedes-Benz Company, it had been designed as a combination small truck and farm tractor for the European farmer. It was also quickly accepted as a valuable military vehicle by several European armies. Rowland had become interested in the vehicle's application as a fireplow unit. When two of these vehicles were delivered late in 1961, they were further equipped by the installation of an hydraulically operated Anderson fireline plow.

The vehicles delivered to the Division were the

Continued on page 14

Figure 1.—Front view showing the guard shields that protect the grill, headlights, and windshield.

Figure 2.—Rear view showing the plow attached and the slip-on pump tank unit in place.

[1] Use of trade names is for information purposes and does not imply endorsement of products by the U.S. Department of Agriculture over other products not mentioned.

WOODS ARSONISTS AT WORK

JOHN E. BOREN III, *Criminal Investigator, Kisatchie National Forest*

It was 10:30 a.m. on March 22, 1964, on the Evangeline Ranger District, Kisatchie National Forest. A Forest Service lookout spotted a column of smoke. Before he could reach for his phone to alert a suppression crew he saw another, then another, then more. By 4:15 p.m. 89 individual incendiary sets had been recorded (fig. 1). The arsonist(s) had planned their work well.

Eleven tractor-plow units and 70 firefighters from the U.S. Forest Service and the Louisiana Forestry Commission limited several potential large fires to a loss of only 795 acres of burned-over National Forest land.

An investigation was immediately initiated by the National Forest Criminal Investigator in cooperation with law enforcement agents of the Louisiana Forestry Commission. It was learned that a horseman had been observed deep in the "Piney Woods," and that numerous fire sets had been reported in the same area. A detailed search of these areas disclosed a fresh set of horse tracks,

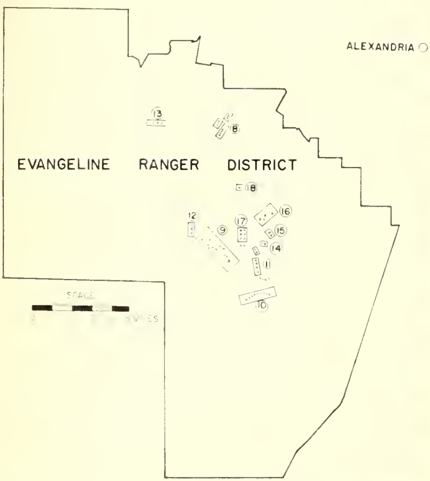

Figure 1.—Map of the Evangeline Ranger District. Each "X" denotes an incendiary set. The numbers indicate the District fire number.

Figure 2.—Remains of the slow-match found at one fire set. Not the fiber glass core, kitchen matches, and electrician tape.

Figure 3.—Fiber glass core of the "fuse" of another slow-match The pen is 5½ inches long.

and later the remains of the incendiary device—a slow-match—was found (fig. 2). Additional searching revealed what was subsequently identified as the core of the "fuse" of another slow-match (fig. 3).

By careful handling, these two fragile items of evidence were preserved and sent to the FBI laboratory in Washington for examination. The FBI reported that the slow-match was constructed of one-quarter-inch braided cotton cord, was cotton filled, and had strands of fiber glass as a center. Common kitchen matches were bound to the cord with one-half-inch electrician-type plastic tape. The other core that was found was identified as fiber glass of the same type used in the slow-match.

Field experiments with slow-matches (fig. 4) made from materials similar to that shown in figure 2 revealed that the cord burns at the rate of 1 inch per 12 minutes. It was determined that the incendiary device had a "fuse" cord of approximately 5 inches. Thus, the arsonist(s) had 1 hour to make their getaway from the area after dropping the slow-match in the forest litter.

Due to the unusual fiber glass core, it was believed that if the store selling this type of cord could be located, it might lead to the identity of the arsonist(s). Numerous inquiries were made at local outlets, but no rope or cord with this particular characteristic was found. These inquiries did, however, develop a list of wholesalers and cord manufacturers. Correspondence with 21 of these companies resulted in the receipt of many

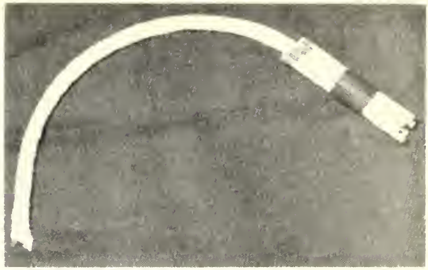

Figure 4.—Sample of a slow-match before burning. The cord measures 5 inches from the end to the head of the matches.

samples of cord. One sample, furnished by a Boston, Mass., manufacturer, appeared identical to the cord used to make the incendiary device. This cooperative company also furnished the identity of their wholesale outlet in the South.

More than 150 forest residents, local businessmen, law enforcement officers, and Forest Service employees have been interviewed. Stories and alibis have been checked, and more leads have developed. The store from which the arsonist(s) obtained their cord has not been located. The investigation is continuing, and it is hoped that the arsonist(s) will be identified and brought to justice through the medium of a piece of 6-inch cotton cord (with fiber glass core).

REWARD PROGRAM MADE STATEWIDE

From The Voice of Forestry

Mississippi Forestry Association,

Jackson, Miss.

As a positive step toward combating destructive forest fires, the Mississippi Forestry Association (MFA) has launched a statewide forest fire reward program, announced James M. Vardaman, Jackson, chairman of the MFA reward committee.

Vardaman said that tree farmers from all parts of the State have pledged a total of $10,000 to be used in offering a $500 reward in each county for information leading to the arrest and conviction of persons setting woods fires. The reward program was started last year, and by the end of the fire season 14 counties were participating. The effectiveness of the program led the MFA board of directors to make the project statewide.

Vardaman said that the MFA is working in close cooperation with the Mississippi Forestry Commission. In each county, personnel of the Commission are posting notices of the reward in public places and at the scene of burned forested areas.

Last year, according to the State Forestry Commission, Mississippi suffered nearly 9,000 forest fires which destroyed more than 90,000 acres at a loss of $3¼ million. Besides timber destroyed, this loss included a number of crops, fences, barns, and other buildings.

Unimog—*Continued from page 11*

Model 411.117. They have a four-wheel drive system. The front drive can be engaged while in motion without use of the clutch. The unit will operate at from 1 m.p.h. (for pulling a plow) to 40 m.p.h. (for use on the highway). A few details of the vehicle follow:

Cost, $5,200 (delivered on State bid).

Total dimensions, 70.5 inches wide, 151 inches long.

Wheelbase, 83.5 inches.

Tire size, 10 by 18.

Clearance under differential, 14.5 inches.

Engine, four-cylinder Mercedes-Benz diesel.

Workload capacity, 2,205 pounds.

Drawbar pull, 4,840 pounds.

As used by the Pennsylvania Forest Service, the units have proven quite versatile. They have, in addition to the fireline plow, been equipped with slip-on units consisting of a 120-gallon steel tank, a portable pump, and a live reel with 300 feet of three-fourth-inch hose. They have been used on fires as follows:

1. As a fireplow that can travel roads at 40 m.p.h., cross rough terrain, and plow firelines.

2. As a direct attack unit, applying water on the fire edge.

3. For scouting fires over terrain unsuitable for use of conventional vehicles.

4. For moving men, equipment, and food from road to fire over difficult terrain.

Figure 3.—Side view showing the plow in position ready for final lowering. In transit the plow is carried in the lift position, secured to the tailgate.

5. To support retardant warterdrops on incipient forest fires, made by water bombers, thus insuring early control and the loss of only small acreage.

In addition to on-fire jobs, the plow units have been used extensively to construct and maintain back lines for hazard-reduction burning in connection with railroad rights-of-way, dumps, hazardous residential and play areas, and similar areas that are prone to fire. Operating costs have been quite low.

No difficulty has resulted from damage to the pump unit from branches or other overhead hazards. However, the units have been used mostly in scrub oak and hardwood brush areas where this hazard is minimal.

Visible Area—*Continued from page 10*

the photo method is used with background lighting. The entire map may be floodlighted for a fast exposure (1/150 second) to faintly bring out the map detail where flashes have not illuminated it. The seen area is exactly where it belongs because the photo serves as the base map.

Results and Potential Uses

Comparison of the pictures (fig. 5) with seen-area charts made by the profile method indicated that the cost of the pictures was more than justified.

With this method indications are that the discrepancy in area might be held to a maximum of 10 percent. Some hidden area near the point source is lightened by reflection error when flashing for extended coverage (fig. 6).

This method is convenient for showing combined coverage of several lookouts (fig. 7). Composite pictures were made with up to 17 lookouts by bringing the whole district area into camera focus, and flashing succeeding lookout pivots without changing film.

This method has not been tried for charting the seen area of an air patrol path, but it is possible that wire tracks can be mounted on the map to represent the course and height of the patrol plane, and that light can be moved along the wire for progressive exposures. Such a method might aid in determining course and altitude in flight plans.

WINDSPEED AND THE PROBABILITY OF FIRE OCCURRENCE

Ralph M. Nelson, *Research Forester,*
Southeastern Forest Experiment Station

An Ignition Index is one of the indexes proposed in the National Fire Danger Rating System. It is questionable whether or not windspeed should be included as a variable. Supposedly, the number of man-caused fires should increase with an increase in windspeed. To check this supposition, analyses were made of several protection units in the East and South (table 1).

The r^2 column in the table refers to the percentages of variance in fires per day that can be attributed to windspeed. The maximum variance was 11.2 percent in New Jersey's Division B. Although the true effect of windspeed was partly masked by unknown changes in risk, the measured effect in terms of percent of variance was not great, considering the range of windspeed in all of the six areas.

Table 1.—*Relation of windspeed to number of man-caused fires*

Area	Period	Days	Fires	Range in windspeed	r^2°
		No.	*No.*	*M.p.h.*	
Georgia, District 4	Jan.–Apr. 1961–63	94	1,221	2–19	0.010
Georgia, District 6	Jan.–Apr. 1961–63	138	401	0–19	.060
New Jersey, Division B	Mar.–Apr. 1959–63	109	912	4–20	.112
New Jersey, Division C	Mar.–Apr. 1959–63	109	1,161	4–29	.083
Rhode Island	Spring cured 1951–60	90	337	1–32	.021
Virginia, District 2	Mar.–Apr. 1959–63	113	1,112	2–21	.048

°r^2 — Coefficients of Determination — the percentage of variance in fire occurrence attributed to windspeed.

In order to minimize error resulting from variability in fuel moisture, only days having estimated fine fuel moistures of 6.5 percent or less were considered. Fuels were highly flammable on all these days. Depending on the area, different methods were used to calculate fuel moistures. These included use of basswood slats, measurement of air temperature and dewpoint, and determination of air temperature and wet-bulb depression.

Also depending on the area, windspeeds were taken from well-operated standard fire danger stations or from airport exposures corrected to a 20-foot standard.

It was impossible to eliminate the effect of risk—the activity of fire starters.

Thus, windspeed apparently had little effect on fire occurrence.

There was much scatter of points about regression lines for each area, but the slope was upward except for the two districts in Georgia. In District 6, the number of fires decreased as wind increased.

The reasons for the differences between protection units in New Jersey and Georgia are not clear. Perhaps the predominantly rural population in the Georgia areas, although careless at times with fires, is more aware of the danger in burning debris and in otherwise starting fires when windspeed is high.

Based on this analysis, windspeed would be a minor variable in an Ignition Index for the East and South and might well be omitted.

The article "The Forest Fires of April 1963 in New Jersey Point the Way to Better Protection and Management," *Fire Control Notes,* July 1964, contained an error. The first sentence of the final paragraph of page 4 should be: "More recent burns that left some surface fuel remaining only reduced the damage, but others that removed nearly all the fuel *did* stop the fire." The authors wish to make clear that relatively clean burns in the year before April 1963 stopped both strong head fires and flank fires, and enabled far better control by ground crews.

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Vortex Turbulence—*Continued from page 6*

only two or three on forest fires. However, what is known about the vortex and about fire behavior can lead to some pretty good guesses.

Because wind tends to break up the vortex and is normally accompanied by much natural turbulence, the chances are that vortex turbulence will probably be noticeable only on a calm day. Not only will the vortex wake be stronger on quiet days, but because the fire will usually be spreading slowly, the sudden air turbulence will be even more unexpected and potentially serious.

On the ground, the effect of vortex turbulence will be felt as a sudden gust which may last only a few seconds or for up to half a minute. In litter, grass, or light brush the result will be a sudden but brief flareup or increase in local fire intensity and rate of spread. In heavy timber or brush fuels with a continuous overstory, vortex turbulence will usually not reach the ground and so will have no noticeable effect on fire behavior.

In patchy fuels, where timber or brush is interspersed with open grassy areas, the effects of vortex turbulence may be extremely serious. Although the vortex wake will not reach the ground beneath a timber canopy, it may in the openings. Because the core usually remains above ground, the true wind direction at the surface is not parallel to the ground but slightly upward (fig. 4). Thus both flames and burning embers tend to be swept upward as well as out. Thus vortex turbulence, compared with a natural gust of the same velocity, has a greater potential for triggering crowning and spot fires because flames and embers are driven up into the crowns.

The most serious situation is calm air on the ground but a light, steady wind aloft. Under these conditions the vortex may be carried far from the aircraft to strike the ground in an unexpected location, with ember showers being moved over long distances by the upper winds. Only rarely would one encounter a fire in patchy timber and brush under precisely these weather conditions; yet this was apparently the case on one well-documented fire in California in 1962.

Summary

Vortex turbulence consists of a pair of miniature whirlwinds trailing from the wingtips of any aircraft in flight. The more heavily loaded the aircraft, and the lower and slower it flies, the stronger the vortex turbulence will be and the more likely to reach the ground. The vortex will be in the form of a horizontal whirlwind with velocities up to 25 m.p.h.—sufficient to cause sudden and violent changes in fire behavior on calm days in patchy fuels.

Wind, gustiness, and surrounding high vegetation will tend to break up or diminish vortex intensity.

The fire crew should be alert for trouble when:

1. The air is still and calm.
2. The fire is burning in open brush or scattered timber.
3. The air tanker is large or heavily loaded.
4. The air tanker is flying low and slow.

The air tanker pilot should be aware of the problem his aircraft can cause. He may know the effect of vortex wakes on his or other aircraft, but may not know the effect on a fire. He can abide by the following rules during situations of possible danger from vortex wakes:

1. Don't fly parallel to the fireline more than necessary.
2. Keep high except when making the actual drop.
3. Ensure that ground crews are alert to the presence of the air tanker and the pilot's intentions.

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FIRE CONTROL NOTES

U.S. Department of Agriculture
Forest Service

FIRE CONTROL NOTES

A quarterly periodical devoted to forest fire control

CONTENTS

Please submit contributions through appropriate channels to Director, Division of Fire Control, Forest Service, U.S. Department of Agriculture, Washington, D.C. 20250. Articles should be typed in duplicate, double space, and with no paragraphs breaking over to the next page. Elite and pica copy should be 54 and 45 spaces wide, respectively.

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 organization.

Authors are encouraged to include illustrations with their copy. Illustrations, whether drawings or photographs, should have clear detail and tell a story. Only glossy prints or India ink line drawings are acceptable. Captions for illustrations should be typed in the manuscript immediately following the paragraph in which the illustration is first mentioned, the caption 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 caption 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.

***Cover:* Native weather observer at Canyon Village, Alaska, aids fire control agencies by making observations in a remote area. See story on page 6.**

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

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CAN GLASS AND METAL CONTAINERS START FOREST FIRES?

D. M. FUQUAY and R. G. BAUGHMAN, *Research Meteorologists, Northern Forest Fire Laboratory*

Most forest fires are related to the activities of man — industrial operations (milling, logging, and railroading), careless smoking, indifferent use of fire by the camper, and arson. Natural causes include lightning and spontaneous combustion. A few even have started by falling aircraft, rockets, and guided missiles. But are there less obvious causes of ignition in the forests?

Glass jugs and cans have been found at the source of forest and grass fires. Could these glass and metal containers start a forest fire by simply concentrating sunlight? The answer is definitely "yes" — but not in the manner most commonly supposed.

