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FIRE CONTROL NOTES

A PERIODICAL DEVOTED TO THE TECHNIQUE OF FOREST FIRE CONTROL

FOREST SERVICE • U. S. DEPARTMENT OF AGRICULTURE

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

Volume 21 Number 4

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

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

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Forest Service, Washington, D. C.

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RAILROAD FIRES[1]

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

I welcome the opportunity to meet with you to consider the very important subject of railroad fire prevention. Fire prevention, like the frequency of man-caused fires, has its "ups" and "downs." Apparently we are in an "up" period nationally. All protection agencies taken collectively have had an upsurge in man-caused fires during the past 2 years. Many explanations are given for this but it would be difficult to be certain of the true cause. Apparently, there is no one cause but several. This upswing in man-caused fires has focused renewed attention on fire prevention.

We are beginning some fire prevention research aimed at trying to determine the exact cause for fires, the reason behind the cause, and at trying to evaluate the various prevention efforts now used with all man-causes. We look forward to the time when application of increased knowledge and improved methods will greatly reduce fires within the forests. We hope railroad fires will follow this path. Recent experience on the national forests has been encouraging.

Railroad fires have been of concern to the Forest Service since we were given the job of protecting the national forests nearly 60 years ago. Fires from railroad causes were very common in western national forests in the early days. Not much attention was paid to either suppression or prevention in those times. As we were able to greatly reduce the acreage burned and resulting damages through better fire control, we began to give more attention to preventing all fires. We recognize that the best fire is the one that never happens. This emphasizes prevention.

In examining the fire record of the national forests for the past 10 years, I note that there has been a general reduction in railroad fires, but the pattern by regions and national forests is irregular. For example, for the 5-year period 1949-54 there were 1,082 railroad fires on the national forests. For the next 5 years this had dropped to 604 or to nearly one-half.

When I set out to plan this paper I asked each Forest Service region for ideas on railroad fire prevention. This included their problems, programs aimed at fire prevention, changes taking place in relations with railroads, and suggestions for betterment. Most regions pointed to a marked decrease in railroad fires. For instance, in Alaska, there have been only three railroad fires on

[1]A paper given at the Railroad Fire Prevention Conference, Roscommon, Mich., June 6-8, 1960.

the national forests in the last 6 years compared to 148 in the previous 5 years. Other regions report a fluctuating situation. Where the situation has improved materially our men credit the improvement to both technology and man's actions. Conversion to diesel equipment, installation of improved spark arresters, new systems of central control which eliminate use of fusees, and other devices have done much to better the situation. I think we must recognize also the improvement in people's habits and in the attention given this problem by the railroads. I am sure there is greater care in tie burning, smoking, right-of-way burning, and similar work jobs. Either Smokey Bear is reaching the railroad employees, or more railroads are giving direction to fire prevention. These and other means are bringing about a better realization of the need to be careful with fire. I will mention more about programs and their merits.

But now let's analyze briefly the specific causes of railroad fires. I was unable to get a complete breakdown of causes, but I think we all recognize those most common and prevalent. Locomotive sparks have, in the past, and continue to be, one of our big worries. Conversion from steam to diesel locomotives has helped. However, we can be certain that diesel engines still cause many fires. One of our big problems is to convince some that diesel engines, whether they be on the railroads, in tractors, or in motor vehicles, can and do cause fires. For several years we have contemplated a new study on the ignition properties of various carbon sparks on forest fuels. Needed answers have been slow because of little financing for such work and our inability to obtain cooperation from industries that should be interested in this subject. Engine manufacturers, fuel producers, and others should be willing to support a program for getting better answers. We are hoping something like this can be worked out soon.

The seriousness of the internal combustion engine spark problem is almost in direct ratio to the number of days of bad fire conditions in any particular area. For instance, one region reports they have a problem whenever humidity is below 25 percent and a particularly serious one when humidity drops to 15 per cent or below. There, of course, are many related sidelights to this problem. These concern idling engines, steep grades, lack of adequate arresters, poor maintenance of equipment, and similar deficiencies.

Brakeshoe sparks are a serious problem and, in some localities, appear to have replaced engine sparks as the No. 1 "boogie." It has been difficult for me to find specific information regarding this cause. Several of our regions reported an improved situation with the changeover to dynamic brakes. I don't know what dynamic brakes are but if they will stop brakeshoe sparks, I am all for them. Brakeshoe fires are still a serious problem and need attention.

These two important causes are of a mechanical nature. People are involved, but their responsibility is not so apparent. There is, however, a set of causes associated with railroads which relate directly to the acts of individuals—usually railroad company employees, although in a few cases they may be users. Under this general class I include tie burning which is a serious risk in dangerous fire weather. There is the ever present problem of smoking by employees and users. Smoking is our No. 2 man-caused fire problem nationally.

Fusees set along tracks to warn approaching trains are a common fire cause. The increased use of central controls or other means of nonfire signaling are encouraging. However, these methods are not practicable in all instances and we continue to have fusee fires in many localities. Generally we no longer have wood-or coal-burning locomotives but there is still a problem of sparks and ashes from dining car stoves, and stoves in mail or express cars and cabooses. Some railroads use coal or briquettes. Sparks may be observed rolling from chimneys at night, and ashes, if dumped in a hazardous place, easily start fires. Right-of-way burning, while preventing many fires, still causes fires. These fires usually result from burning too late in the fire season, or from inadequate preparation and lack of precaution during actual burning. Burning is a valuable tool but it is not cheap and requires skill and care to assure fires do not escape the planned area. Hobos are another cause directly related to railroads and men, but I am not sure you can entirely blame the railroads. These voyagers of the railroads have largely transferred their allegiance to the paved highway and hitchhiking, but a few "jungle" camps have "residents" who cause fires by careless smoking or campfires.

I have given a brief rundown of the problem. Now what can we do about it? Actually that is why we are here and I would be presumptuous if I were to claim knowledge of the complete answer. However, to get things started, it might be well to list some of the things that I believe should be done to a greater extent than at present. In the sparks-from-engine field there are many developments taking place in arresters. It is refreshing to hear of success experiences such as the major railroad on the west coast that has practically eliminated locomotive fires in one year with a new turbo type arrester. I recall at a former meeting such as this there was much talk regarding fuels and additives and what might be done in that line regarding the problem. Undoubtedly there have been developments since then although they have not been brought forcefully to my attention. I am sure we will hear more about them before this meeting is over.