Broken kerosene and gasoline jugs occasionally found near the origin of forest fires have led to speculation that the volatile liquids were directly heated by the sun until gas pressure broke the container, and the liquid spontaneously ignited. This explanation is unsatisfactory because these volatile liquids cannot be heated to their autoignition point by direct sunlight. Besides, water jugs also are believed to have started fires. *However, another physical explanation is plausible: the capability of any transparent container, full or partially filled with a clear liquid, to form an optical lens and focus the sun's rays onto combustible materials.*

Forest fire researchers have long wondered whether containers could start forest fires. In 1946, Gisborne attempted to cause ignition in grass by scattering bottles and bits of broken glass in an open field. Apparently he was not successful. MacTavish (1960)[1] recently reported that a Canadian forest fire research party, after finding several exploded cans in burned areas, examined the ability of aerosol cans to ignite light fuels. The cans originally held ether for starting cold engines. The Canadians decided that the cans were not heated to the point of explosion by direct sunlight after they found they could ignite punky wood by reflecting sunlight from the shiny concave bottom of an aerosol can. However, Dempewolff (1964)[2] reports that aerosol containers, especially those for the new highly volatile ether engine-starting sprays, have exploded in closed automobiles under a hot sun, where temperatures readily soar above 150° F.

We repeated the Canadians' tests by igniting woody fuels with solar energy reflected from the bottoms of common aerosol cans. We also ignited various woody fuels and pine needles by using glass containers filled or partially filled with water to concentrate the sun's rays.

A can ignites a fire differently from the way a bottle does. The spherically concave bottoms of cans *reflect* and focus the sun's rays at a point near the center of curvature of the reflector (fig. 1). Nearly all cans can be bent or deformed to make a similar reflector. Light rays passing through a bottle containing a clear liquid are *bent* or *refracted* so that they focus beyond the bottle (fig. 2). The effect is similar to that produced by a common reading glass. Because of the compensating effect of refraction at the four air-glass interfaces, there is very little convergence of sunrays that pass through an empty glass container. To focus sunlight, a vessel must contain a reasonably clear liquid having an index of refraction approximately the same as its own. Water, kerosene, gasoline, and many other liquids meet this requirement.

Figure 1.—Concentration of sunlight by the bright concave bottom of an aerosol can.

[1] MacTavish, J. S. A new worry in forest fire control. Timber of Canada. June 1960.

[2] Dempewolff, Richard. Those handy aerosols can be dangerous. Popular Mechanics. March 1964.

Figure 2.—Sunlight concentrated on a tree trunk by a gallon jug filled with water.

We used aerosol cans to start fires by reflecting sunlight from the bottom of a can onto a piece of woody material about 1 inch away. Cans with shiny surfaces invariably started smoldering fires within a few seconds. The ignition capabilities of liquid-filled containers shown in figure 3 were examined by holding fuels near the focal point of the refracted light. The concentrated sunlight from some of the bottles cause ignition of dry pine needles within a few seconds. Th needles smoked, but no open flames were observe between ignition and complete degeneration to ash Cans and bottles both started smoldering fires i punky wood.

After determining that cans and bottles could star fires, we used the following laboratory method t determine the relative ability of each container t concentrate light rays. A collimated beam from a 1 mm. motion picture projecter simulated parallel ligh rays from the sun. A type B2M photocell measure the intensity of light falling on the container and th maximum intensity near the focal point. The relativ intensity factor was defined as the ratio of the maxi mum refracted or reflected intensity to the inciden intensity. The results are summarized in table 1.

The gallon jug (number 1) and aerosol cans (num bers 2 and 3) ignited pine needles in less than 1 seconds on a clear summer day. In sunlight passin through a Thermopane window in late October, bot tles 1 and 4 and aerosol cans 2 and 3 ignited punk wood. The ignition ability should be much greate in direct summer sunlight. The ignition occurre whenever a container had a relative intensity rati

Figure 3.—Bottles and aerosol cans tested for fire-starting capabilities.

TABLE 1. *Relative intensity factor and ignition ability of containers*

Container[1]	Maximum relative intensity ratio (lab test)	Caused ignition in sunlight		
		Yes	No	Not sufficiently tested
1. Glass jug	28	X		
2. Pressure can (bright)	22	X		
3. Do	20	X		
4. Rose bowl	14	X		
5. Fish bowl	12			X
6. Pressure can (dull)	11		X	
7. Syrup bottle	7		X	
8. Do	6			X
9. Dressing bottle	6			X

[1] Container numbers refer to correspondingly numbered containers in figure 3.

greater than 11. A colored glass gallon jug and aerosol can with a dull concave surface (number 6) failed to ignite woody fuels in direct summer sunlight: the intensity ratio of this can was only about one-half that of a similar can with a shiny surface.

We concluded that aerosol containers and liquid-filled jugs and bottles can start fires in forest fuels by concentrating sunrays. When bottles or cans are found in burned areas, the fire may have been started by refraction or reflection of the sun's rays; rupture of containers is the result of fire, not the cause. The probability of any given glass jug or metal can starting a fire is almost impossible to predict because of the interaction of several factors: Container location and orientation, fuel distribution and condition, and weather.

Fires from these sources could be reduced by putting a dull finish on cans or by allowing only colored glass jugs in forested areas. One thing is certain—the absence of glass and metal containers from woods and grasslands would lessen the probability of fire occurrence.

A COMBINATION POCKET METER FOR WINDSPEED AND DIRECTION

GEORGE R. ELLIS, *Fire-Weather Forecaster, U.S. Weather Bureau, Los Angeles*

The Dwyer wind meter (fig. 1) can be easily attached to a small automobile-type compass so an observer can simultaneously determine windspeed and direction. The usual compass mounting arm assembly is replaced by a pair of metal clamps about 2 inches long. The clamps are bent inward and adjusted to hold the lower end of the meter snugly. Such a bracket can be made fairly easily from heavy-gage sheet aluminum.

Since the user of the Dwyer meter faces into the wind to obtain a maximum reading, the compass will indicate the magnetic direction from which the wind is blowing. The compass reading should be corrected for the magnetic declination of the local area. This reading is accurate enough for fire-weather observations.

This device is convenient for field use since it eliminates the necessity of taking out a pocket compass every time a wind-direction reading is needed. The combined instrument can be hung from a hook on the belt.

Figure 1.—The Dwyer wind meter attached to a small automobile-type compass.

SKY FIRE IN ALASKA — SUMMER 1964

F. D. Paxton, *U.S. Weather Bureau, Anchorage, Alaska*
L. D. King, *Bureau of Land Management, Anchorage, Alaska*

1964 Fire Season

Alaska had its lightest fire season on record in 1964. Only 160 fires occurred in a State with 225 million acres of forest, range, and tundra land to protect (fig. 1). The 65 fires caused by lightning burned just over 3,300 acres.

However, 1964 represented a potentially critical fire season because rainfall was below average for both June and July. The July 1964 average of only 0.99 inch created a highly volatile situation.

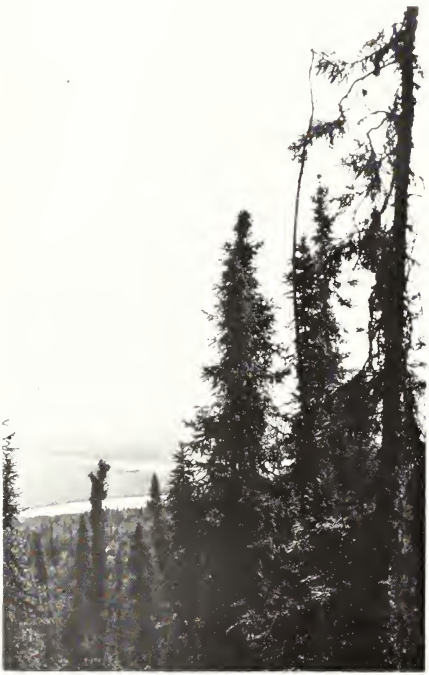

Figure 1.—Timbered southwest slopes, Brooks Range, Alaska (summer 1964).

Earlier Fire Seasons

In many previous years, millions of acres have burned. In 1957 the State suffered a burn of 5,340,-554 acres. About 1 to 5½ million acres have burned at least seven times since 1940. Before records were kept, it can be conservatively estimated that an average of about 1 million acres burned each year.

Hardy and Franks[1] state that 80 percent of the forest lands in interior Alaska has burned during the past 70 years. An observer flying over this vast area can easily see the marks of recent and ancient burns. The areas burned and restored through time again become possible sites for extensive fires.

Alaskan Thunderstorms

The thunderstorm season in Alaska normally begins about May 1 and ends about October 1. Most Alaskan thunderstorms occur during the long summer days when interior areas become relatively warm and dry. Such prolonged heating is conducive to thunderstorm activity. These are "air mass" thunderstorms. Frontal, orographic, and squall line storms do occur in Alaska, but they are not as common or difficult to forecast.

Organization

New observation stations in remote areas were used during the 1964 summer season (fig. 2). Inhabitants of these areas were trained, and they proved to be diligent observers (fig. 3).

The fire-weather forecasting assistance provided by the Weather Bureau has already been beneficial to the fire control system of the Bureau of Land Management. Forecasting the occurrence of thunderstorms capable of creating lightning which cause fires, and forecasting surface winds and other weather conditions once a fire has begun are of prime importance in aerial inspection of potential fire sites and in fire control.

Working in the Bureau of Land Management communications center at Fairbanks, the Weather Bureau

[1] Hardy, Charles E., and Franks, James W. Forest Fires in Alaska. U.S. Forest Serv., Intermountain Forest and Range Expt. Sta. Res. Paper INT-5. 1963. 163 pp.

forecaster and Bureau of Land Management fire control personnel quickly became aware of the operational techniques of the other agency. To insure immediate consideration of pertinent weather information, two teletype circuits were installed. One provided a direct contact with major Bureau of Land Management fire stations and the Weather Bureau's main forecast office in Anchorage. The other provided aviation weather information from statewide Weather Bureau and other reporting units. Fire control personnel always had up-to-the-minute fire weather information and forecasts. This organization provided several important operational benefits. During the normal working day, field personnel needed only to establish radio contact to discuss weather conditions with a forecaster. During morning planning of patrol

Figure 2.—Local observer at Kobuk, Alaska, measuring precipitation (summer 1964).

Figure 3.—Native observer at Canyon Village, Alaska (summer 1964).

flights, the pilot, fire control personnel, and the forecaster were able to meet personally and analyze projected weather conditions. This saved invaluable flight hours and permitted an aircraft to be above the area of greatest fire potential on a given day. In addition, as weather conditions changed, it was only minutes before a patrol flight could be re-oriented to meet a new threat.

Summary

We attribute much of our below normal burned area to good planning. Better communications, more observations, quicker on-site inspections, and more effective use of fire weather forecasts all were partly responsible. Planning for the 1965 season will be expanded and will include some more innovations.

50 YEARS OF FIRE WEATHER SERVICE

ALICE J. SVORCEK, *Secretary*
U.S. Weather Bureau
Missoula, Mont.

Introduction

The destructive 1910 forest fires in the Pacific Northwest made the public and fire protection people much more aware of the great need for improved protection. A key requirement was better information on weather.

In 1911, Congress passed the Weeks Act, which included a provision for Federal aid to forest protection groups. In the spring of 1913, the U.S. Forest Service and Western Forestry and Conservation Commission asked the Weather Bureau to begin a study of meteorological conditions conducive to conflagration in Washington and Oregon, and methods of forecasting these conditions. The Weather Bureau then arranged for additional weather reports from British Columbia. For the 1914 fire season a warning system was initiated for Washington, Oregon, Idaho, and California. Forecasts for Washington and Oregon were issued by the district forecaster at Portland, Oreg., and for Idaho and California by the district forecaster at San Francisco. These efforts marked the beginning of specific meteorological help to fire control agencies by the Weather Bureau.

Fire Weather Service: Formation and Growth

The Fire Weather Service was officially established as a separate forecasting service of the Weather Bureau on April 10, 1916. Forest areas where serious fires were likely to occur were studied, and a cooperative plan for providing weather reports from stations in these areas was initiated by Weather Bureau and Forest Service officials.

The West

Abnormally dry forests in California, Oregon, and Washington in early 1924 prompted emergency preparations for the fire season. The Forest Service and forestry associations of Washington and Oregon offered financial assistance to the Weather Bureau for the assignment of meteorologists to study weather conditions and to issue local forecasts. Meteorologists George W. Alexander and Charles I. Dague were the first fire weather forecasters assigned to Seattle, Wash., and Portland, respectively. California fire weather forecasts were issued by San Francisco District Forecaster E. H. Bowie. The first fire weather forecasts under the new arrangements were issued August 1, 1924.

Offices were established in the 1930's at Boise, Idaho, Missoula, Mont., and Mt. Shasta and Pasadena, Calif.; the Boise office was later moved to Spokane, Wash. During the 1940's the Boise office was reopened, and subdistrict offices were added at Pendleton, Oreg., and Olympia, Wash.

One great problem of the Fire Weather Service was sending the forecast and its interpretation to the firefighters in the field. The idea of using mobile units to provide on-the-fire weather information is credited to Leslie G. Gray. Gray, a fire weather meteorologist at San Francisco, assembled the first mobile unit in 1928, using a truck which he equipped with a two-way radio, meteorological instruments, and facilities for charting weather data. This original model was placed at Pasadena. He adapted four more large trucks for the Weather Bureau in 1936. These were placed at Missoula, Seattle, Portland, and Mount Shasta.

The East

The first organized fire weather warning service in the Eastern States began in 1924, in cooperation with the Connecticut State Forest Fire Warden. In 1925, service was extended to include the remaining New England States and the Adirondack section of northern New York. Forecasts were issued from New Haven for Connecticut and from Boston for the remainder of New England. Forecasts for the Adirondack region were issued from Albany, N.Y.

The South

Service in the South began in the winter of 1932-33. Forecasts were first issued from the Asheville, N.C., Weather Bureau office in the spring of 1933 for a limited area of the southern Appalachians.

New Plan Becomes Necessary

Several stations had integrated forecasting programs by the 1950's. The duties of fire weather men on these stations were too varied to permit them to keep pace with growing fire control programs. A firm foundation and guide was needed for the Fire Weather Service.

1961 Plan for Fire-Weather Service Expansion

Early in 1961 a "National Plan for Fire-Weather Service" was jointly developed by the Weather Bureau and U.S. Forest Service in cooperation with other fire control agencies. The plan proposed more intensive service to meet the needs of all fire protection agencies, and it is gradually being implemented as funds are made available.

Adoption of this plan resulted in establishment of new fire-weather offices at Albuquerque, N. Mex., Phoenix, Ariz., Reno, Nev., Denver, Colo., Medford, Oreg., Wenatchee, Wash., and Fresno, Sacramento, and Eureka, Calif., in the West; St. Louis and Houghton Lake, Mich., in the Midwest; and Fort Smith, Ark., Raleigh, N.C., Jackson, Miss., Shreveport, La., and Montgomery, Ala., in the South; Beckley, W. Va., in the East; and Anchorage in Alaska. Staff additions have been made at 12 other offices.

Under the new National Plan, 18 mobile forecasting units were acquired late in 1961. These are camper units mounted on pickup trucks. Each camper is equipped with radio, facsimile, and modern meteorological instruments. Normally, one mobile unit is dispatched to each project fire. However, three of these units provided weather forecasts and information to several protection agencies at the huge Nevada brush fires in August 1964. In September 1964, four units gave up-to-the-minute weather information to fire bosses on the California fires.

To meet the prime objective of the National Plan — that of providing detailed advisories for fire control and forest management activities — several important tasks remain:

A. The Fire Weather Service needs a vigorous research program.
B. Communications must be improved in many areas to facilitate an exchange of information between fire control people and meteorologists in the field units and at base stations.
C. Operating plans and forecast formats need to be standardized.
D. The manpower to carry out the National Plan must be assigned to the fire program and trained in the specialized problems encountered by the fire weather meteorologist.

The National Fire Weather Plan provides a mutual charter for the Weather Bureau and fire control agencies, and when it is fully implemented it will greatly benefit the American people by saving money and resources.

NORTHWEST OREGON AND CYCLISTS REACH UNDERSTANDING

Adapted from THE FOREST LOG, *State of Oregon, Department of Forestry, Salem, Oreg., November 1961*

Motorcycles are a primary fire hazard when operated in dry forest fuels, and they aggravate soil erosion problems in steep terrain during the rainy season. They are of year-round concern to the forest land manager, and this activity is gaining popularity.

Increasing use by motorcyclists of the mountainous terrain in the Tillamook burn has resulted in the need for an agreement between local foresters of the State Forestry Department and the major motorized organizations utilizing the area. The presence of about 250 to 300 motorcyclists from the Portland-Beaverton-Gresham area and outlying points devoted to hill climbing, trail riding, and racing over the firebreaks and roads in the rough back country has necessitated the development of some ground rules.

A special system known as "Class of Riding Day" has been in operation for over a month with good results. Green, yellow, and red classes of riding days have been designated, with current conditions posted at Forest Grove, Tillamook, and Lee's Camp.