There was also previous mention of engine design. I am now getting entirely out of my field, but if something can be done in the original design of engines to eliminate fire-starting sparks, certainly that will be very worthwhile. Many of our field people tell me that when new diesels are first put into operation they do not cause fires, but as they get older they begin to give trouble. This probably goes back to contributing problems of equipment inspection and maintenance. These are important if we are to be sure equipment does not emit dangerous sparks. Engines permitted to idle for a long time at one place and build up carbon often throw sparks. I know this problem is not easily cured but it must be met.

As I mentioned previously, I hear some very good reports on dynamic braking as a remedy for the brakeshoe problem. Again this is not within my field of experience or knowledge, but I am sure that additional work could be done on braking materials, or perhaps dynamic brakes can be adopted universally. If this is not possible, simply a matter of more care offers some remedy.

When we get into the field of people's actions we are, of course, exploring the field of why people do things and what influences them. Here we need some human "research." Recently I attended a management session in which one thing said frequently was "don't look under the hood" in relation to people. However, I feel we must "look under the hood" to find out why people do things if we are to change their habits.

Education is needed with railroad people as well as with others. This can be done through posters, talks, articles in trade publications, and similar media. It has always been somewhat of an enigma to me why some major railroads do not show more concern about damaging fires caused by their operations. I believe much can be done to cure a basic problem if all companies show more concern. Employees usually reflect the policies and concern of management. If management is genuinely concerned about stopping fires, the actions of the employees are going to be influenced.

Then, of course, there are a lot of "doing" jobs which can help eliminate railroad fires. Removing hazardous growth from the rights-of-way is a positive measure, but in these days of concern with soil erosion and attention to land management we can expect an increasing public concern about burning or excessive removal of vegetation from rights-of-way. In total, these rights-of-way amount to a lot of land area in the United States. Plowing or bulldozing firebreaks also creates some problems. Not enough has been done to find fire-resistant, slow-growing plants for ground cover. We are looking for some such plants for the mountains of Southern California to replace highly flammable brush which is now the principal watershed cover. If some good new cover is developed, I am sure the information will be passed along to the railroads for widespread use.

A field of action which we usually try to avoid, but which has its place in any complete program, is law and regulation. Where railroads cross national-forest land, we have regulating clauses in use permits and agreements. These have been helpful in the total fire problem even though they have sometimes been resisted by railroads, and have been the subject of more than one verbal battle. Many States have regulatory laws requiring cleanup and certain preventive devices on the equipment. In our present society, laws and regulations are necessary and I think will continue to be necessary in railroad fire prevention. However, I hope, in the long run, education and a cooperative approach will greatly reduce our railroad fires and eliminate the need for more laws or regulations.

I am sure large fire suppression bills and damage payments for railroad-caused fires have been a strong deterrent to more fires. Fire prevention is a major objective of law enforcement. However, we would much rather prevent a fire than prepare necessary reports and make a case for collecting costs and damages. These are necessary when government property is destroyed or costs incurred by carelessly caused fires. I hope, in the future, our program can be largely based on a cooperative approach in which the protection agencies, the railroads, fuel companies, equipment manufacturers, and others concerned would each assume responsibility to better the current record.

Our regions report encouraging results of meetings between Forest Service and railroad people, many of which have been held jointly with State and other protection agencies. Joint inspections of rights-of-way and equipment, annual discussion of problems, memos of understanding and local arrangements all fit this cooperative picture. I am optimistic that by assuming an attitude of cooperation and by working hard at it we can materially better our railroad fire record in the coming years. Certainly this is a program that we can join without controversy and one I can assure you the Forest Service will do all it can to further.

TRACTOR-PLOW LINE BURNING DEVICE

L. W. LEMBCKE

Chief, Mechanical Section, Wisconsin Conservation Department[1]

For many years, tractor-plow fire suppression units have been in use. Each year thousands of fires are suppressed, and over the years detailed information has been provided on the tactical use of tractor-plows. The basis for widespread adoption of the tractor-plow has been the speed at which good line can be constructed.

The amount of line that can be constructed, however, is only part of the story and is not as important as the amount of held line. It has been stated that the rate of line holding is generally about one-fourth the rate of line plowing. If this is the situation, either the rate of line holding should be increased or the rate of line plowing reduced.

Experience in Wisconsin can be compared with experience elsewhere. Equipping tractor units with two 75-gallon saddle tanks and a power take-off pump has increased the rate of held line. Late model tractors with more powerful engines and longer tracks, and equipped with hydraulic pumps for plow control, seem likely to increase the rate of line plowing, and the 3 to 1 ratio may maintain.

The need for adequate burning out of lines at a greater rate of speed was recognized, and all the varieties of backfiring devices from fusees to drip torches were tried out over the years. The limiting factor, if there was only one, seemed to be the rate at which known devices, and these must be lightweight, could burn out line under most conditions. Man-carried devices were slow and caution usually dictated that fire would not be set faster than the line holding crew felt was safe.

As a result, in many instances the tractor-plow units construct line at their best speed and depend on both line holding crews and numerous plow lines to establish early control. Quite often this effort is successful, but on high intensity fires the amount of line plowed is many times the amount of line held. This has many obvious disadvantages.

An approach to the problem of more nearly equalizing the ratio of line holding to line plowing is the installation of an automatic burning device on our standard sulky plow (fig. 1). The entire operation is controlled by the tractor operator and requires no manual effort other than the operation of a switch.

The fuel is L-P gas (propane) contained in two 40-pound tanks securely mounted between the moldboards of the plow and providing a 4- to 6-hour supply. The tanks are connected to an adjustable regulator (reducing valve) which reduces the gas

[1]Photographs by V. E. Holtz, Wisconsin Conservation Department.

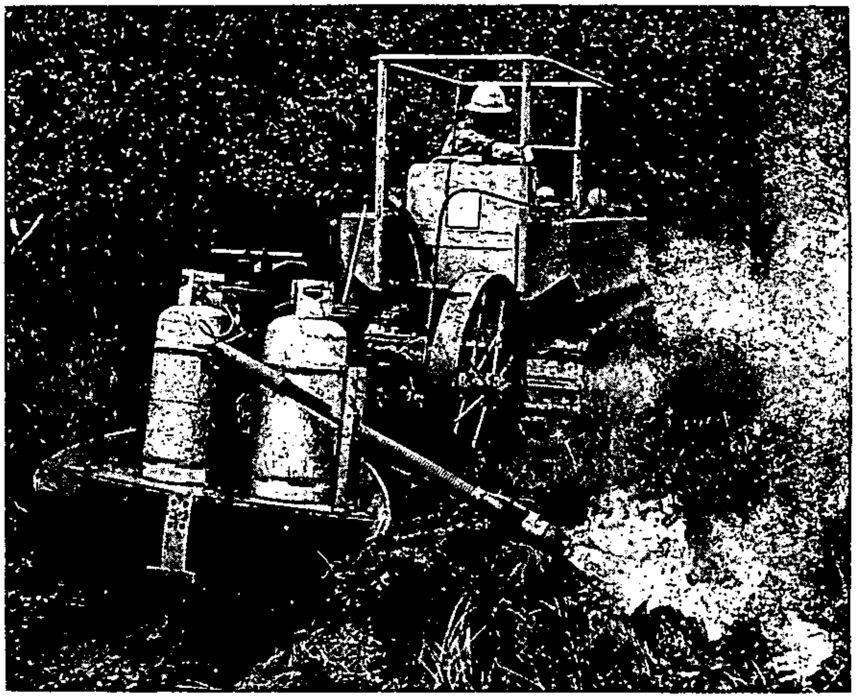

FIGURE 1.—Tractor-plow line burning device in operation.

pressure to a preset level (10-30 pounds) and feeds it to a solenoid valve. The gas flows from the solenoid valve through a rubber (welding) hose to the burner (fig. 2).

The burner is mounted on a heavy coil spring which allows the required flexibility and provides a housing for the gas hose and ignition wire. The burner is a common type L-P gas burner having a capacity of about 300,000 B.t.u. at 30 pounds pressure and will produce a 3-foot flame. A spark plug is incorporated in the burner for igniting the gas. The current for opening the solenoid valve and ignition is taken from the tractor battery and is controlled with a single automobile ignition switch. High voltage for ignition is produced by means of an automobile ignition coil located on the plow. A condenser is located across the points on the switch to give a better spark.

In use, the manual valves on the tanks are opened. Whenever burning is required, the tractor operator, by turning the automotive type ignition switch to the "run" position, opens the solenoid valve permitting the gas to flow through the nozzle. Positioning the switch to the "start" position and releasing it produces one electrical arc on the spark plug. Repetition of the spark plug ignition, if necessary, can be had by repeating the "start" switch operation. Moving the switch to the "off" position closes the solenoid valve shutting off the gas supply.

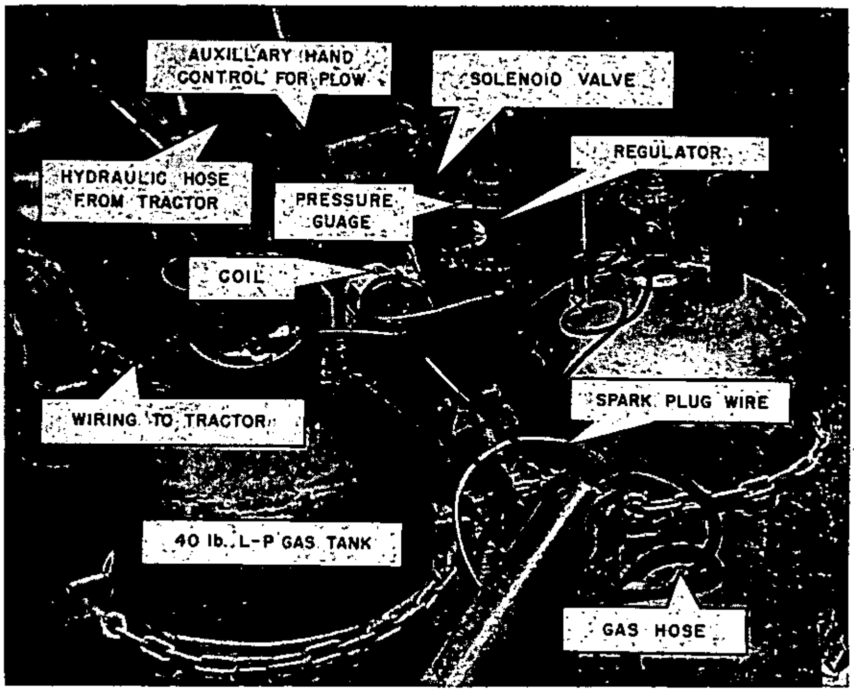

FIGURE 2.—Close-up of ignition system and regulation of gas supply to burner.

The burner head mounting has vertical and lengthwise adjustments to meet the various plowing conditions. Removal of two self-locking pins permits a rapid change from one side of the plow to the other.

As an added safety precaution, the manual control valves on the gas tanks are closed while the unit is in storage. The entire control assembly is protected with a guard, not shown in the photograph. Four units have been installed and are in operation. Continued field use will demonstrate the value of the device and influence the final details of design. Since the installation of the pilot model, minor changes have been made based on experience, but the basic idea is unchanged. Following additional field experience by suppression crews, modifications, if any, will be incorporated and plans developed for more units.

PRESSURIZED PUMP CAN DESIGNED FOR MOPUP

JAMES G. FISHER
Farm Forester, Oregon State Board of Forestry

A new type of backpack pump can has been developed by Doyle Stockton, Assistant District Warden, Oregon State Board of Forestry, Medford, Oreg.

The Stockton pump can is a 2½-gallon container consisting of two cylinders carrying water under pressure (fig. 1). Connections at the top and bottom of the container equalize the pressure and amount of water in the two cylinders. This construction also balances the weight of the water and prevents it from shifting within the pump can.

Water is placed in the pump can by unscrewing the pump located on top of one of the cylinders. A later model will be filled through the top of the other cylinder, whose concave lid is to serve as a container to collect water from shallow waterholes. Pressure for the can is applied by means of approximately forty to fifty strokes of the pump handle.

Using a pistol-type nozzle with adjustable tip, water can be directed just where it is needed in the amount needed and under effective pressure.