The green permits riders to travel throughout the burn on State forest lands except on dirt roads and steep firebreaks that are wet.

The yellow indicates restrictions on the use of certain areas of high fire hazard or excessive resistance to control of fire and requires the clamping of screen wire over the vehicle's exhaust outlets.

A red day means that no riding is permitted anywhere in the burn.

When the burn is covered by a permit closure, the cyclists are under the same obligation as the rest of the public to obtain an entry permit.

SOUTHERN FOREST FIRES: A SOCIAL CHALLENGE[1]

GEORGE R. FAHNESTOCK, *Research Forester, Southern Forest Experiment Station*

The Problem

Annually, the 11 Southern States have half to four-fifths of the forest fires and roughly the same proportion of the area burned in the Nation, excluding Hawaii and Alaska. The 169,500 fires in 1950 were the most since World War II, and in 1947 a record 21 million acres burned. In 1957, the easiest year in history, 44,100 fires burned 2.2 million acres. 53 and 65 percent of the respective totals for the United States. Based on estimates, the South should supply 55 percent of the country's current and future timber demand (fig. 1). In 1952, a moderately bad year, fire losses were 5.8 billion board feet of sawtimber, equivalent to nearly a billion dollars' worth of finished wood products. In addition, fire destroyed 1.4 million cubic feet of growing stock — small trees representing much future productivity. The region's timber economy cannot tolerate such losses, and the productivity of forest land is greatly reduced.

More than 98 percent of the South's forest fires are caused by people, but the protection effort, including research, has been focused on the fires, not the people. Since the end of World War II the South has made great advances in fire control. About 90 percent of all forest land is now under organized protection (compared with less than 50 percent in 1945). Early detection and prompt attack using improved methods and machines have reduced the average fire size on protected land by one-half. But a downward trend in the rate of occurrence has not been apparent.

Figure 1.—Fire-damaged timber on the Osceola National Forest, Fla.

History

Fire always has been a factor in the development of southern forests. Before the coming of man, lightning caused occasional fires that spread over wide areas. Later the Indians used fire to drive game and to reduce the density of undergrowth.

Early white settlers in the South had to clear the forest and keep it in check; the easiest possible means was burning. They readily adopted the Indian method of burning unwanted brush to "green up the range" for domestic livestock. Indiscriminate burning was encouraged by low land and timber values, destructive timber exploitation followed by tax delinquency of cutover lands, absentee ownership of large blocks of land for mineral speculation, need for livestock range, and many other economic factors. The necessity for fire protection has increased with enlargement of the density of settlement, demand for a sustained yield of forest products, and use of the forest for recreation.

Research

In 1938, the Forest Service started an attempt to determine the roots of the fire-prevention problem through psycho-sociological studies in several areas with a high incidence of man-caused fires. Social scientists interviewed rural inhabitants and observed their folkways; some of the interviewers subsequently recommended fire-prevention practices. Today not many people are familiar with Kaufman's report on the Clark National Forest, Anderson's on the Deerlodge, Curtis's on the Cumberland, and Shea's summations of the three; Shea's separate report on the Talladega; or Weltner's studies of the Apalachicola, Kisatchie, Bienville, and DeSoto.

From the investigations he conducted or supervised, Shea, a psychologist, concluded that fire-setting was largely an expression of the social frustrations of an isolated rural population with low income. He emphasized the personal pleasure derived from starting fires or watching the woods burn. Shea suggested that the Forest Service obtain the confidence of the people by providing recreational outlets for their frustration.

Weltner, a sociologist, attributed incendiarism more

[1] Presented at the national meeting of the Rural Sociological Society, Washington, D.C., August 1962.

to disruption of the existing socio-economic structure. For example, he pointed out that in much of the rural South physical wealth and social leadership were measured in terms of the number of cows owned, and proper management of cattle was thought to require range burning. Therefore, the community leader with many cattle often was the leading woodsburner. Weltner recommended improving personal relations, communication and general cooperation between protection agencies and the rural population.

Weltner's and Shea's work undoubtedly has influenced protection agencies and forest users, although Shea's major thesis was not acceptable to foresters.

The other investigators also indicated the many ways in which fire was related to the rural culture. In general, they concluded that fire entered and remained in the Southern rural culture largely for economic reasons, but that a complicated interplay of social and psychological forces brought about the present wide variety of uses of fire and attitudes toward it.

Prevention research ended when World War II started, and action has revived only recently. An exploratory study in Mississippi in 1958 and a more exhaustive one in Louisiana in 1961 have shown that the same factors are responsible for patterns of fire occurrence. The problem has changed little in nature or magnitude in 25 years.

The Job Ahead

The following major steps in fire prevention research must be taken. These steps are listed about in sequence, but two or more may be in progress concurrently.

Measure the physical problem.—Fire occurrence varies amazingly with location. For example, Grant Parish, La., averaged 180 fires per million acres annually from 1956 through 1960, while Livingston, an apparently similar piney-woods parish, had more than 2,400. Weather largely determines when fires will occur in a given location. A system of fire danger measurement is in effect South-wide and can be used to account for the weather variable in comparing fire occurrence rates between areas and periods of time. Forest type, soil, topography, population density, and other factors interact to influence geographic and chronological patterns and intensities of fire occurrence. The physical problem must be clearly defined before priorities for and the nature of further work can be decided (fig. 2).

Study the psycho-sociological problem.—State forest fire control chiefs have enumerated 37 types of people who start fires in 45 ways for 125 reasons. Although some of the separate entries in each of these categories probably could be grouped, additional distinctive entries could be found to take their places. One could almost conclude that fires in the South start in every possible way and for every conceivable reason. Of course, the situation is not that simple—or not that complicated, depending on how you look at it.

A distinctive characteristic of fire occurrence in the South is the large number of incendiary fires, i.e., those set on purpose to burn over the land of another. There are a wide variety of reasons; many of these are technically sound and would be acceptable if the individual obtained permission for setting the fire, chose the proper time to burn, and controlled the extent of the burned area.

The South, like other parts of the country, has many fires that are due to carelessness in various circumstances. The chief cause is debris burning, which includes such diverse activities as burning trash in the dooryard and discarding large piles of dead vegetation in clearing land. The burner does not intend to let the fires get away, but many do. The persistence of fires attributable to carelessness reflects considerably the same social factors that nurture incendiarism, notably a type and degree of public tolerance that makes the fire-setter hard to catch and even harder to convict.

Obviously, we need to understand the basic attitudes and practices of the people who start the fires. General knowledge on this score is pretty good, but it must be identified much more reliably with specific localities, population groups, and even individuals. It also will be necessary to understand the broader implications of public opinion, the ambient climate that tells whether sympathy will be for or against the fire-setter.

Find out what constitutes effective influence.—How can people be persuaded to exchange old practices for new ones? Specifically, how can the fire-setters be made law abiding; the careless, more heedful; the irresponsible, more cognizant of values and the rights of others? Largely, we don't know how to communicate with our worst fire risks, that is, how to speak their language.

Once communication is established, the problem is to motivate. Research must find out what incentives will be most productive of the desired results. The

Figure 2.—Firelighters build a fireline on the Cherokee National Forest, Tenn.

advertising industry annually contributes invaluable knowledge and services to promote fire prevention through mass propaganda. Perhaps as pertinent in the South, however, are the sociologists' findings concerning the acceptance of new agricultural practices. The so-called "diffusion process" should work with firesetters, once effective motivation is discovered.

Fire prevention undoubtedly faces a major obstacle in that the impetus still comes from protection agencies rather than from the people of the grassroots. Badly needed is a means of enlisting the general public in active opposition to uncontrolled fire. Effectiveness of existing methods and media must be analyzed and evaluated impartially. The goal is the challenging one of learning how to persuade people to act for their own good in the face of indifference and of contrary, cherished customs (fig. 3, p. 16).

Design prevention systems.—The prevention studies of the late 1930's and early 1940's stopped with the writing of recommendations. A coordinated prevention effort embodying the new ideas did not develop, although sporadic beneficial changes in policy and practice did occur. Future research on fire prevention must offer a bridge for the gap between factfinding and action. This means participation in all phases of system design, including determination of priorities, establishment of goals, selection of techniques (also development of new ones), and assignment of responsibility.

Research and action agencies must cooperate closely. And from this need to cooperate arises another problem for the social scientist — some foresters do not realize that they need special techniques for dealing with people just as they do in accomplishing the physical jobs of forest management. More than one otherwise progressive forester has opposed fire prevention research on the grounds that we already have the know-how and need only apply it.

(Continued on page 16)

LIQUID PHOSPHATE FIRE RETARDANT CONCENTRATES

R. W. JOHANSEN[1] and G. L. CROW[2]

Introduction

Fire control organizations and suppression methods used to combat forest fires in the Southeast have improved rapidly since the time when only handtools and pine boughs were used. Most wildfires can now be successfully combatted by using current detection methods and tractor-plow units and ground tankers. But the few fires that become large account for most of the area burned. In Georgia, during 1954-56, 1 percent of the fires accounted for more than 90 percent of the area burned.[3]

The best method of preventing conflagrations is to suppress fires while they are small. This requires early detection and quick, effective control action. About a decade ago, Operation Firestop proved that the use of aircraft could appreciably increase area accessibility, and thereby reduce the time between detection and an early, adequate attack.

Early Retardants

The first retardant used in air tankers was sodium calcium borate. However, in 1959, tests in Georgia showed conclusively that ammonium phosphate solutions were superior to borate on the fine forest fuels in the Coastal Plains.[4] Later studies in California indicated that thickened diammonium phosphate (DAP) solutions performed satisfactorily on western fuels.[5]

Initially, solutions of diammonium phosphate were of a 15 to 18 percent concentration (about 8 percent P_2O_5) made from dry salt crystals. Their use required physical handling of the salt, as well as mixing tanks and pumps for recirculating and transferring the liquid from the mixing container to an air tanker or holding tank.

[1] Research forester, Southern Forest Fire Lab., Southeast. Forest Expt. Sta., U.S. Forest Serv., Macon, Ga.

[2] Metallurgical engineer, Tennessee Valley Authority, Wilson Dam, Ala.

[3] Davis, Kenneth P. Forest fire control problems and research needs in Georgia. Ga. Forest Comm. and Southeast. Forest Expt. Sta. 1957.

[4] Johansen, R. W. Monoammonium phosphate shows promise in fire retardant trials. U.S. Forest Serv., Southeast. Forest Expt. Sta. Res. Note 137. 1959.

[5] Dibble, Dean L. Roadside hazard reduction with fire retardant chemicals. U.S. Forest Serv. Pacific Southwest Forest and Range Expt. Sta. Res. Note PSW-N-21. 1963.

Liquid Phosphate Concentrates

In 1961 representatives of the U.S. Forest Service met with Tennessee Valley Authority personnel at Wilsom Dam, Ala., and discussed the possible use of liquid phosphate concentrates in lieu of the dry salt. Preliminary evaluations at the Southern Forest Fire Laboratory indicated that retardant solutions made from liquid phosphate concentrate are about as effective as those made from DAP salt. These evaluations have been substantiated by operational trials in the South.

In 1962 the Forest Service contracted for air tankers on a trial basis in the southern Appalachians. A liquid ammonium phosphate fertilizer (11-37-0 grade), manufactured by the Tennessee Valley Authority from ammonia and superphosphoric acid,[6] was used as the base retardant. The correct quantity of this liquid concentrate was metered directly into the aircraft, and then water was added for dilution to the desired concentration of 8 percent P_2O_5. Except for pumping the liquid, agitation was not required, and most of the manual handling was eliminated. In addition, the trial drops made on wildfires met with undisputed success.[7]

Composition of concentrate

The phosphate in the liquid concentrate being manufactured by the Tennessee Valley Authority at Wilson Dam, Ala., is present as ortho- and polyphosphates in about the following percentages.

Pyrophosphate, 19
Orthophosphate, 28
Tripolyphosphate, 17
Other (mainly tetrapolyphosphate), 6

This material has a fertilizer designation of 11-37-0 and sometimes is referred to as "Pyro." When one part by volume of concentrate is mixed with five parts of water, the N-P_2O_5-K_2O percent is about 2.4-8-0 and the solution has a phosphate equivalent (P_2O_5) of 8 percent. This phosphate equivalent is the same as that in a 15-percent DAP solution prepared from dry

[6] Slack, A.V., and Scott, W.C. Developments in high analysis liquid fertilizers. Commercial Fert. 105: 21-26. November 1962.

[7] Spring, John B. The southern Appalachian air tanker project. South. Lumberman 205(2561): 166. 1962.

[8] Spring, John B. Chemical retardants in fire control. Forest Farmer 23(5): 6-7. 1964.

salt, which has an $N-P_2O_5-K_2O$ percent of 3.2-8-0. Both provide successful results when applied on forest fuels in the Southeastern States.

Other available concentrate forms are designated as 10-34-0 and 8-24-0. The 10-34-0 is produced commercially from ammonia and wet process superphosphoric acid, and the 8-24-0 from ammonia and ortho- (regular) phosphoric acid. To obtain an 8 percent phosphate equivalent solution with 10-34-0 and 8-24-0, 1 gallon of concentrate would be mixed with 4.45 and 2.5 gallons of water, respectively.

The amount of salt that ultimately adheres to a forest fuel can be partially controlled in two ways: (1) the solution concentration can be altered by regulating the amount of salt per unit volume of water, or (2) the solution viscosity can be increased, resulting in a buildup of film thickness on forest fuels. In certain instances, i.e., when heavy litter fuels are treated, use of unthickened solutions or those with reduced surface tension may be necessary to obtain adequate penetration. The amount of salt adhering to any aerial fuel, however, would be maximized by treatment with a saturated solution thickened with a compatible thickener to the highest viscosity that would still disperse evenly when dropped from an air tanker or pumped from ground equipment.

Thickening and coloring phosphate solutions

Thickened mixtures are desirable for increasing salt retention on fuels and for carrying color. A mixing tank or an eductor in a pressurized waterline can be used to mix certain industrial gum or clay thickeners in any of the phosphate solutions. The final viscosity increase is frequently influenced by the form of parent material used to make the phosphate solution, as well as by the thickening agent (table 1). When mixed with Keltex FF and CMC-7HS, an 8 percent phosphate equivalent solution made from 11-37-0 concentrate will thicken less than one made from dry diammonium phosphate (DAP) salt. In contrast, J*aguar* 307 and Polysaccharide B-1459 developed higher viscosities in solutions made from 11-37-0 than those made from DAP. When bentonitic or attapulgus clays are used as thickeners, the salt form used to make the retardant solution has no effect on the final viscosity.

Attempts have been made to add a thickening agent at the source of manufacture that would yield viscosities adequate for covering heavy fuels even after the concentrate has been diluted 5:1. This procedure would eliminate the need for mixing tanks or eductors at the loading station. Unfortunately, experimentation has not been successful.

If color is desirable in the solutions, the necessary ingredients can be added to the concentrate during manufacturing. Recommendations for each 40 gallons of concentrate are 15 pounds of Attagel No. 30, 1 pound of ferric oxide, and one-half pound of Rhodamine "B" concentrate dye. When diluted 5:1 in the field, enough color strength remains so that drop or spray patterns are visible.

TABLE 1.—*Viscosities of thickened 8 percent phosphate equivalent solutions made from DAP and 11-37-0 concentrate*

Thickener	Cost	Concentration	Viscosity[1]			
			DAP		11-37-0	
			6 r.p.m.	60 r.p.m.	6 r.p.m.	60 r.p.m.
	Per pound	*Percent*	*Centipoises*[2]	*Centipoises*[2]	*Centipoises*	*Centipoises*
Keltex FF	$1.20	1	950	760	500	442
CMC-7HS	.60	1	700	470	250	180
Jaguar 307	.55	1	1,800	850	2,487	1,060
Polysaccharide B-1459	1.75	.5	3,400	540	5,300	940
Bentonite (Volclay No. 90)	.014	2	2,250	105	2,250	105
Attapulgite (Attagel No. 30)	.014	2	1,500	300	1,500	300

[1] Viscosity is a measure of the resistance of a liquid to flow or shear. The 6 and 60 r.p.m. values denote the turning rates of a spindle on a Brookfield viscometer. Differences in viscosity between the two speeds are due to differences in the reaction of the liquids to shear.

[2] Centipoise is a unit of viscosity measurement. Water and SAE 30 oil at 70° F. have values of 1 and 250 centipoises, at 6 and 60 r.p.m., respectively. The viscosity of these liquids is unaffected by differential shear.