A belt-type holster will be developed for the nozzle, leaving both hands free for tool work when water is not needed. The pump can may be mounted on a small packboard, although the can is molded to fit the fire-fighter's back by having a contour plate welded to it.

FIGURE 1.

FIRECLIMATE SURVEY TRAILER

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The need for a compact mobile unit to record around-the-clock weather observations with a minimum of attention may be answered by the fireclimate survey trailer (fig. 1). Designed for use on fire environment studies or going fires, this unit packs a full complement of instruments and is readily transported behind a jeep or pickup.

This war-surplus 2-wheel ¼-ton trailer is known to the Armed Forces as the M-100 cargo trailer. It was fitted with a rooflike canopy made of ⅛-inch aluminum and supported by aluminum angles. Each half of the canopy consists of two doors which may be opened in pairs or individually, and the entire top was weather stripped for protection against dust and moisture. The unit is equipped with a recorder, power supply, and weather instruments.

The recorder keeps track of wind speed and velocity on a strip chart. It is an Esterline Angus 20-pen operation (event) recorder model AW, shock-mounted in a weatherproof metal box. To insure safe transporting, the entire unit is bolted to the floor of the trailer with shockproof motor mounts.

The power supply is mounted in an identical metal box together with a master timer and electric circuits. Special circuits for energizing the anemometer and wind vane were necessary to insure long battery life and ample current when all pens of the recorder were being used. The circuit design is a resistor-capacitator type and uses ten 3-volt batteries for power (fig. 2).

With this setup, wind direction can be recorded in code to eight directions of the compass by four pens of the recorder (fig. 3).

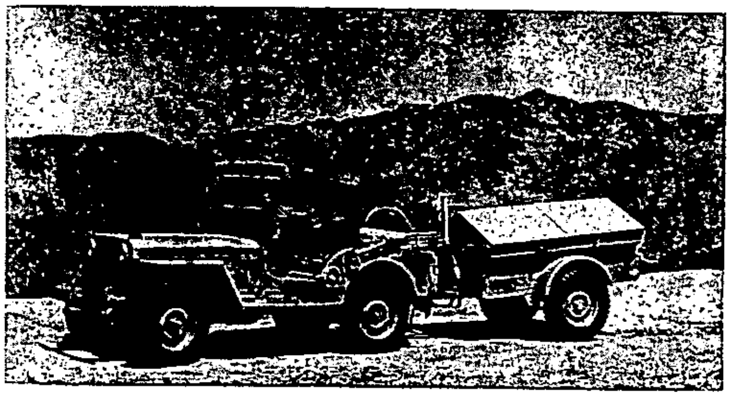

FIGURE 1.—Fireclimate survey trailer and jeep.

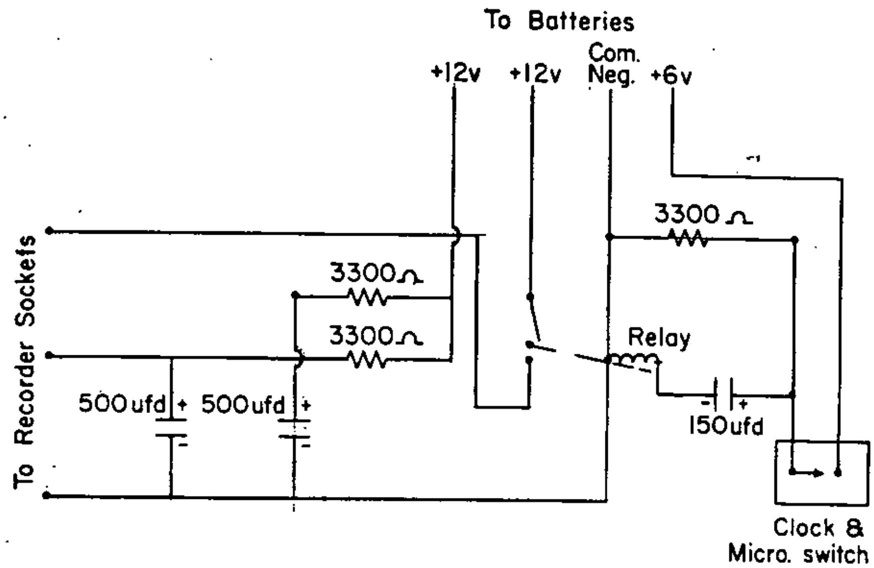

FIGURE 2.—Circuit for anemometer and wind vane.

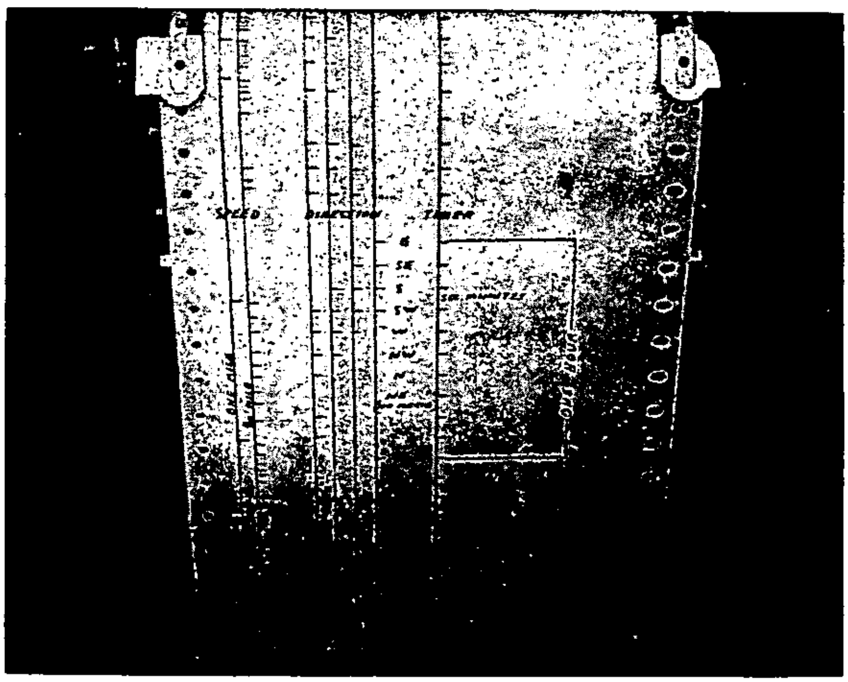

FIGURE 3.—Strip chart recorder showing record of wind speed, wind direction, and timer clock.

Wind direction is recorded every 6 minutes. To record eight directions with four pens, one direction must be coded to use no pens and hence leave no marks. Therefore the master timer is needed to verify that the recorder and other components were working when no mark was made. To do this job, a separate timing clock is connected to one pen of the recorder. The clock's microswitch also activates the wind vane circuit every 6 minutes. Wind speed is recorded by two pens, one marking each mile of wind and another each one-tenth mile.

Instruments carried in the trailer include wind vanes and anemometer, hygrothermograph, and fuel-moisture sticks and scale.

The wind vane, designed by the Forest Fire Research Division of the Pacific Southwest Station, has five silver-tipped contacts, one for each wind-direction pen on the recorder and a ground. The vane has proved both trouble- and maintenance-free during extensive field use. A small airways type anemometer is used.

The hygrothermograph is a standard Friez model with an 8-day clock. A padded, shockproof metal box mounted on the trailer floor provides safe and weatherproof transportation for the hygrothermograph, and for ½-inch fuel-moisture sticks and their wire supports and portable scales (fig. 4).

The instrument shelter was also designed especially for fire-climate surveys. It weighs only 18 pounds, is about 16 inches

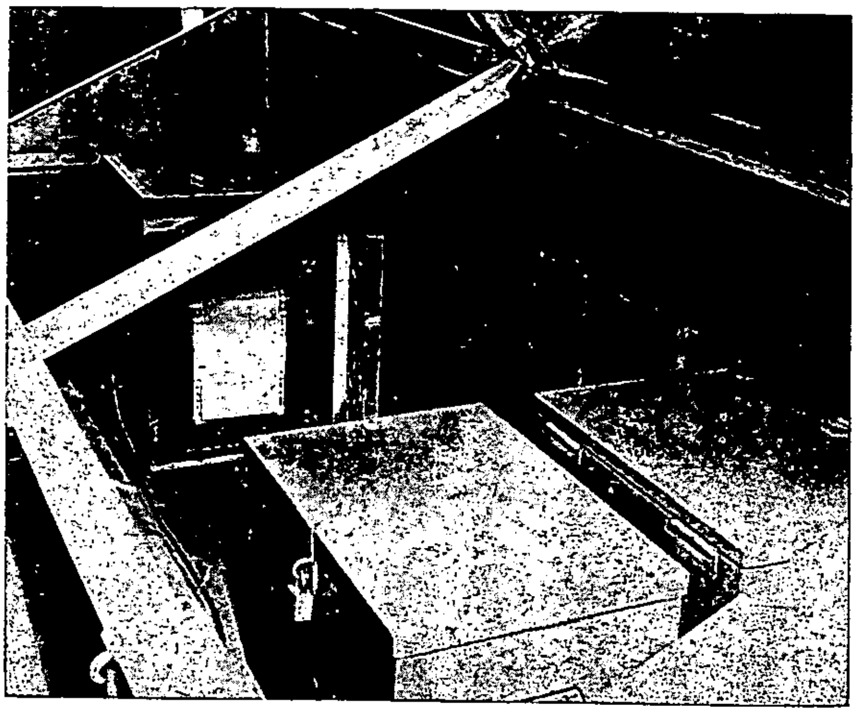

FIGURE 4.—Closeup of interior of trailer.

square, and is adapted for use with screw-on telescoping legs. In recent tests, temperature and relative humidity in the small shelter showed no appreciable difference from those in a standard shelter. Shelter and tripod legs are strapped to the trailer floor for transporting.

A 24-foot telescoping mast supports the anemometer and wind vane (fig. 5). Made of lightweight aluminum, the mast collapses to 6 feet. When extended, it can withstand winds of more than 100 miles per hour, without use of guy wires. The mast is mounted by sliding it into a 4-foot, 1 ¾-inch pipe welded to the trailer frame and body. Two tapped holes in the pipe sleeve take wing bolts which apply a light pressure on the mast to prevent it from twisting after the wind vane has been orientated.

The mobile unit has performed satisfactorily on three going fires and one fire investigation, and it has been a valuable aid to both the fire-weather forecaster and the fire behavior specialist.[1] All the instruments have undergone extensive field tests, some for more than 2 years. One installation gave more than 39,000 consecutive recorded observations over a 5-month period without major servicing. The unit performed well in temperatures ranging from 5° below zero in 24 inches of snow to over 114° above.

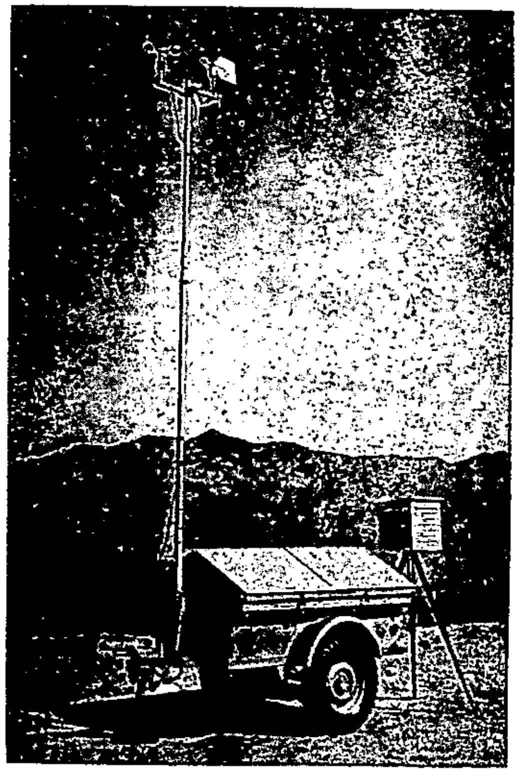

FIGURE 5.—The fireclimate survey trailer in operation.

[1]C. C. Chandler and Clive M. Countryman. *Use of Fire Behavior Specialists Can Pay Off*. Fire Control Notes 20(4): 130-132. 1959.

It withstood winds of 80 m.p.h. The only modification planned is to replace the aluminum cover with a fiberglass canopy which will be lighter, more easily waterproofed, and more easily mass produced.