Corrosion problems

The 11-37-0 liquid phosphate concentrate and the 8 percent phosphate solution used operationally are not excessively corrosive to mild steel or aluminum-base alloys under normal conditions of storage and use (unaerated solutions up to 80-90° F.). The concentrate usually is stored in mild steel tanks, and the tanks in aircraft carrying the retardant solution usually are aluminum. Tests made by the Tennessee Valley Authority (table 2) show that the corrosion rate of mild steel by the concentrate is only 3 to 6 mils per year, and that the rate of three aluminum-based alloys is 16 to 20 mils per year. However, with 0.1 weight-percent of sodium dichromate inhibitor in the retardant solution, the corrosion rates of two of the three aluminum alloys were only about 4 mils per year.

Because of this indicated improvement, the 11-37-0 concentrate is supplied containing 0.41 percent sodium dichromate so that the 8 percent solution will contain about 0.1 percent.

Neither the concentrate nor the solution was corrosive to copper-base alloys. Both were corrosive to magnesium alloys, however, and sodium dichromate was not an effective inhibitor.[7] This is not considered serious because (1) there is no reason for the concentrate to be in contact with aircraft parts and (2) the retardant solution may be in contact with aircraft parts outside the aluminum tank for only a very short time as the result of spray when the load is dropped. The short exposure time and the usual procedure of thoroughly washing the aircraft after each day of use minimizes the corrosion problem.

Summary

Liquid phosphate concentrates can be used advantageously in making fire retardant solutions, especially at permanent air tanker loading installations. At a cost of approximately 6 cents per gallon, f.o.b. producer, for an 8 percent phosphate equivalent solution, this retardant mix is slightly cheaper than those prepared from most dry salts. The greatest advantage of the liquid concentrate is the ease with which it can be handled. Other advantages include less need for storage space and mixing tanks, and excellent stability. Where the need for a viscous retardant solution exists, the advantages of using liquid concentrates are diminished.

[7] To prevent skin irritations, sodium dichromate corrosion inhibitors should not be permitted to contact the skin.

Table 2. *Corrosion tests of alloys in 11-37-0 concentrate and 8 percent phosphate solution made from it*

Alloy	Corrosion rate at 80° F., unaerated		
	11-37-0 concentrate without inhibitor	2.1-8-0 solution made from 11-37-0 concentrate	
		Without inhibitor	With 0.1 percent sodium dichromate inhibitor
	Mils/year	*Mils/year*	*Mils/year*
Aluminum base:			
A.S.A. 1100-H14	16	17	4
A.S.A. 2024-T3	18	26	29
A.S.A. 5154-H32	20	23	3
Copper base:			
Copper, deoxidized	<1	<1	—
Brass, red, A.S.T.M. B-36-61, alloy No. 3	<1	<1	—
Bronze, silicon, Herculoy 418	<1	<1	—
Bronze bearing, 80-10-10	<1	<1	—
Magnesium base:			
A.S.T.M. B94-58, die casting AZ91A	193	63	10
A.S.T.M. B91-60, forging, AZ31B-H23	237	12	15
Steel:			
A.S.T.M. A-285	6	8	1
A.I.S.I. C1012	3	13	1

The only thickener tested that is compatible with the 11-37-0 concentrate is attapulgus clay. The amount of clay added should not exceed 6 weight percent in order to keep the concentrate viscosity at a pumpable level. The resultant solution, when five parts of water have been added, has a viscosity of less than 200 centipoises. Generally, higher viscosities are preferred when thickened retardant solutions are needed. Although none of the dyes or pigments tried could be

(Continued on page 16)

Fire Retardant Concentrates
—Continued from page 15

dissolved or suspended in the undiluted 11-37-0 concentrate alone, coloring materials can be dispersed if attapulgus clay is also added to the mixture.

Liquid phosphate concentrates offer many advantages and no serious disadvantages when compared with dry salt, and fire control personnel should seriously consider their use. Further refinements with thickeners and coloring agents may make the use of liquid concentrates even more flexible.

Southern Forest Fires—Continued from page 12

Activate the prevention program. — This is the job of the protection agency, but research properly has a big stake in it. The first operations should be jointly sponsored pilot studies; the full-scale programs should follow. But the research job does not end here. The researcher and administrator must continue to collaborate for their mutual benefit: the former learns how his ideas are working out and obtains ideas for further research; the latter gets his questions answered and contributes valuable information on practical aspects of the job.

Finally research must continue because conditions and people change. Population pressure on forests for outdoor recreation will be an increasingly potent influence on fire and other problems. So, although the goal of fire prevention research is to put itself out of business, it looks as if it will have plenty to do for a long time.

Preplanned escape measures might save up to 85 percent of all lives lost in home fires, National Fire Protection Association studies show.

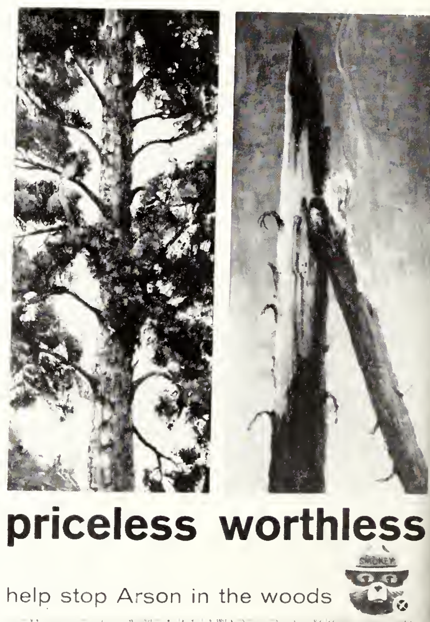

Figure 3.—Cooperative forest fire prevention material used in the Southern campaign.

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FIRE CONTROL NOTES

U.S. Department of Agriculture
Forest Service

FIRE CONTROL NOTES

A quarterly periodical devoted to forest fire control

CONTENTS

Cover—**Infrared imagery of the Gilkinson Fire, Wallowa-Whitman National Forest, Oreg., at 8 p.m., July 22, 1963. Aircraft was 8,000 feet above terrain. This imagery is transferred to aerial photos and maps to give fire bosses up-to-date information on fire perimeter, spot fires, and hot spots. See story on page 3.**

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

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INFRARED—A NEW APPROACH TO WILDFIRE MAPPING

ROBERT L. BJORNSEN, *Forester, Northern Forest Fire Laboratory,*
Intermountain Forest and Range Experiment Station

Introduction

For campaign fires, accurate and quick intelligence is needed on the location of fire perimeters and spot fires. The fire boss and his staff need this knowledge to effectively maneuver manpower, equipment, and logistical support—particularly during critical fire periods. Airborne infrared fire mapping may provide a major advance in fire intelligence.

For 3 years, personnel of Project Fire Scan, a special program of the Northern Forest Fire Laboratory, have been testing an airborne infrared scanner. The U.S. Department of Defense is cooperating in the program, and the Electronic Command, U.S. Army Material Command has supplied the infrared equipment used in a Forest Service aircraft. Because results may significantly affect civil defense, the Office of Civil Defense is providing financial assistance and technical consultation.

Airborne Infrared Mapping

Individual sorties are scheduled so the fire boss will have optimum information. As the aircraft flies over the fire area, the scanner picks up the infrared energy emanating from hot burning fuels and surrounding terrain. The energy is converted to an electrical signal that is subsequently amplified by special electronics and re-converted to a visible light signal displayed on a cathode ray tube. Polaroid photographs of the cathode ray tube are then made. The resulting thermal imagery provides clear detail of the fire perimeter, hot spots, small fires outside the main fire perimeter, and terrain features.

When a sortie is completed, the infrared imagery is placed in a plastic tube and dropped to an imagery interpreter at fire headquarters. Perimeter and spot fire intelligence is then transferred to aerial photos and maps of the fire area. The average time from the start of a sortie until intelligence is transferred to maps is 2 hours—1¼ hours of flying time plus three-fourths of an hour for interpretation of the imagery. This interval will be reduced when operational scanners can produce better imagery in less time.

Program Accomplishments

Twenty-three wildfires, ranging from a few acres to many thousand acres, were mapped by the Project Fire Scan infrared scanner during 1962, 1963, and 1964. Fuel types varied from grass in Nevada through brush in California to mature coniferous timber in Montana. Character and control status progressed from uncontrolled spotting fires to creeping fires in the late stages of mopup. Because of dense smoke, instrument flying was often required, and much useful imagery was also obtained during darkness. Figures 1 and 2 compare results obtained from normal aerial photography with those provided by use of the infrared technique.

Figure 1.—Conventional oblique aerial photograph, Coyote Fire, Los Padres National Forest, Calif.

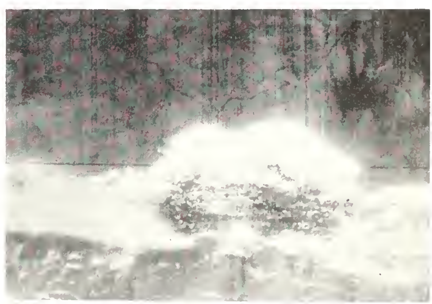

Figure 2.—Infrared thermal imagery through heavy smoke, Coyote Fire, Los Padres National Forest, Calif.

Improved Scanner

The experimental infrared scanner used does not meet requirements for size, weight, angular resolution, reliability, and imagery quality. A prototype scanner designed specifically for airborne infrared fire mapping will satisfy these requisites. Performance tests on the new scanner will probably be completed by midsummer 1965. Analysis of the fire-mapping capability of this scanner will be the basis for preparation of production model specifications. This scanner may be available for purchase and use during fire season 1966.

Capabilities and Limitations

Recognition of the capabilities and limitations of infrared scanning is a necessary prerequisite to effective use of the scanner as a fire-mapping tool. Use of infrared fire mapping permits the following:

1. Mapping of fires day or night.
2. Mapping of fires through dense smoke and smog.
3. Rapid surveillance during critical periods.
4. Accurate plotting of fire perimeter and spot fires.
5. Prompt determination of rate of spread.
6. Under smoky or nighttime conditions, determination of physical changes made by man since the last aerial photos were taken.
7. Perimeter intensity intelligence for efficient deployment of mopup forces.

The major limitations of infrared fire mapping are few, but important:

1. Infrared energy does not penetrate solid matter, cloud cover, or fog.
2. Few specially trained infrared imagery interpreters are available.
3. As with any airborne reconnaissance, extensive smoke pall from large fires can create aircraft navigational problems.

Conclusions

Test flights have demonstrated that campaign fire intelligence requirements can be met rapidly and accurately with airborne infrared scanners. Among other benefits, fire perimeter and spot fire intelligence from airborne infrared scanning will remove one of the fire boss's greatest problems, i.e., knowledge of the fire's location, particularly after a blowup has occurred. Airborne infrared scanning cannot solve all fire intelligence problems, but it is intended to supplement normal ground and air reconnaissance.

INFRARED FIRE DETECTION

Airborne infrared scanners also have shown great potential for fire detection. However, before this potential can be exploited, research must answer many questions about the relationships between detection probability, fire size, view angle, and vegetation characteristics. A major effort in fire detection research at the Northern Forest Fire Laboratory is directed toward these problems.*

*Hirsch, Stanley N. Infrared as a fire control tool. West. Forestry and Conserv. Assoc., West. Forest Fire Res. Council Proc.: 5-10. 1962.

CANADIAN INFRARED SCANNER

Canadian Department of Forestry,
Ottawa, Canada

An infrared scanner that may greatly improve forest fire detection in Canada will be tested this summer in the Ottawa area.

The scanner will be carried on regular fire patrol flights by aircraft of the Quebec and Ontario Departments of Lands and Forests. From mid-June through mid-August, the scanner will be flown by an aircraft of Quebec's Forest Protection Service. For the next 2 months of the fire season, the device will be carried on an aircraft of the Ontario Forest Protection Branch. The project is being co-ordinated by the Federal Department of Forestry.

Small fires may be pinpointed before they can be seen. The scanner is designed to record very slight differences in ground temperature on the terrain being scanned. These variations will activate a light signal or sound signal, or both, within the aircraft. The scanner also will produce a continuous thermal photograph or map of the terrain, permanently recording the precise location of hot spots.

A NEW EXPERIMENTAL FIRE AREA IN SOUTHERN CALIFORNIA

JOHN D. DELL, *Fire Research Technician, Riverside Forest Fire Laboratory, Pacific Southwest Forest & Range Experiment Station*

Forest fire research gained a new outdoor laboratory with the recent transfer of 13,000 acres of southern California chaparral from the Bureau of Land Management to the Forest Service. This site, known as the North Mountain Experimental Area, is in the San Jacinto Mountains. It is administered from the forest fire laboratory in Riverside, and is connected to the laboratory by roads open yearlong (fig. 1).

Site and Facilities

North Mountain is typical chaparral brushland. Elevations range from 1,500 to 4,357 feet. Three extensive drainages divide the area into a complexity of terrain representative of much of southern California's mountainous fire hazard areas.

The area will provide a site for testing materials, conducting demonstrations, and training firefighters. Seven hundred acres has been allocated as a testing site for the Forest Service Equipment Development Center at Arcadia, and 1,200 acres will be used for training firefighters. A small, functional administrative site, including a shop and warehouse, will be developed to facilitate and service projects. Additional access roads have been proposed for prospective study areas. A network of heliports and helispots will provide additional accessibility to the area, both for protection and research. The area can be used for cooperative research by other Federal agencies, by State and local fire organizations, and by university research groups. Research will not be limited to local problems; general fire control knowledge will also be sought.

Fuel-Break Construction

Since 1954, the California Division of Forestry has intensely treated land at North Mountain. Large areas of dense, highly flammable brush have been broken up by a network of strategically placed fuel breaks (fig. 2). These are wide strips of land from which heavy fuels were removed and replaced with lighter cover that offers less resistance to fire control (fig. 3). Nearly all of these fuel breaks are accessible via a well-planned road system.

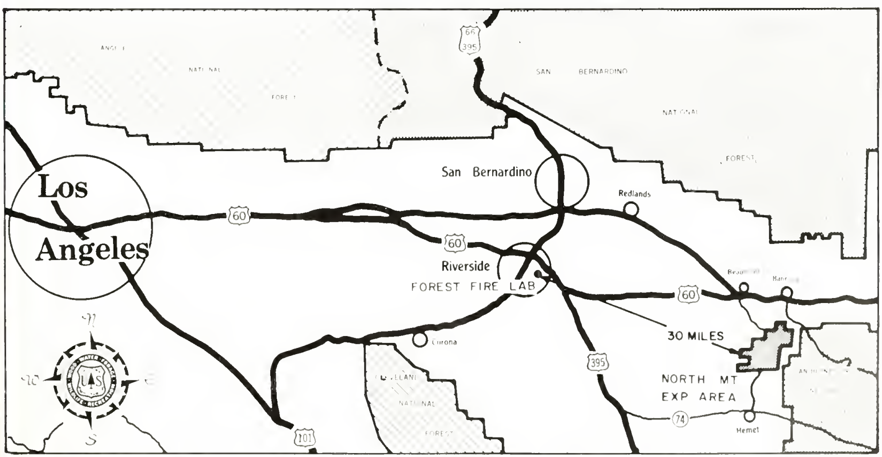

Figure 1.—The North Mountain Experimental Area is in the San Jacinto Mountains 30 miles from the forest fire laboratory in Riverside.

Figure 2.—Aerial view of a portion of the Experimental Area showing part of the extensive fuel-break system constructed by the California Division of Forestry.

Area's Fire Protection

Fire protection for the experimental area is provided by employees of the Riverside County unit of the California Division of Forestry, with nearby San Bernardino National Forest personnel assisting in a mutual aid zone. Within a 10-mile radius there are two Division of Forestry district headquarters and a county road camp. These units have up to 100 trained men available for firefighting. Three Forest Service fire stations are on the adjacent San Jacinto Ranger District. A new Forest Service lookout on Black Mountain covers North Mountain. The Ryan Field Air Attack Base in Hemet is only minutes away, permitting fast attack by air tankers if needed.

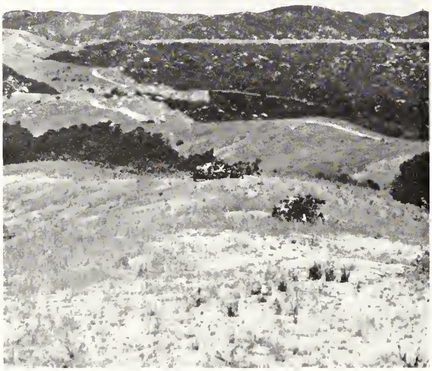

Figure 3.—A North Mountain fuel break on a ridgetop. This break is 300 feet wide.

New and Future Studies

Forest Service research started at North Mountain in 1964.

The extensive fuel-break system at North Mountain provides researchers with opportunity for such studies as the joint research project recently begun with the Agronomy Department of the University of California at Riverside. Researchers are investigating effects of herbicides and chemicals on certain brush species, adjacent soils, and seedling and sprout growth. Also to be studied are the physiological conditions affecting shrub resprouting and the effect of soil moisture management on the establishment of woody and herbaceous seedlings.

Other parts of the broad program of developing chemicals and techniques to control sprouting brush include a planned scrub oak control study and additional studies involving fuel-break sterilants.

A seed production and storage study will attempt to find the seed yield of chaparral species and determine how long seed will maintain viability in the soil. This study will also investigate the effects of fire on seeds.

Fire behavior specialists are conducting fuel volume studies. These studies represent an attempt to determine principles and methods of fuel measurement which may serve as a basis for a comprehensive fuel survey and classification system. Some areas at North Mountain will be allocated for test burn plots for fire environment studies.

Studies of live and dead brush fuel moistures may soon provide important knowledge on forest fire behavior in chaparral. Diurnal fuel moisture variations in chamise and other flammable species are being studied during critical fire danger periods.

Meteorologists from the Forest Fire Laboratory are learning more about fire weather and are testing new instruments and equipment. Recently they studied the valley wind convergence zone in the Wolfskill Canyon Area to determine some of the mechanisms that produce down-canyon afternoon winds (fig. 4). Personnel from the U.S. Weather Bureau and California Division of Forestry assisted.

Researchers from the Engineering Department at the University of California at Los Angeles and from the Forest Fire Laboratory are examining the feasibility of using waste water from local valley communities to supply nearby mountain areas with scarce water for fire control and for green fuel-break irrigation. North Mountain may be used as a pilot study area for such a project.

Summary

This area provides forest fire researchers with their own field laboratory. Here research projects may be undertaken, studied, and analyzed without conflicting with other land management uses. The new North Mountain Experimental Area and the Forest Fire Laboratory at Riverside should provide a highly effective combination for improving our knowledge of fire and its control.

Figure 4.—Meteorologists studying fire weather at North Mountain.

PREVENTION OF FIRE CAUSED BY ELECTRIC FENCERS IN WASHINGTON STATE

Loren A. Tucker, *Supervisor, Fire Control Division, Department of Natural Resources, State of Washington*

Electric fence controllers should control livestock but not set fires. Some fencers have a self-maintaining feature—they burn off the weeds that grow up around the wire so the farmer does not have to mow them.

In 1964, Washington's Department of Natural Resources analyzed the State's fire reports of miscellaneous cause and determined that self-maintaining electric fencers were starting an alarming number of fires. A recheck of fire reports indicated that all fires set by fencers were started by a type which the Underwriters' Laboratories would not approve. The Underwriters has certified several makes of fencers as fire safe but has never put its label on the weed burner models.

The Department's Fire Control Division began to attack this fire source. On June 2, 1964, the Board of Natural Resources promulgated Resolution 54. It declared that fencers which had not been certified by the Underwriters' Laboratories as fire safe could not be sold without a bright red warning label. The label, which is furnished to dealers by the Department, contained the statement seen in figure 1.

Since the label warns the prospective purchaser that he can use the uncertified fencer for only 5 months, the Department believes the weed burner controller will no longer be popular.

The Washington State Department of Labor and Industries has agreed to join with the Department of Natural Resources in the enforcement job. Department of Natural Resources men have contacted every known outlet of fencers in the State and have distributed about 15,800 labels.

The Underwriters' Laboratories has cooperated with the Department of Natural Resources splendidly and is prompt in notifying the Department as soon as another fencer is certified. There are many approved "certified fencers" on the Underwriters' lists.

Results of this prevention effort will not be available until at least one above normal fire season passes. However, the reactions of those affected by the Resolution indicate that the required results will be obtained.

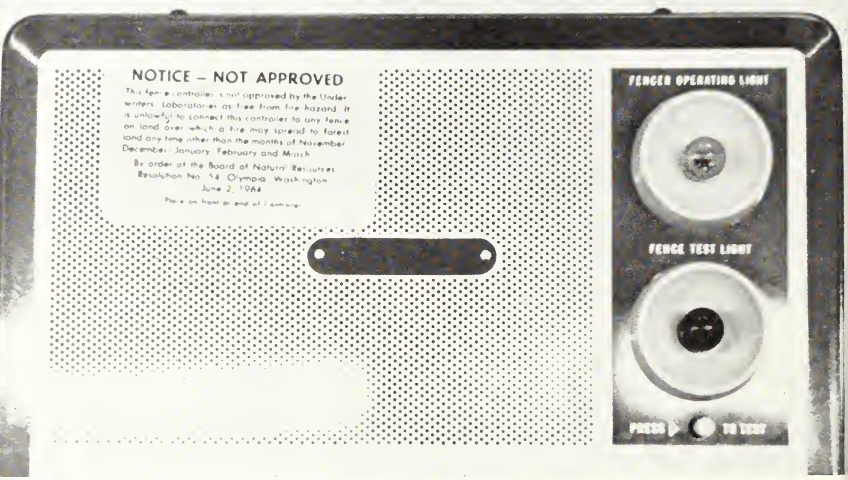

Figure 1.—Uncertified fencer bearing Washington Department of Natural Resources warning label.

EXPERIMENTAL PARADROP OF TRACKED PERSONNEL CARRIER FOR USE ON INACCESSIBLE FIRES

JAMES W. THURSTON, *Anchorage Fire District Supervisor, Bureau of Land Management, Alaska*

Introduction

Helicopters often have been used around the perimeters of large fires in the remote portions of interior Alaska. Because they are expensive to operate and their legistical requirements are great, Bureau of Land Management fire control personnel look for other methods of meeting these transportation needs.

Many of the hours flown by helicopters assigned to project fires involve movement of personnel, equipment, and supplies from one portion of the fire perimeter to another. Much of this activity, such as food distribution, is routine; if needs are anticipated, the speed of a helicopter is not required. Use of tracked vehicles capable of transporting personnel and negotiating streams, lakes, and swampy areas is considerably less expensive. Due to the vast distances separating the road net from these fires, aerial delivery of these machines is necessary. When the fire is out, these vehicles can be driven cross country to the nearest airstrip at leisure, and flown back to the fire-control headquarters.

The feasibility of delivering these vehicles by parachute was explored. Through the cooperation of the U.S. Army, Alaska, a carrier was rigged for paradrop by the USARAL Support Command's parachute maintenance branch at Ft. Richardson. The experimental drop was made from a U.S. Air Force C-119 Flying Boxcar.

Description of Carrier

A Bombardier BB Carrier was used. It has a cross-country cruising speed of 15 m.p.h. and is amphibious when equipped with an outboard motor. It has a water-cooled, four-cylinder, 57-hp. Simca Flash Special engine. The vehicle rides on tracks 27 inches wide which are supported on rubber wheels. It is approximately 94 inches long, 72 inches wide, and 46 inches high. Up to six men or 1,000 pounds of cargo may be moved. For added utility, mounts were installed to accommodate a small hydro pump and a 55-gallon water tank.

Rigging

During the fire season the Bombardier sits on an 8-foot-square drop platform. For added strength, $^3/_4$-inch plywood on a 2- by 6-inch frame was used. Two lengths of 18-inch-wide honeycomb cardboard 6 inches thick were placed under each track. The center hull of the vehicle was also supported by four columns of the same material. Fourteen lengths of parachute webbing on the sides, front, and rear secured the platform to the carrier. Lifting eyes, able to withstand a 4-G opening shock, were welded to the four corners of the carrier frame, and the cargo sling was attached. The rear engine mounts were also strengthened to stand opening shock. An Army Type G-11A 100-foot cargo parachute was attached to the sling, with its 15-foot extraction parachute (fig. 1). The final rigged weight, including the platform, cardboard, and parachute, was 2,730 pounds.

Dropping

The carrier was dropped at an altitude of 1,500 feet. The wind was light and variable, with a surface speed of 5 to 8 m.p.h. Extraction of the load and subsequent deployment of the cargo canopy was normal. A 15-foot chute was used to pull the load from the aircraft. The opening time of the cargo canopy was

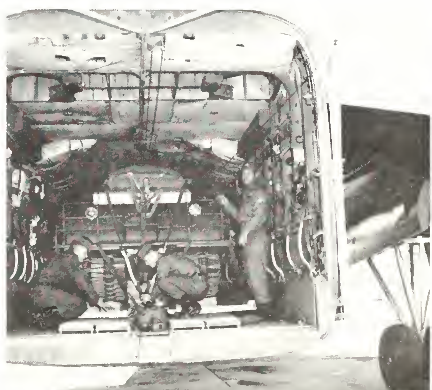

Figure 1.—Front view of Bombardier rigged for drop with a 100-foot cargo parachute. (U.S. Army photo.)

Figure 2.—Bombardier just before impact. The extraction chute in the foreground is falling free.

6 seconds, considerably longer than the normal opening time for personnel chutes. Immediately after the cargo canopy came out, the extraction chute broke free and fell separately. Once the canopy was fully deployed, and throughout the descent, oscillation was negligible (fig. 2). The platform and carrier landed in a flat position, skidding after impact approximately 10 feet over level ground in the direction of the surface wind.

Inspection After the Drop

Immediately after the drop, ground inspection revealed no damage to the Bombardier (fig. 3). The platform was also undamaged; however, it is considered expendable. The honeycomb cardboard remained intact, showing only dents from the wheels and metal cleats of the tracks. Within 10 minutes after the drop the carrier was driven off the platform in good operating condition.

Conclusions

Aerial delivery of personnel carriers appears feas-

Figure 3.—Bombardier immediately after the drop.

ible when a suitable drop zone is available within a few miles of the fire. Although further tests in various drop areas must be evaluated, steep ground and/or timbered areas probably should be avoided because the cargo may overturn just prior to impact or may roll on impact. The flat and rolling tundra plains of interior Alaska have many square miles of suitable drop area. Military aircraft and riggers are able to paradrop loads up to 18,000 pounds; therefore, aerial delivery of even heavier equipment to remote fires can be considered.

HALLIE DAGGETT

Adapted from the LOG, *California Region, U.S. Forest Service, November 15, 1964*

On Monday October 19, 1964, death brought an end to the colorful career of Hallie Daggett of Etna, Siskiyou County, Calif.

Daughter of a Salmon River pioneer miner, Miss Daggett became the first woman lookout in the United States in June 1913 at Eddy Gulch Lookout on the Klamath National Forest. The ranger took her up to the log cabin and left after giving her a rough map of the area. He instructed her to report any fire she saw by calling him on the grounded telephone line connected to his office at Sawyers Bar.

The idea of a woman being a lookout was novel to the people of the area, and she had many visitors to that lonely spot. People wondered if a woman really had what it took to be a lookout. However, she established a tradition, for more than half of the lookouts in California are now women.

THE HELICOPTER CARGO NET

JEFFERY R. DAVIS, *Supervisory Smokejumper,*
Aerial Fire Depot, Missoula, Mont.

Introduction

The 8-foot-square helicopter cargo net, with a connecting "spider" suspension system, provides an efficient implement for transporting cargo used in Forest Service field operations.[1]

The net, suspended below the helicopter and released by the helicopter bombshackle device, facilitates handling of odd-sized cargo bundles without prepackaging. It will easily accommodate the helicopter's maximum payload.

Type VI nylon webbing is the most satisfactory material used in the nets. Type VIII cotton webbing may also be used; it satisfies minimum tensile strength and construction demands. Nylon is preferred because it costs less, is more durable, and has less bulk and weight.

The nylon "spider" suspension system, connecting the four corners of the net to the helicopter bomb shackle (fig. 1), is constructed of 1-inch tubular webbing.

The nets can be used in any area or job where helicopters can operate (fig. 2). More than 50 have been constructed at the Aerial Fire Depot parachute loft in Missoula, and these are now used on many National Forests in Region 1.

Value

The net is particularly useful in transferring cargo from wilderness forest fire sites to more accessible

Continued on page 16

[1]Detailed plans are available on request from the Regional Forester, U.S. Forest Service, Missoula, Mont.

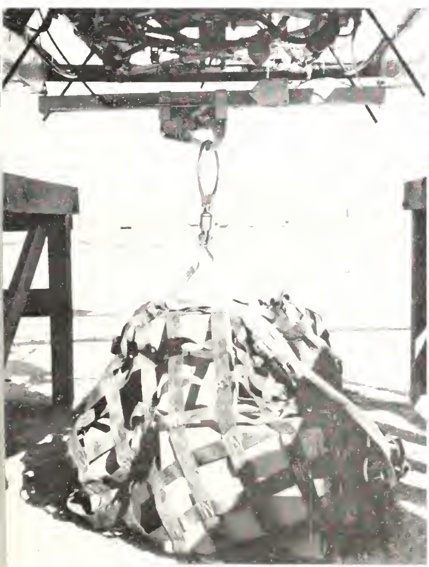

Figure 1.—Helicopter cargo net loaded and secured to helicopter bombshackle by nylon suspension straps.

Figure 2.—Helicopter in flight showing cargo net in operation.

NORTHERN CHEYENNE MODEL FIRE DRAG

W. Howard Welton, *Forester, Bureau of Indian Affairs, Lame Deer, Mont.*

While grass fires have low resistance to control, rapid action is needed to keep them small and to suppress them. We designed an effective chain drag that can be handled by one man and can be kept in vehicles normally used where grass fires occur. The first unit was built during the 1964 season. No grass fires subsequently burned, but results from experimental fires were rewarding.

The unit consists of six $\frac{3}{8}$-inch chains $3\frac{1}{2}$ feet long bolted to an angle iron bar and dragged by a boom on the front bumper (fig. 1). Four-inch crossbars of $\frac{3}{8}$-inch-round steel bars are welded to the last 33 links of each chain. The crossbars are welded on opposite sides of parallel links, giving the unit uniformity. All bolts must be riveted (fig. 2).

Figure 1.—The fire drag in operation.

The boom is made of two sections of pipe. The outer pipe has an inside diameter of $2\frac{1}{2}$ inches. It is fastened to the front bumper by U bolts made of $\frac{3}{8}$-inch steel rod. The inner pipe has an inside diameter of $1\frac{1}{2}$ inches. Both pipes are drilled with $\frac{9}{16}$-inch holes 1 inch from each end. The larger pipe is also drilled about one-third of its length in from each end. The inside pipe is held in place when not in use by dropping a $\frac{1}{2}$-inch bolt through the end holes of both pipes. The bolts are drilled at the bottom and fastened with cotter pins. When the boom is to be used, the bolts are removed, the inside pipe slides outward two-thirds of its length, and one bolt is placed through its end and the corresponding hole in the outer pipe. The second bolt is replaced in the end, which now extends to the side of the vehicle.

The drag is pulled by placing the grab hook of any size of tow chain in the middle link of the yoke (fig. 2), and fastening it to the boom with a clove hitch. The end bolt runs through the clove hitch and holds it in place at the end of the boom. The length of hitch must be adjusted to prevent the rear wheel from running onto the drag during turning.

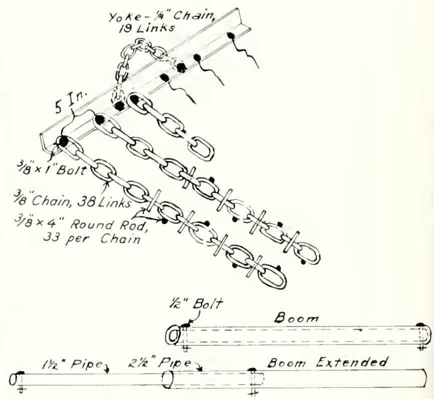

Figure 2.—Diagram of fire drag.

The drag moves forward or backward, so the operator can back up to cover the missed portion of a fire. It is also effective in mopping up because it will separate and smother burning manure. While the jeep appears to be the optimum vehicle (fig. 1), any vehicle that can reasonably negotiate the terrain involved can be equipped and used.

Specifications for the fire drag follow:

Material	*Estimated cost*
1 — Angle iron ($1\frac{1}{2} \times 1\frac{1}{2} \times \frac{3}{16} \times 27$ inches)	$ 0.70
1 — Chain ($\frac{1}{4} \times 17$ inches)	.32

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FIRE PREVENTION MESSAGE FROM THE AIR

BRANCH OF FIRE CONTROL, *North Central Region,*
U.S. Forest Service

Forestry technician Ross K. Marion of the Clark National Forest in Missouri observed an aircraft towing a banner over Poplar Bluff one day and noticed that everyone was watching and reading the message. He felt this would be a good way to present a fire prevention message to the many deer hunters and other users of the National Forest.