The fireclimate survey trailer can operate in all types of weather, has low power requirements, and can be set up in less than half an hour and left in one location indefinitely. It needs checking only once every 8 days. It compiles and maintains legible and accurate records of wind speed and direction, relative humidity, and temperature. There is ample room to carry other instruments.

REDUCTION OF FUEL ACCUMULATIONS WITH FIRE[1]

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Forester, Southeastern Forest Experiment Station

Prescribed burning has often been used to reduce fuel accumulations, but only rarely has specific information been gathered to determine the effectiveness of a burning program. A 4-year study on the Camp Experimental Forest[2] in Sussex County, Virginia, provides a measure of the effects of repeated prescribed burns on the depth and character of the forest floor. The objectives of the burning program were seedbed preparation, fuel reduction, and the control of understory vegetation.

The stand used in this study consisted mainly of 60-year-old loblolly pine (*Pinus taeda* L.) in mixture with blackgum (*Nyssa sylvatica* Marsh.), red maple (*Acer rubrum* L.), and a scattering of various oaks. The average basal area per acre was 120 square feet for the pine and 35 square feet for the hardwoods.

Initially the very abundant shrub layer, composed mostly of Clethra and Vaccinium, had an average height of about 2½ feet. It probably would have prevented adequate pine regeneration after harvest unless reduced by some special treatment.

Below the dense shrub layer was a heavy accumulation of litter. Measurements of the litter depth and shrub height were taken before each fire (table 1). The average fuel accumulation was 4.8 inches deep and consisted of normal forest leaf and twig fall, along with larger pieces of wood, stumps, down trees, and other woody material. According to Metz, the average annual litter fall from such a stand is slightly more than 2 tons per acre.[3]

The stand was located on two soil types: Fallsington very fine sandy loam and Othello very fine sandy loam, about equally represented. These soils have very poor drainage; water stands on the Othello most of the year. Under such conditions, normal decomposition is greatly retarded, resulting in an excessive buildup of litter and in the development of an A_0 horizon. This horizon consists of partially decomposed organic matter and contains many small leaf pieces and roots.

The A_0 horizon or mat is usually very moist and is not ignited by the ordinary prescribed burn, except when a stump or log

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[1]This article was presented as Southeastern Forest Experiment Station Research Notes 143 in April 1960.

[2]Maintained in cooperation with Union Bag-Camp Paper Corporation, Franklin, Va.

[3]Metz, Louis J. *Calcium content of hardwood litter four times that from pine; nitrogen double.* U. S. Forest Serv. Southeast. Forest Expt. Sta. Res. Notes 14. 1952.

catches fire, thus drying out the mat around it. Then a slow, smoldering ground fire is started that is very difficult to extinguish short of flooding or trenching to mineral soil. When exposed by fire or other disturbances, the residual mat forms a very good seedbed.

The study area was composed of four 40-acre compartments. One compartment was not burned, and served as a control. The others received a winter burn, and then one, two, and three summer burns respectively.

The winter fires served to create more uniform conditions within each compartment, and were considered as a preparation for the summer burns to follow. These winter fires reduced the height and density of the low hardwoods and facilitated wind movement through the stands.

The summer fires, in June or July, did the heavy work of fuel reduction, control of understory vegetation, and seedbed preparation. Most of the study area was burned by head fires, although backfires were frequently used to prevent breakovers into unburned areas.

The weather characteristics were very similar for all of the summer fires. The burning index was 4 or 5,[4] the relative humidity was close to 50 percent each time, and the air temperature between 84° and 92° F. The fuel moisture ranged between 5.6 and 7.6 percent. Winds were westerly, with velocities usually close to 2 to 4 m.p.h. measured at 8 feet above the ground.

At the end of the burning program, samples of organic matter were collected, weighed, and separated into their woody and litter components. Subsamples of woody and litter fuel were ovendried and a conversion factor obtained so that the dry weights could be expressed as tons per acre of dry fuel.

The results revealed that each fire caused a considerable reduction in the depth of the litter and in the average height of the shrub layer. A fuel reduction of 9.1 tons per acre resulted following a winter and one summer burn (table 2). Two additional summer fires removed another 5 tons of fuel per acre. The most surprising fact revealed by this study was the very high initial fuel weight of 36 tons per acre. This concentration can best be explained by the wet, poorly drained site and heavy stand of trees and lesser vegetation.

Supplementary samples were taken to determine the relative amounts of the readily flammable upper layer of litter and of the less flammable lower layers. The first series of fires (one winter, one summer) caused considerable change in the composition of the fuel; subsequent fires seem to have had little effect upon the relative amounts of the two fuel types (table 3).

This study points out that on Fallsington and Othello very fine sandy loam soils, fuel accretion comes not just from leaf and twig fall, but also from below. The dark mat of partially decomposed organic matter that develops under such conditions dries out and fluffs up following a fire in the litter above, and is capable of sustaining a fire within a short time.

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[4] Type 8-0 Fire Meter

TABLE 1.—*Average litter depth and shrub height before each fire*

Time of measurement	Litter depth	Shrub height
	Inches	*Inches*
Before the winter fire	4.8 ± 0.6	29.3 ± 4.6
Before first summer fire	3.0 ± .4	14.8 ± 1.7
Before second summer fire	2.5 ± .3	8.3 ± 1.3
Before third summer fire	1.8 ± .4	6.0 ± 1.4

TABLE 2.—*Fuel per acre remaining following treatments*

Treatment	Litter	Woody fuel	Total fuel
	Tons	*Tons*	*Tons*
Unburned control	32.8	3.3	36.1
One winter and one summer fire	24.4	2.6	27.0
One winter and two summer fires	21.8	1.7	23.5
One winter and three summer fires	20.5	1.6	22.1
Total reduction	12.3	1.7	14.0

TABLE 3.—*Proportion of fuel by litter layers following treatment*

Treatment	Upper layer of litter	Lower layer of litter
	Percent	*Percent*
Unburned control	23.5	76.5
One winter and one summer fire	13.1	86.9
One winter and two summer fires	16.5	83.5
One winter and three summer fires	14.6	85.4

SCORCH AND MORTALITY AFTER A SUMMER BURN IN LOBLOLLY PINE[1]

PETER H. ALLEN
Forester, Southeastern Forest Experiment Station

Foresters who use prescribed fires in loblolly pine management are concerned with damage to trees in hotspots. A 5-acre hotspot developed during a prescribed summer fire on the Camp Experimental Forest[2] and gave us an opportunity to evaluate pine and hardwood mortality after the crowns were severely scorched. Most healthy loblolly pine survived despite severe needle kill, and the fire-killed timber could have been salvaged in harvest operations.