Ross's suggestion was adopted, and a banner is now being towed on the Clark and Wayne-Hoosier National Forests of the North Central Region. The banner has 18 nylon letters 5 feet high and reads "Prevent Forest Fires."

The aircraft towing the banner (fig. 1) is equipped with a PA system, and the pilot broadcasts another message. Flights are conducted over towns, recreational areas, and football and baseball games — any place where there are large crowds within or adjacent to the Forest protection area.

This method of fire prevention has reached many people, and the cost of this operation is far less than for the normal direct methods. Many favorable comments have been received from the public; the banner apparently is a very effective prevention tool.

The Regional Forester, Milwaukee, Wis., will furnish on request detailed information on purchase costs and operational procedures.

Figure 1.—Plane towing fire prevention banner.

Fire Drag *Continued from page 12*

6 — Chains (3/8 × 42 inches)	7.70
198 — Round bars (3/8 × 4 inches)	4.95
1 — Pipe (2 1/2 inches i.d. to fit bumper)	5.10
1 — Pipe (1 1/2 inches i.d. to fit bumper)	2.40
8 — Bolts (machine 3/8 × 1 inch)	.30
6 — Flat washers (3/8 inch)	.05
2 — Lock washers (3/8 inch)	.05
Welding	30.00
Total	$51.57

Every 15 seconds a fire breaks out some place in the United States, according to the National Fire Protection Association.

Preplanned escape measures might save up to 85 percent of all lives lost in home fires, National Fire Protection Association studies show.

FIRE TIMEKEEPER'S "CREW ORGANIZER"

Stanley S. Tornbom, *Timber Management Assistant, Deschutes National Forest*

Three systems of recording fire time, the alphabetical, the numerical, and the crew system, are named according to the manner in which fire time reports are filed for use in fire camps. The method of filing determines the procedures in posting daily time for firefighters, and in processing men for transfer and release.

The crew system is recommended whenever it is possible to use it.

The primary deterrent to use of the crew system is lack of facilities in fire camps for filing and storing time reports. Small boxes, large envelopes, and large paper clips or clamps have been used. However, there is always danger of losing time reports or of getting them mixed. Lack of proper facilities for the crew system has encouraged the use of the less efficient alphabetical and numerical systems because time reports can be easily filed alphabetically or numerically in a standard 5- by 8-inch cardboard box.

The fire timekeeper's "Crew Organizer" (figs. 1, 2) is a portable unit that can be carried to a fire camp by plane or auto and can quickly be set up on the ground, or on a table, or can be attached to a tree, post, or wall. If it rains, the units can be folded to protect the time reports; if the camp is moved, the units can be folded and moved intact to the new location.

The time reports are filed by crews as men arrive at the fire camp, or as they are organized into crews. Crew names and the number of men in each crew are written on the plastic strips above the clamps to identify the crews.

Crews may be divided into four groups consisting of day and night Forest Service personnel and day and night non-Forest Service personnel. On a large fire, one crew organizer may be used for each of the four groups; on a smaller fire, two organizers can normally handle all four groups.

Unposted crew time reports can be placed on top of the fire time reports and when posted, they can be placed behind the time slips. Consequently, all data pertaining to each crew is in one place. Also, the following items can be quickly checked:

(1) The number of men, by day and night shifts, working on a fire

(2) Whether their time has been posted

(3) Names of crews

(4) Overhead

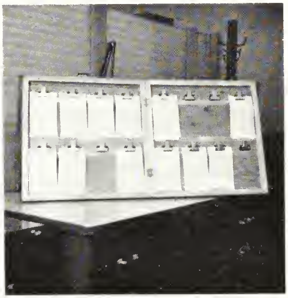

Figure 1.—The crew organizer shown fully extended, propped on legs, and locked into position.

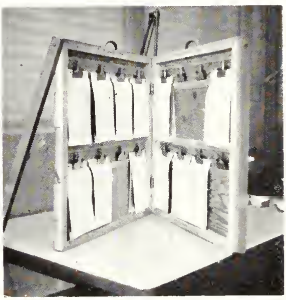

Figure 2.—The crew organizer, partially opened to show hinging and leg construction.

Used as described, the crew organizer becomes the nucleus of the timekeeper's organization and facilities.

If organizers are not available in a fire camp, the same results can be approximated if a building is available where nails can be driven into the wall, or where clips can be attached. If nails are used, they should be about 16d common nails, and the heads should be cut off after they are driven. The time reports can be hung on the nail by the center hole in the top of the time report. Names of crews and other pertinent data can be entered on masking tape placed above the time reports.

If no building is available, a unit can be built by setting two posts in the ground and nailing a few surfaced boards or a piece of plywood to the posts. Then nails or clips (Esterbrook ball bearing #20 or equal) can be mounted to this surface. If nails are used, a heavy weight must be placed on top of the time reports to keep them from blowing away.

These alternative methods describ-

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"QUICK" MOUNT FOR TOOLBOXES

JAMES R. CROUCH, *Management Analyst, Division of Administrative Management*[1]

Have you ever wanted to mount or remove a ½-ton pickup toolbox in a few minutes? It can be done.

The folks on the Neches Ranger District in Texas and on the Yazoo-Little Tallahatchie Flood Prevention Project in Mississippi have a simple method—the "Quick" mount. Using this method, two men can quickly load or unload a box. This method saves man-hours and permits more flexibility in the use of pickups.

For example, one less vehicle may be required to do your work. When a crew is hauled to work, the box can be used as a seat and as a tool container. When the vehicle arrives at the job site, the box can be quickly and easily unloaded. The truck can then be used to haul bulky materials and supplies.

The components (fig. 1) of the "Quick" Mount follow:

Item	*Quantity*
Lumber, 2 × 4 × 96"[1]	2 pieces
Lumber, 2 × 4 × 48"[1]	2 pieces
Carriage bolts, ⅜ × 4"[1]	6 each
Carriage bolts, ⅜ × 2½"[1]	6 each

[1] The length will vary by truck.

Figure 1.—Components of mount: Bolts, runners, and end pieces.

Figure 2.—End piece in place.

The steps in installing the mount follow:

1. Cut runners to correct length and bolt to bottom of box, using ⅜ × 4-inch bolts.

2. Cut end pieces to correct length and notch to match runners on box. Bolt one piece to front of vehicle bed (fig. 2) and the other to tailgate (fig. 3), using ⅜ × 2½-inch bolts.

3. Place box in vehicle. Insert runners into notches at front of vehicle bed and then close tail gate (fig. 3). This locks box into place.

Figure 3.—End piece in place on tailgate; runners under box. (Note: Raise tailgate and box automatically locks into place).

[1] The information in this report was obtained when the author was Assistant District Ranger, Neches Ranger District, Crockett, Tex.

Crew Organizer —

Continued from page 14

ed have been used by the writer, and their use has led to the design of the crew organizer. While these methods do not provide the flexibility of the crew organizer, the basic advantages of organization and visual control still exist. It is believed to be several times as efficient as the alphabetical or numerical system.

Savings resulting from use of the crew organizer and the system described are difficult to calculate. It is estimated that in situations where the crew method is employed, use of the crew organizer and the system of visual organization reduces by 25 percent time spent by time officers and recorders.

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TOPOGRAPHIC RELIEF MAPS

Donald H. Thomas, *Fire Control Officer, Mendocino National Forest*

Figure 1.—A fire control officer indicates contour lines on a topographic relief map.

Fire control officers find that it takes more than talk to teach a new employee what a contour line is. Sand tables and other devices have been used to aid the telling by showing. The Corning Ranger District of the Mendocino National Forest purchased a set of three topographic relief maps for use in demonstrating contour lines (fig. 1).

The maps were obtained from the U.S. Army Corps of Engineers, Army Map Service, 2100 North New Braunfels Ave., San Antonio, Tex., for $2.50 each. The size of each map is 18 by 27 inches. They are printed on a rigid, heavy-duty plastic. Normal temperature ranges do not cause the relief pattern to distort. Horizontal and vertical scale is 1:250,000. Contour interval is 100 feet and is based on photoplanimetric methods. Horizontal and vertical control was field checked in 1957. The relief pattern is very accurate.

The map sections are constructed to allow sufficient overlap for joining sections together. The maps have proved to be a valuable training aid in our fire control work.

Helicopter Cargo Net —

Continued from page 11

pickup areas, and in engineering projects such as the transportation of bridge building equipment and lookout tower components.

In August 1964, on the Lewis and Clark Forest, the cargo nets were satisfactorily used to transport 60,000 pounds of hardware and lumber for bridge construction. The net saved time and labor, and was highly recommended by the men in charge of the project.

Specifications

The cost of materials and labor follows:

Nylon net			
Webbing, type VI nylon	124 yards	@ $0.14	= $17.36
"V" rings, steel	4 each	@ $ .05	= .20
Labor	5 hrs.	@ $2.98	= 14.90
Total			= $32.46
Cotton net			
Webbing, type VIII cotton	124 yards	@ $0.30	= $37.20
"V" rings, steel	4 each	@ $ .05	= .20
Labor	6 hrs.	@ $2.98	= 17.88
Total			= $55.28
"Spider" suspension system			
Webbing, tubular 1-inch nylon	24 yards	@ $0.17½	= $ 4.20
Snaps, steel	3 each	@ $ .05	= .15
Labor	2 hrs.	@ $2.98	= 5.96
Total			= $10.31

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FIRE CONTROL NOTES

U.S. Department of Agriculture
Forest Service

FIRE CONTROL NOTES

A quarterly periodical devoted to forest fire control

CONTENTS

COVER — How would a fuel break affect this fire? See story on p. 3.

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

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VALUE OF A TIMBER FUEL BREAK—THE WET MEADOW FIRE

EUGENE E. MURPHY *and* JAMES L. MURPHY[1]

How effective are fuel breaks[2] in northern California timber country? On July 5, 1962, a fuel break on the Stanislaus National Forest (fig. 1) helped stop the Wet Meadow Fire at 23 acres. Although not a conflagration, it was the first sizable fire on the 40,000-acre Duckwall Conflagration Control Unit. Here Stanislaus National Forest personnel and fire researchers from the Pacific Southwest Forest and Range Experiment Station are studying the prevention and control of conflagrations by fuel modification through integrated land management.

Figure 1.—A planned fuel break, cleared as part of the Duckwall Conflagration Control Project, extended along the ridge at the head of the canyon where the fire was located.

VALUE OF A FUEL BREAK

Nine miles of fuel break constructed along the main ridge stopped the Wet Meadow Fire at 23 acres. Without the fuel break, the fire would have crossed the ridge into heavy brush and burned at least 60 more acres (fig. 2). About $18,000 in suppression costs may also have been saved. Thus, the $10,300 expenditure for constructing the fuel break was justified.

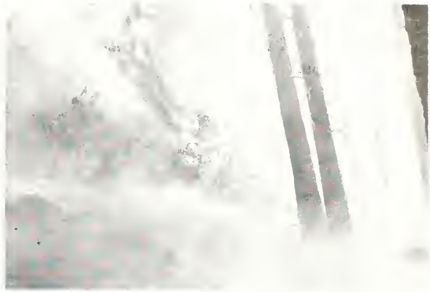

Figure 2.—The fire burned fiercely in the thick brush as it started up the steep slope and headed for the ridge where the fuel break was located.

ENGINEERING FUEL BREAKS

Local weather as well as topography resulted in a "pull and push" of the Wet Meadow Fire toward a prominent knob and a saddle. The inertia of the fire caused it to "lick over" the fuel break and to throw spot fires at these two points. The fire burned fiercely although it was only a high fire danger day (fig. 2). Erratic local winds were an important cause of the fire's behavior. Fuel breaks in timber must be widened at critical pressure points. Stocking may have to be reduced in timber country because the flames tend to flash through crowns at the edge of a fuel break.

An old cabin on private land was in the path of the Wet Meadow Fire. Though it was within the fuel-break system, brush and debris had not been cleared. Ten men took nearly one-half hour to build a fireline around the cabin. During extreme fire danger, the fire would have burned the cabin and swept across the ridge.

During the summer following the fire, private property owners on the Duckwall Unit were contacted. They were encouraged to help complete the fire-barrier system (with partial Federal financing through the Agricultural Conservation Program if desired) or to grant the Forest Service a fuel-break easement. The fire helped show landowners the importance of fuel modification, and they participated wholeheartedly the first year. The cabin incident also stressed the need for hazard reduction at other critical points, such as at campgrounds and along roads.

[1] Respectively, District Ranger, Mi-Wok Ranger District, Stanislaus National Forest, Calif., and Research Forester, Pacific Southwest Forest and Range Experiment Station, Berkeley, Calif.

[2] FUEL BREAK—a wide strip or block of land on which native vegetation has been permanently modified. Fires that burn into a fuel break can be readily controlled because they will be of lower burning intensity and will offer less resistance to control than native vegetation.

MAINTENANCE OF FUEL BREAKS

Fuel breaks must be maintained to remain effective. The PSW Station researchers have begun a series of studies to determine the cost and effectiveness of various herbicides for control of undesirable regrowth and of soil sterilants for maintaining firelines within fuel breaks. Optimum rotation and cutting cycles for timbered fuel breaks and costs and schedules of TSI work are also being studied.

FUEL BREAKS NEED FAST, STRONG ATTACK

The Wet Meadow Fire showed that fuel modification must be combined with fast, strong attack by an efficient fire control organization experienced in constructing fuel breaks. Under severe burning conditions the fire would have hit the ridge in 15 minutes. Quick reconnaissance, probably by aircraft, would have been needed to positively locate the fire and to report its condition. Air tanker attack with 15-minute traveltime would have been required to help keep the fire from crossing the fuel break. Quick followup by ground crews would have been necessary. Traveltime for the nearest ground crews was 40 minutes. Hence, access roads must be improved, and attack crews and equipment may have to be relocated during high fire danger.

LAND DEVELOPMENT

Water developments to supplement the many miles of grass-covered fuel breaks would help utilization by livestock. They would also furnish water for fire control. Road and trail construction and maintenance would also facilitate access.

SUMMARY

A combination of fuel modification, fast, strong fire attack, and land development is necessary to control conflagrations in northern California timber country.

IMPROVED DISPATCH PLANNING

HARLEY E. RIPLEY, *Dispatcher*
Shasta-Trinity National Forest

As air tankers, helicopters, and other new tools are added to fire control, and as wild land resource values rise, initial-attack fire dispatching becomes more complex and requires quicker action.

The Shasta-Trinity National Forest uses planned area dispatching for man-caused fires. During the 1961-64 period, planned, prompt, aggressive dispatching helped hold hundreds of fires at small acreages under difficult burning conditions. These include individual and group man-caused fires, where starts occur without warning. Lightning storms usually give some warning, so the rapid dispatching allowed by the planned area dispatch system is not usually needed for lightning fires.

The system can be used with decentralized Ranger District dispatching or with centralized Forest dispatching. However, the larger the dispatching workload, the more attractive planned area dispatching becomes.

SHASTA-TRINITY AREA DISPATCH PLANNING

1. Three fire danger rating ranges and related plans applicable to conditions on the Forest are established. In the Region 5 fire danger rating system, we chose the burning index as the desired unit of measure. Definitions of the plans follow:

A. **Green plan.**—History shows the normal initial attack force (the nearest two or three crews) have controlled fires with no escapes. The burning index is 0-11 (on a total scale of 100 points).

B. **Orange plan.**—History shows some fires escape initial attack. The burning index is 12-18.

C. **Red plan.**—All-out effort is needed to control fires. The burning index is 19 and above.

2. Logical initial attack areas are established and outlined on the Forest map, and the areas are numbered or lettered for easy identification. Preattack planning blocks are used to avoid the confusion resulting from use of two sets of blocks. We often group several blocks to form initial attack areas where similar action applies to two or more blocks (fig. 1).

3. Planned initial attack and followup are developed for each area: this includes any cover needed for vacated stations. The district rangers and the central dispatcher collaborate very closely in this phase of the planning.

A dispatch plan is made for each area, for the three brackets of fire danger. The manpower and equipment moves are in two categories (fig. 2).

Category 1 includes manpower and equipment available to the Districts and cooperator forces. Category 2 covers such items as air tankers, smokejumpers, helicopters, and State Division of Forestry crews and equipment that are more easily contacted by the central dispatcher.

ACCESSIBILITY OF PLANS

After the plans are made, they must be widely distributed to all individuals and crews involved. In the central dispatcher's office they can be summarized on 5- by 8-inch cards: Kardex or Unisort cards are quite suitable. A master index card must be set up for each plan (green, orange, and red) to facilitate sorting the card for the block in which the fire is reported.

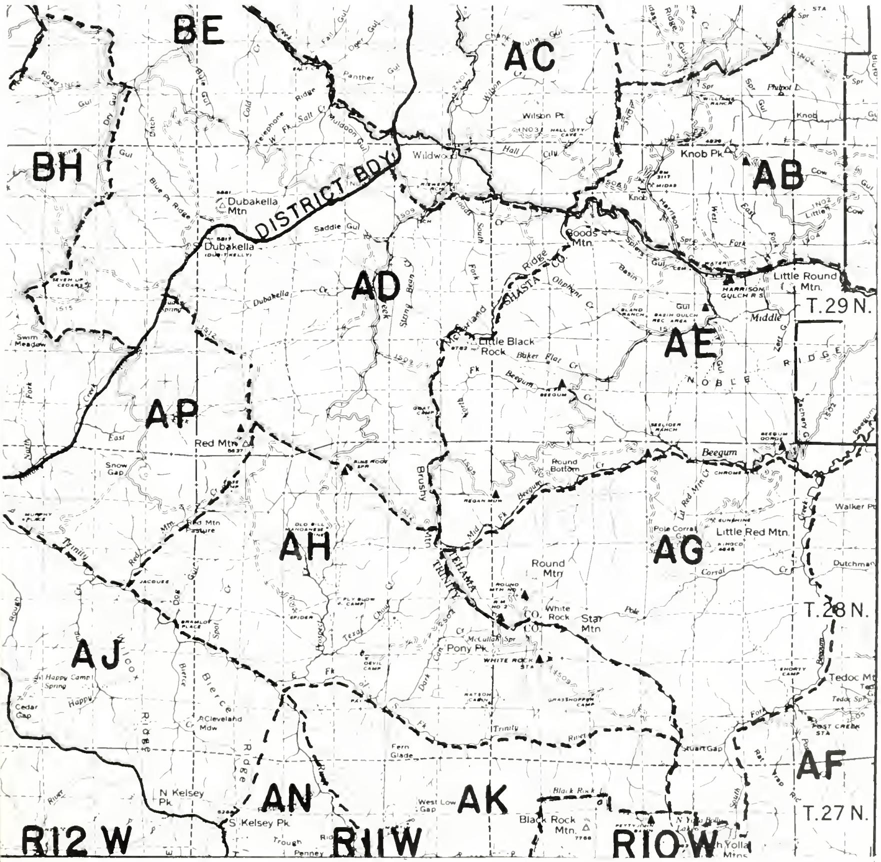

Figure 1.—Solid black lines indicate Forest and District boundaries. Broken black lines separate blocks. The first letter indicates the District, the second letter the block. (Area dispatch plan map)

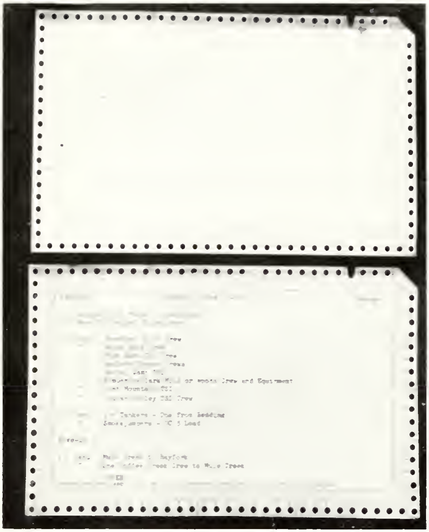

Figure 2.—Sample preplanned attack plan for Shasta-Trinity National Forest.

Each crew or individual should have an abbreviated plan and a map showing his assignment at the various fire danger locations and levels. The abbreviated field summary can be carried in a pocket notebook, with dictionary-style tabs to identify areas and color codes for various levels of fire danger. Some Districts have modified desk-top pushbutton alphabetical directories to indicate areas and activity levels.

UTILIZATION OF PLANS

When a fire is reported and the location determined on the dispatcher's string map, he announces the block letters and map location on the radio by saying, for example, "We have a fire in Block AD, Township 29 N., Range 11 W., Section 15: the dispatch plan is green." The dispatcher then rolls category 2 items as needed and checks with the District to be sure all category 1 action has started.

The District clerks check the plan for the designated block, and then start action on the District.

Men going to the fire check field copies of the plan. As the crews start to roll they announce to the fire or their planned cover position that their radio is on and in service. They later announce their arrival at the fire.

When the fire boss is sure the fire can be controlled with the forces that have arrived, he informs the dispatcher, who will hold or turn back forces that have not yet arrived.

The planned moves, which involve many people and much equipment in the moderate and high fire danger categories, may be altered when the central dispatcher or a qualified fire boss deems it advisable. The plan is to keep men and equipment rolling toward a reported fire until control is assured.

The advantages of this "instant" dispatching over the old one-at-a-time method are greatest on a large area with a heavy, diversified workload. However, this system will not eliminate the need for a competent, experienced dispatcher who must direct all actions of this system.

INEXPENSIVE REFILL DEVICE FOR SMALL TANKERS

Ray Miller, *Area Forester*
Idaho State Forestry Department

The Idaho State Forestry Department uses numerous small tankers for initial attack on forest and range fires. These units are often operated independently of mother tankers and far from water pumping facilities.

Refilling equipment is necessary to permit continuous use of these pumpers on individual fires. An auxiliary pump, a suppression pump, or a quick-refill attachment can be used. The high-pressure, low-volume pumps mounted on the tankers are generally not satisfactory because of the long time necessary for filling and the poor suction of many low-volume pumps. Auxiliary high-volume pumps can be carried with the pumper for filling; however, the auxiliaries are expensive, and the added weight is undesirable.

The "quick-refill," using the venturi-tube principle, has been the best means of refilling tanks. The refills are small, light, and pick up much water. The cost of commercial refills, complete with accessories, is $20 to $40.

Refills presently used by the Idaho State Forestry Department are compared in table 1.

Table 1.—*Cost and water pickup of quick-refill venturi-tube types*[1]

Model	Approximate cost with accessories	Water pickup
	Dollars	*Gal./min.*
Hurst	(2)	13
Bean	$30	26
Penberthy	20	9
M-1, 1/8"[3]	8	20
M-2, 3/32"[3]	8	16
M-3, 5/32"[3]	8	8

[1] Input: 4 1/2 gal./min., 300# pressure, 300 feet 1/2-inch-i.d. hose, Wanner pump, 1 1/2-inch-i.d. discharge hose.
[2] Unknown.
[3] Orifice diameter in jet.

In use, 1/2-inch hard line hose is attached to the refill with the swivel joint (fig. 1, item 13), and the filler hose is attached to the opposite end. The entire refill is placed in the water source, and the end of the filler hose is put into the storage tank. The pump is started as in normal operations, and the tank is filled.

The M-1, M-2, and M-3 units are shop-built refills similar to the one shown in figure 2. The only significant difference between the units is the size of the hole in the jet. The hole size can be varied to fit pumps of various capacities. Results obtained from all units of these refills during the 1961 fire season were satisfactory.

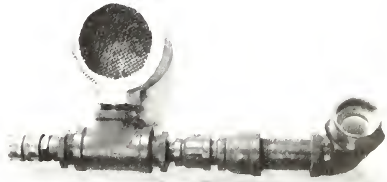

Figure 2.—Shop-built refill.

These shopmade units cost less than $7 and require less than 1 hour to build. They should be painted with a high-grade epoxy paint to protect the parts from corrosion. The following items, used in the fabrication of these refills, are numbered according to the numbers shown in figure 1.

Item No.	Description	Cost
1.	1" brass-close nipple	$0.51
2.	1" 90° elbow	.16
3.	1" 2" 3" nipple	.07
4.	1" 3/4" bell reducer	.17
5.	3/4" close nipple	.04
6.	3/4" 1/2" bell reducer	.17
7.	1/2" close nipple	.03
8.	1/2" × 1" bushing	.09
9.	1" "T"	.23
10.	3/4" × 1" bushing	.09
11.	1/2" airhose coupling	.55
12.	3/4" HT-3/4" and 1/2" pipe adapter	.25
13.	3/4" HT double female swivel	.25
14.	1" brass close nipple	.51
15.	Intake screen (Western Fire)	3.50
	Total	$6.62

(Continued on page 9)


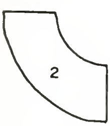
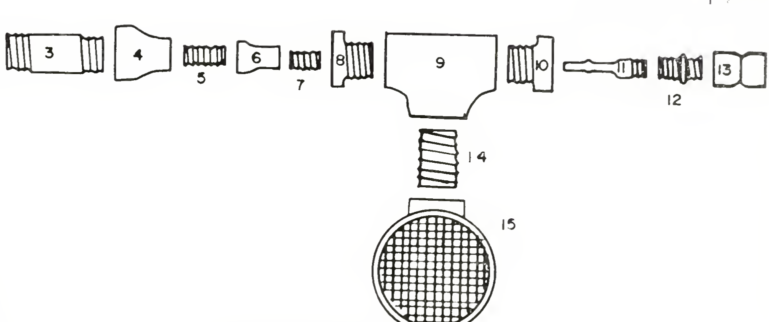

Figure 1.—Diagram of assembly.

BACKPACK MIST BLOWER AS A FIRELINE BUILDER

John F. Welsh, *District Ranger,*
Buffalo District, Ozark-St. Francis National Forest

The backpack mist blower has been an effective forest fire fighting tool in the pine-hardwood and hardwood types of the Arkansas Ozarks. The machine was designed for application of liquid herbicides and insecticidal dusts, but without special adaptations it also has been used for airblasting firelines. The blower is used primarily to remove fine, loose fuel from the proposed fireline.

Most of this material is hard to move effectively with handtools, and even when a plow can be used safely, most of the material falls in behind the machine. A properly directed airblast quickly moves most of the material. Effectiveness depends on many factors, including quality, quantity, size, and compactness of fuels; steepness of terrain; and rockiness of soil.

Earlier Uses of Blowers

A wheeled blower was developed in the late 1950's to clear hardwood leaves from firelines in Missouri.[1] In 1962, a backpack mist blower was used to apply water in fire suppression.[2] However, use of the backpack mist blower for airblast line building is apparently new.

Site Conditions

Arkansas Ozark fuel types are medium to high in both rate of spread and resistance to control. Hardwood leaves usually are the most conspicuous and troublesome component. Soils are thin and rocky. Topography consists of broad, flat ridgetops and rough, steep drainages, with vertical bluffs not uncommon. Rocks and steep slopes preclude wide use of plow units, and steep terrain reduces the utility of a wheeled blower. Because of rising watershed, timber, and wildlife values, slow and inefficient fire suppression with handtools outside the plowable area can no longer be tolerated. The backpack mist blower is one good answer to the difficult fuel, soil, and topographic conditions.

Instrumentation

The mist blower used to suppress fires on the Buffalo District of the Ozark-St. Francis National Forest is the Model KWH-75, manufactured by Kiekens Whirlwind of the Netherlands (fig. 1). It has an air-cooled, two-cycle engine with 6,000 r.p.m. The fuel tank capacity is 0.6 gallon. The blower was not basically modified; however, the unneeded herbicide tank, valves, tubing, etc., were removed to reduce weight. The weight of the blower without the mist tank is 35 pounds. The blower delivers 435 cubic feet of air per minute through a bent metal tube, under the operator's right arm, into a flexible hose about 5 inches in diameter and 3 feet long. The flexibility of the airhose permits the operator to direct the jet of air.

Personnel

Recommended personnel for building firelines with the mist blower consist of a line locator, a blower operator, and a followup crew. The line locator also breaks up matted fuel beds with a fire rake (Council Tool). The blower operator constructs line of the desired width and cleanness by varying his speed of advance and the degree of lateral swing of the air nozzle. The followup crew usually consists of one to four men, depending on the amount of matted or coarse fuel, the difficulty of holding the line, and, of

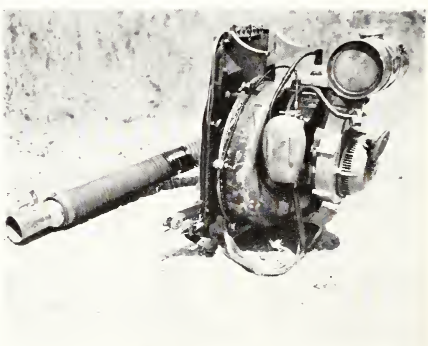

Figure 1.—The stripped-down backpack mist blower ready for action.

[1] Nichols, J. M., and Paulsell, L. K. A new idea in firefighting: air blast line building. Univ. Mo. Agr. Expt. Sta. Bul. 725, 7 pp., illus. February 1959.

[2] Lashley, O. L. Backpack mist blower for fire suppression. Fire Control Notes 23(4): 107, illus. October 1962.

course, the availability of manpower. Trained followup crewmen serve as relief blower operators.

For each man-hour, a trained crew can construct 18- to 20-inch firelines about 13 to 25 chains long, depending on amount of fuel, slope, rocky soils, etc. On February 12, 1962, a Class 4 fire day, 14 men and 2 blowers controlled the Koen Fire at 129 acres. Within 2½ hours after initial attack, they built and held 190 chains of fireline at the rate of 5 chains per man-hour. Blowers have since been used on all fires except those that were controlled by other means before a blower could be dispatched (fig. 2).

Summary

Some advantages of the backpack mist blower are:

1. Low cost: about $300.
2. Versatility: The mist blower can be used in timber management and other functions outside the fire season.
3. Portability in rugged terrain: The blower can be used where a man can walk safely.
4. High effectiveness in clearing fuel between small rocks where handtools cannot reach (fig. 2).
5. Speed: Fireline is built almost as fast as a slow walk.
6. Low skill requirements: Inexperienced men learn to use it quickly.

Some disadvantages of the blower are:

1. Ineffectiveness in coarse or matted fuels and in dense, low brush.
2. Inability to build fireline down to mineral soil.
3. Possibility of mechanical failure.

Special safety precautions to be observed in using the mist blower in fireline construction are:

1. Protect eyes of blower operator and nearby workers from flying particles.
2. Be sure of footing while carrying blower.

Figure 2.—Fireline cleared by the mist blower through an area too rocky for plowing or effective use of handtools.

3. Pick escape route to prevent heavily laden blower operator from being trapped by fast-moving fire.

Experience indicates safe, dependable, effective operation can be achieved rather easily. Advantages of fireline construction with the mist blower definitely outweigh disadvantages under the conditions described. Therefore, the backpack mist blower should be a powerful new fire suppression tool under certain fuel, soil, and topographic conditions.

Refill Device—(Continued from page 7)

The refill shown in figure 1 is designed for use with a 1-inch filler hose. If 1½-inch filler hose is used, item two can be exchanged for a 1-inch street elbow and item one for a 1- by 1½-inch brass bushing (fig. 2). Use of a 1-inch filler hose slightly reduces the volumes, according to table 1, that are picked up by the refill. The surface of item one that contacts the gasket of the filler hose may need facing to prevent cutting of the gasket and to insure a good seal. Item 11 is the jet that provides the power for the refill. It is constructed from a ½-inch air-hose coupling. The small end of the hose coupling is filled with bronze, and a ⅛-inch hole is drilled in the center of the weld. The hole sizes may be varied according to the volume of the pump and its operating pressure. The hexagon corners of the hose coupling must be ground off in order for it to pass through the hole in item 10.

THE EFFECT OF THE EARTH'S CURVATURE IN VISIBILITY MAPPING

C. E. Van Wagner,[1] *Fire Research Officer*
Canadian Department of Forestry

The profile method of drawing visibility maps has been well described in the literature, e.g., by Show et al. (1937)[2] and by Catto (1960).[3] Using good contour maps, reasonably accurate visibility maps can be drawn in the office. However, field checks are advisable. The techniques of field sketching are covered by Show et al. (1937)[2] and by Chorlton (1951).[4]

There are two variations of the profile method. In one, vertical profiles along lines radiating from the tower are plotted separately, and lines of sight are drawn to the successive ridges; the visibility information is then transferred to the radial lines on the map. In the other, use of a profile board permits the operator to plot visibility directly along the radial lines on the map without first plotting the profiles. A movable arm pivoted at the tower position is set at a different angle for each line of sight, and a vertical scale laid on its side is used to determine whether points on the other side of intervening ridges are visible.