The fire, made to evaluate the reduction of hardwood competition and litter for seedbed preparation, was the first summer fire after an initial fuel-reduction burn two winters before. At 1:00 p.m. on the day of the fire the northwest wind at a weather station in the forest was less than 5 m.p.h., the air temperature was 80° F., the relative humidity was 50 percent, and the fuel moisture content was 4.7 percent. The hotspot was the result of poor firing technique; in haste to complete the work, workers strung lines of fire on all sides. Where the fires converged, the intense heat severely scorched the crowns of the 60-year-old loblolly pine.

The amount of needle scorch 3 weeks after the fire and mortality 1 year later are shown in table 1. Sixty-five percent of the pines 5 inches d.b.h. and larger were severely scorched, with needle kill in more than two-thirds of the crown. The trees 5 to 8 inches in diameter, in the lower crown position, were most severely scorched. Mortality was greatest among these least vigorous trees; survival increased with size. Of the pines larger than 8 inches, only 10 out of 404, or 2 percent, were killed.

The hardwoods were generally more susceptible to fire injury than pine. Survival differences are apparent among the hardwood species (table 2). American holly, white oak, and other oaks (principally southern red, black, and post) were most susceptible. Sweetgum and red maple were more fire resistant, while blackgum was least damaged. Mortality differences by tree size were not as great as in pines, and 12 out of 19, or 63 percent, of the hardwoods larger than 8 inches were killed.

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[1]This article was presented as Southeastern Forest Experiment Station Research Notes 144 in May 1960.

[2]Maintained in southeastern Virginia by the Southeastern Forest Experiment Station with the cooperation of the Union Bag-Camp Paper Corporation, Franklin, Va.

TABLE 1—*Crown scorch and 1-year mortality of loblolly pine in a 5-acre hotspot*

Diameter class (inches)	Trees severely crown scorched	Mortality
	Percent	*Percent*
5	87	48
6	76	34
7	73	20
8	58	8
9	64	5
10	51	0
11	54	6
12	47	0
13+	37	4
Average all diameter classes	65	21

TABLE 2.—*Hardwood top kill 1 year after burning*

Species	Total stems		Dead		Mortality
	Number	Average d.b.h.	Number	Average d.b.h.	
		Inches		*Inches*	*Percent*
White oak	34	6.6	26	6.8	76
Other oaks	34	6.6	26	6.6	76
Holly	35	7.4	26	6.7	74
Sweetgum	26	6.0	12	5.8	46
Red maple	27	7.8	12	7.0	44
Sourwood	3	6.6	1	5.0	33
Blackgum	42	7.5	9	6.7	21

LEAD PLANE TECHNIQUES IN AIR TANKER ATTACK

[Excerpts from a Forest Service paper given at the Air-Ground Coordination Workshop, Boise, Idaho, January 25-29, 1960]

The question is often asked, particularly by persons who have never observed air tanker operations, "Why is a lead plane necessary?" Any type of fire suppression action requires direction and supervision to gain the most benefit from the tools and manpower being used, in this case the aerial tanker. It is the primary purpose of the lead plane to remain over the fire, observe its course and behavior, and determine the action to be taken. Then the target must be positively identified to insure that the tanker's load of retardant is not wasted.

The lead plane pilot should be alert at all times for unsafe practices or conditions. Tanker pilots are sometimes tempted to fly under conditions approaching marginal. It is the responsibility of the lead plane pilot to test the air for turbulence, to observe and report snags or topographical hazards, plan the approach and escape routes, and evaluate visibility. The lead plane pilot should have experience in making actual drops so he can recognize, at the earliest moment, the beginning of an unsafe or poor pass. It is possible, with experience, to judge the airspeed of a drop plane within 5 knots.

An experienced lead plane pilot is invaluable in breaking in and qualifying new tanker pilots. The technique employed is to brief the pilot on the target and make a pass with the lead plane so that he can observe your run. Then pull around and fly formation with him, talking him through the entire maneuver. You must direct every step of the operation over the fire, and be merciless when any maneuver contrary to safe operation is observed. Tendencies to "show-boat" or take unnecessary risks must be stopped.

A written report of each drop should be kept and a critique held with all concerned. This reporting is also a requisite to evaluation of air tankers.

Many different makes and types of airplanes have been used for lead planes and all have had undesirable features. A lead plane should have the following characteristics:

1. High speed enroute to the fire.
2. Low speed for circling at the fire.
3. Unimpared visibility.
4. Structural integrity.
5. Low fuel consumption and large fuel capacity.
6. Low maintenance.
7. Low acquisition cost.
8. Adaptability to other uses.

Personal preference enters into any discussion of aircraft, but there are certain basic things to keep in mind. A high wing airplane offers the best visibility as long as the airplane is straight and level; however, when turning, the wing interferes with visibility. The low wing airplane has the best configuration for a lead plane, particularly when used at low altitude. Speed range is another desirable attribute in a lead plane, high cruise speed in going to the fire and low stall speeds to permit slow turns over the fire and require less turning radius. Tandem seating has advantages as it permits both the pilot and the air attack boss to keep the target in sight, provides unrestricted visibility in turns to the right, as well as to the left.

Two lead plane techniques have been used. The first technique is where the lead plane circles at approximately 1,000 feet at the fire and directs the air tankers by radio. The advantages of this system are better visibility and less hazard to the lead plane. The second technique is the low-level, "show-me" method wherein the lead plane simulates the tanker pass and identifies the target both by radio and by rocking his wings over the target. Under this system the lead plane prescribes the attack and escape routes, and supervises the drop plane through all phases of the operation.

It is immediately apparent that there are certain prerequisites to performing capably as a low-level lead plane pilot. He should be a skilled, competent, and confident pilot and an experienced tanker pilot. He should have a working knowledge of fire behavior and suppression. Tanker experience is needed so he will know when a target is marginal, or when a tanker is commencing a potentially hazardous pass. Experience will also enable him to judge the airspeed of the tanker and evaluate the drop. It is desirable that the lead plane pilot have experience in all types of aircraft being used for tankers.