Several sources of error in the profile method (e.g., height of trees on ridges, projection of ridges above highest contour, and doubt of exact tower elevation) are well-known, but there is one source that is not mentioned in the literature. This is the effect of the earth's curvature.

A formula is used to determine if that effect is large enough to be considered. In surveying, the vertical depression of distant points due to the earth's curvature is given in feet by $0.667\ K^2$, where K is the distance in miles. In practice, atmospheric refraction curves the line of sight slightly downward, reducing the apparent error to $0.574\ K^2$. Table 1 shows the depression in feet for distances of 1 to 20 miles. The actual errors in screening are always less than the figures given because the intervening ridge is lowered by the earth's curvature. Consider figure 1. T is a lookout tower, R is an intervening ridge at distance x from T, and P is a point at distance y from R. The dotted lines represent a flat-earth surface and the resulting plotted line of sight, the solid lines the curved-earth surface and true line of sight. The point P is screened from sight by the vertical interval between line of sight and the earth's surface; the interval is apparently greater in the curved-earth model than in the flat-earth model. The question is: How much greater?

Table 1.—*Depression due to earth's curvature and atmospheric refraction*

Distance	Depression	Distance	Depression
Miles	*Feet*	*Miles*	*Feet*
1	1	11	81
2	3	12	96
3	6	13	113
4	11	14	131
5	17	15	150
6	24	16	171
7	33	17	193
8	43	18	216
9	54	19	241
10	67	20	267

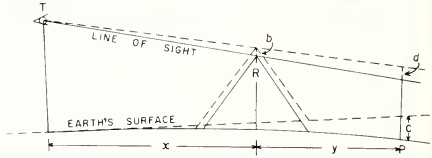

Figure 1.—Diagram of effect of earth's curvature in visibility mapping with exaggerated vertical scale.

The position of P is lowered by the earth's curvature an amount c, equal to $0.574(x + y)^2$. The line of sight is lowered an amount d, due to the depression of the ridge R by an amount b. But d bears to b the same ratio as the distances of P and R from T. That is,

$$\frac{d}{b} = \frac{x + y}{x}$$

but $b = 0.574\ x^2$

therefore $d = 0.574\ x^2\ \frac{(x + y)}{x}$

$$= 0.574\ x\ (x + y)$$

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[1] The author is stationed at the Petawawa Forest Experiment Station, Chalk River, Ontario.

[2] Show, S. B., Kotok, E. I., Gowan, G. M., Curry, J. R., and Brown, A. A. Planning, constructing, and operating forest-fire lookout systems in California. U.S. Dept. Agr. Cir. No. 449. 1937.

[3] Catto, A. T. Visibility maps for fire protection. Pulp and Paper Mag. of Canada, Woodlands Rev., Conv. Issue: 4-20, 41. 1960.

[4] Chorlton, R. W. The preparation of visible area maps by field sketching. Canada Dept. Resources and Devlpmt., Forest Fire Res. Note No. 16. 1951.

The net error in vertical screening equals e − d and is always unfavorable because e is always greater than d.

$$\text{Error} = e - d = 0.574(x + y)^2 - 0.574x(x + y)$$
$$= 0.574\,y(x + y)$$

The error is in feet, and the distances are in miles.

That is, the net error depends on the product of the distances from tower to point and from ridge to point: it is slight for points just past an intervening ridge regardless of distance, and substantial only for points far past a ridge. Table 2 shows the net error for a few sample configurations. The vertical errors due to the earth's curvature would be least in hilly country abounding in ridges because each would limit the line of sight for a short distance. In mountainous country the vertical errors would be small compared with the great variations in screening below line of sight, and the horizontal errors in visible area would be slight on steep slopes. *It is in fairly level topography with only a few ridges, each limiting the line of sight for a considerable distance, that the appearance of a visibility map might be considerably altered.* The effect of vertical errors would be more important on a map showing different degrees of vertical screening rather than simple visible area.

TABLE 2.—*Net curvature errors for some combinations of distances from tower to ridge and ridge to point*

Distance: Tower to ridge	Distance: Ridge to point	Net error	Distance: Tower to ridge	Distance: Ridge to point	Net error
Miles	*Miles*	*Feet*	*Miles*	*Miles*	*Feet*
5	1	3	15	1	9
5	5	29	15	5	57
5	10	86	15	10	143
10	1	6	20	1	12
10	5	43	20	5	72
10	10	115	20	10	172

(A potential pitfall in separating lightly and heavily screened areas with the profile board deserves mention here. Screening is understood in the vertical sense, not perpendicular to the line of sight. A negative error results if degrees of screening are marked on the movable arm, or if the width of the arm is used to separate light and heavy screening. This error is due to the exaggerated vertical scale and equals the difference between AB and AC in figure 2. The angle α of the movable arm is obviously the same as the angle BAC. Therefore, AB equals AC cos α. The error amounts, for instance, to 14 percent of AC when α is 30°, and to 29 percent when α is 45°.)

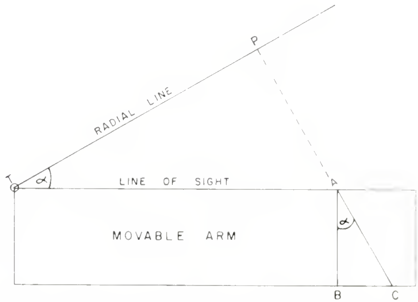

Figure 2.—Effect of measuring degree of screening perpendicular to line of sight instead of to earth's surface. True screening is along AC.

Whether the earth's curvature should be considered in a given job of visibility mapping can be judged by comparing some typical curvature errors in the tower area (consult table 2 or use formula) with the accuracy desired. The correction is readily made if profiles are plotted — each plotted elevation is reduced according to its distance from the tower (see table 1), and the drawn lines of sight will then be in the correct positions. If the profile board is used, a correction must be made both at the ridge when setting the line of sight and to each subsequent point as it is tested; alternatively, the upper edge of the board can be cut to the proper curve and placed tangent to the radial line at the tower.

According to the National Fire Protection Association, the two largest single property loss fires of 1964 probably occurred at Walker Air Force Base, N. Mex. On February 13 and on March 9, fire and explosion destroyed missile launching facilities. Each incident cost about $11½ million.

U.S.S.R. FOREST FIRE RESEARCH AND METHODS OF FIRE CONTROL[1]

Valentin G. Nesterov, *Head Forestry Chair*
Timiryasev Agricultural Academy, Moscow, U.S.S.R.

U.S.S.R. forests contain 25 percent of the world's forest resources. Much attention is given to the protection of these forests from fires. An effective fire control system is the main component of forest fire research. It is used to regulate the type and amount of fire-prevention measures used throughout the country.

A system of forest fire protection was first expounded by the author in 1939.[2] As a principle of the system, we take the mathematical expression of interaction among the following components: Burning ability, fire weather. propaganda. fire-resistance characteristics of the forest. discovery and analysis of fires. and localization and suppression of fires.[3]

The fight against forest fires can be represented by a formula. with six major factors. that is perfect only when we have few fires and suppress them early. In viewing the formula. imagine two competing forces—one representing fire strength and the other fire suppression forces.

The first step in the fire control system is the division of the forest into plots—blocks of the same burning ability and. of course. of the same fire danger. This first procedure is as follows:

Neighboring plots or blocks should first be distributed into classes of burning ability.

Class I.—Coniferous stands on dry or fresh soils. and plantations of leaf-bearing forest on dry soil.

Class II.—Coniferous stands on wet and swamp soils.

Class III—Leaf-bearing stands on fresh and wet soils. (In some regions fresh leaf-bearing stands can be included in Class II).

Each class of forest blocks is subdivided according to fire danger into the following sections:

Section A.—A road is inside the section or not more than 200 meters away, or a settlement or a timber enterprise is within 5 kilometers.

Section B.—The nearest settlement is within 5 to 10 kilometers.

Section C.—It is more than 10 kilometers to the nearest settlement.

To calculate the second determinant of the system we have defined the fire danger of weather using "complex meteorological methods."

Experience gained from meteorological studies of 20.000 forest fires shows that duration of dry season. quantity of rainfall. temperature of air. vapor-pressure deficit. and windspeed are the best indices of burning ability of vegetation.

Understanding of physical processes occurring in the phenomena and the correct establishment of interaction coefficients permit us to construct the most reliable index of fire danger to forests. The general formula is:

$$T = K_1 K_2 \int F(u) du$$
$$\cong K_1 K_2 \Sigma (u)$$

where: T = burning index;

u = meteorological index for a day

$= t\ d$ where t = temperature; d = vapor-press deficit;

K_1 = coefficient representing last rainfall; and

K_2 = coefficient representing wind influence

= 1 for wind <6 meters/second (0–12 m.p.h.)

= 2 for wind = 6–10 meters/second (13–22 m.p.h.)

= 4 for wind >10 meters/second (23+ m.p.h.).

For example, let us see what changes occur in the burning ability of a forest with changes in the simplified complex index, $\Sigma (t\ d)$. Here one must consider the sum of products resulting from the multiplication of temperature of air, t, by vapor-pressure deficit, d, at 13.00 each day beginning from the last rainy day and ending on the day when the burning index is calculated. This determinant changes as follows:

Class I.—The index is less than 300 degree-millibars. Fires are impossible.

Class II.—500–1,000 degree-millibars. Weak surface fires can appear.

Class III.—1,000–4,000 degree-millibars. Strong surface and weak crown fires are quite possible.

Class IV.—More than 4,000 degree-millibars. Generally dangerous crown fires can result. Burning ability is very strong.

On the basis of these classes the Central Institute of Weather Forecasting publishes daily information maps

(Continued on page 14)

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[1] Adapted from paper presented at Symposium on Forest Fire Research, Tenth Pacific Sci. Cong., August 1961.

[2] Nesterov, V. G. Instructions on working out a plan of fire protection measures of a forest. All-Union Res. Inst. 1940.

[3] Nesterov. V. G. Burning ability of forest and methods of its defining. 1949.

FIREFIGHTING FARM LABORERS

Morrison "Jim" James, *Forester,*
Division of I&E, Berkeley, Calif.

Forest Service fire control officers fighting wildland fires in California have seen their initial attack crews fail to stop a fire. Fast followup was required to contain the fire in the first burning period. When California is hard hit by simultaneous fires or by a large fire such as the recent Coyote Fire, the supply of local pretrained and organized crews may be exhausted. The Forest Service must then rely on crews recruited from outside sources.

Reserve Labor Supply

The City of Porterville, headquarters for the Sequoia National Forest, is in an agricultural area where farm labor requirements are only intermittently great. A labor force of several hundred men, primarily of Spanish-American extraction, lives in and near Porterville. The Forest Service has usually obtained pickup labor by contacting one or more of three labor contractors. The contractors, after assembling the desired number of men, were hired as labor leaders. Fortunately the normal fire season coincided with a period when farm labor requirements were low.

Individual laborers were hardened physically and were skilled in the use of handtools; however, many had physical defects and many could not speak English. In addition, mobilization was slow, turnover was great, and teamwork and prefire training were lacking.

The three contractors, all of Spanish-American extraction, were known by reputation and experience to be reliable, conscientious, and anxious to help the Forest Service and the farm laborers they worked with. They were classified as labor leaders and were asked to select one man as a crew leader for each 25-man crew and one man as a squad leader for each 5 to 7 laborers. The crew and squad leaders were chosen, subject to approval of the Forest Service, and a graduated pay scale was worked out, commensurate with the responsibility of the position.

Each labor leader organized three or four 25-man crews. Labor leaders and crew leaders must be able to speak English and Spanish and must attend a Forest Service training session. Crew leaders are required to have previous fire experience and a current physical examination on file with the Forest Service. Alternate squad leaders are designated to save time in making up crews. The crew man must be accepted as a mem-

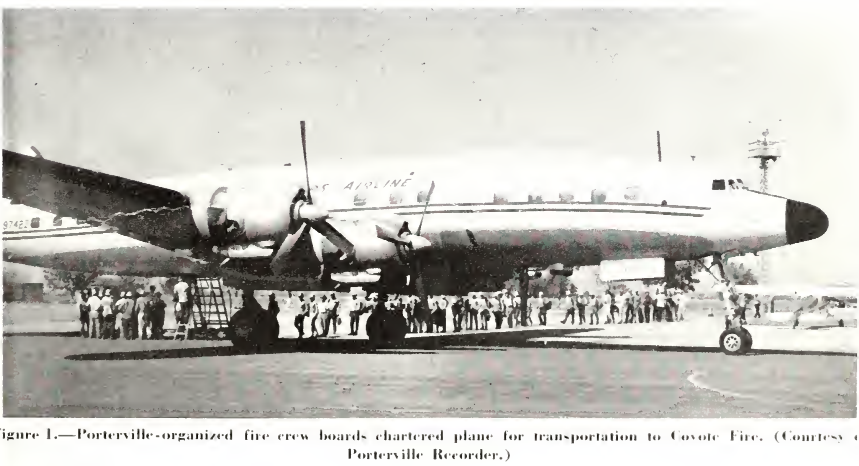

Figure 1.—Porterville-organized fire crew boards chartered plane for transportation to Coyote Fire. (Courtesy of Porterville Recorder.)

ber of a crew and have a record of a recent physical examination on file. While not necessarily desirable, crew men are permitted to shift between crews. This is done primarily to reduce the time required for roundup and mobilization.

Each man on the approved list is issued a card showing his name, address, crew affiliation, and highest qualified position. This card must be presented before he is hired for each fire. The card expires when he is due for his next physical examination.

Training

Training sessions are conducted by the Forest Service and the California Department of Employment. Attendance is required of all leaders. Emphasis is on Forest Service fire organization, crew organization and function, safety, rules of conduct, and requirements for employment. The curriculum is designed to equip the native leaders to provide for crew welfare, integrity, and safety, on the line and in camp. They are expected to work under the direct supervision of a qualified Forest Service fire crew boss and operate the crew as a well-organized, skillful hand crew. The leaders do receive some training in firefighting techniques and skills. However, most instruction is on-the-job training. A crew may be suspended from the hiring list for failing to do a good job.

Results

Results have been good. About 350 trained and well-organized men are available from this source and can be bussed or flown to a fire (fig. 1). The California Department of Employment office in Porterville has the personnel and facilities to screen and sign these men in a minimum of time, day or night. During the 1964 fire season these crews were called on to fight 16 fires on seven National Forests. They worked 10,140 man-days.

U.S.S.R.— (Continued from page 12)

showing meteorological indices of the burning index of our forest areas, and issues bulletins forecasting the burning index of forests for 3 days, a synoptic period of about 1 week, and 1 month. This service enables us to discover fire at the initial stage of its development and to arrive quickly—the most important needs in firefighting.

The third point of the system requires improvement of propaganda concerning precautionary measures against fire and rules on careless handling of fire sources in forests. We use widely the extensive opportunities provided by the press, cinema, television, education, etc. We have found it useful to determine fire-prevention rules for special forestry activities—forest cleaning works, timber exploitation areas, forest settlements, etc.

The fourth point of the system involves strengthening the fire-resisting characteristics of the forest. It is of great value to clear logging debris and dead trees, to plant fire-protection forest belts, to sow fireproof grasses, to build firebreaks, to construct communication lines and roads, and to properly distribute fire-lookout towers, landing fields, and fire-chemical stations. To obtain the most efficient fire prevention, cuttings, mineralized zones, wet and grass barriers, wet forest zones, rivers, streams, and roads should divide forest areas into isolated blocks as small as possible. This is my "principle of an exclusive circle of barriers."

The fifth factor of the system is to discover forest fires as quickly as possible and to determine their characteristics. The best results are achieved by combining ground and air watch services. Great attention must be given to the use of photoelectric cells, radar, and other technical achievements.

Localization and suppression of fires is the sixth part of the system. According to my proposal different types of fire-chemical stations with motor and horse-drawn transport were organized. The following comparative coefficients indicate the speed of localization and suppression of forest fires, with different suppression techniques:

1. Digging a trench around a fire with handtools—1.
2. Horse plowing in two furrows—15.
3. Horse plowing in one furrow—30.
4. Tractor plowing—60.
5. Creation of chemical protection belts using portable sprayers—3.
6. Liquidation of fire by hand pumps—9.
7. Suppression of fire by flamethrowers—10.
8. Liquidation of fire by chemical solutions using portable sprayers—12.
9. Liquidation of fire by water using motor pumps—20–30.
10. Development of protective chemical and mineralized zones using tractors—45–60.

The fight against forest fires from the air also gives good results.

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