Tanker pilots who have dropped borate under both types of lead systems have expressed preference for the low-level method. As long as they keep the lead plane in view, they have a reference for terrain clearance and airspeed, and are relieved of the responsibility of initial identification of the target.

The air attack boss can be of great value. He directs the lead plane pilot in planning the attack and selecting targets. But the direction of the tankers and the final decision on the feasibility of the target remains the responsibility of the lead plane pilot.

Attack procedures start when the lead plane pilot reports to the base in the morning. At this time he thoroughly pre-flights the aircraft, warms up and checks the engine, and performs a full radio equipment check. It is the responsibility of the lead plane pilot to make sure that he has the necessary maps and charts for his area of responsibility. By maintaining a listening watch, he can determine which tankers are airborne. A low-level circle is made to determine how and where to make the attack, to observe the condition of the air, visibility, the path of attack and escape, the minimum altitude over the target and hazards such as snags, wires, or other obstructions. At this time careful note will be taken of the presence and location of any personnel on the fire.

The tanker planes will start calling in on air net when approximately 5 minutes from the fire. At that time the lead plane pilot can tell them the specific location on the fire where they are to drop, and the general altitude at which they will work. As the tanker approaches the fire, the lead plane is positioned to make a dry run that the tanker can observe. As the lead plane arrives over the target, the pilot rocks the wings, at the same time telling the tanker over the radio, "Here." Immediately after passing over the drop spot, the lead plane breaks off the pass in a level turn, if possible, so that the results of the drop can be observed. Generally, by the time the first tanker is dropping, other tankers have arrived over the fire and are able to observe the preceding drop. The tankers should be kept in a circle above the lead plane. This permits them to observe the drops and get an idea of what the attack is trying to accomplish. It also adds to safety as it enables the tanker pilots to keep each other in view. Many tankers are blind on turns to the right, and whenever possible, a left hand pattern should be established.

The lead plane must be constantly alert for propellor wash from the tankers, and blowups on the fire which can bring severe to extreme turbulence. High speed passes by both lead plane and tankers can impose "G" loads in excess of the structural limitations of the airplanes, particularly when they are heavily loaded, and accuracy and effectiveness fall off with increases in speed. The lead plane should stay in the immediate vicinity of the target for safety and, for good handling of the tankers, stay in the drainage being worked.

Good communications are very important. All transmissions must be made in a calm, clear manner; speech must be slow and distinct. In case of radio failure while using the low-level lead plane system, it is possible to pull up and fly formation with the tanker to gain his attention, then make the regular pass, rocking the wings over the target. The lead plane must not leave the fire until relieved or the tankers have stopped coming. The communications chain must be strictly adhered to to prevent confusion and misunderstanding.

In the case of two fires in close proximity, utilizing one or more air attack bases, or one fire using two or more bases, or a large campaign fire where a divided attack using two lead planes is waged, communication is the most important single factor. A chain of communication and command must be set up prior to the dispatch of the first airplane and must be adhered to without deviation.

AIR TANKER CAPABILITIES AND OPERATIONAL LIMITATIONS

[Excerpts from a Forest Service paper given at the Air-Ground Coordination Workshop, Boise, Idaho, January 25-29, 1960]

The U.S. Forest Service started operational use of air tankers in 1956. During that year, small aircraft with about 100-gallon capacity dropped 124,000 gallons of fire retardants and suppressants. Use of air tankers has increased to the point where a large variety of tankers, some having capacities of 3000 gallons, dropped almost 3.5 million gallons in 1959. With this rapidly expanding use of air tankers, there is need for more detailed attention to the effectiveness, efficiency, and safety of the entire operation. Study and training in aircraft capabilities and operational limitations is a vital part of this.

The Federal Aviation Agency sets the minimum requirements for pilot qualifications and aircraft airworthiness. There are certain limiting factors that must be recognized and considered: (1) Pilot ability, (2) aircraft capabilities, and (3) operational limitations.

PILOT ABILITY

Pilot ability does not affect the capabilities built into the aircraft, but it does have an important bearing upon the operational limitations of the aircraft. Basically pilot ability can be summed up by three things: Planning, judgment, technique.

Experience contributes greatly to pilot ability. Air tanker pilots should have experience in low-level flying in heavy aircraft over typical terrain and under adverse conditions.

AIRCRAFT CAPABILITIES

Air tankers should have good load carrying capacity, good air speed, and be fairly maneuverable under loaded conditions. Today's airplanes are designed either for high speed or high load capacity.

The old Fairchild 71, Travel Air, and Ford Trimotor planes have wing areas of 270 to 310 square feet for the single engine models and up to 835 square feet for the trimotors. The thickness or camber of the wings on these planes were designed for high lift with good maneuverability, but not for high speed.

There is not an airplane being built today by United States manufacturers that can duplicate the load carrying capacity and slow flight maneuverability that enable these planes to land and take off from rough unimproved mountain meadows. But due to distance, low speed, and small load capacity, these old planes are not satisfactory for most air tanker work. For these reasons, flight operators have turned to large military surplus aircraft as these planes are about the only ones available that can be adapted to air tanker work.

It is known that maneuverability becomes more restricted as speed and wing loading increase. Because of this, many multi-engine aircraft available today approach the limits for efficient and safe operation, particularly in mountainous terrain. As a result, maneuverability is a factor that must be considered in selecting suitable aircraft.

As the weight of aircraft increases, stall speeds increase. This affects landing and is accentuated in turns; the greater the degree of bank, the higher the stall speed. The safety factor may become critical when aircraft are operated at maximum weights. The reduced maneuverability in turns is more pronounced for low load factor airplanes (maximum load).

Whenever adjusted gross weight is increased above the designed gross weight, the load factor which can be reached in flight must be proportionately reduced. In general, the higher the original design load factor of the airplane, the greater the possible weight increase. The load factor, however, cannot be reduced below a certain limit because of structural strength.

The rough, turbulent air generally associated with forest fires can impose overload stress on the aircraft beyond that for which it was designed, particularly during maneuvers while carrying maximum loads of retardants. The danger of this is more easily recognized if a comparison is drawn between the heavily loaded aircraft in tight maneuvers and an overloaded pickup on rough roads. Something is bound to give in either case unless the loads are lightened or maneuvering or driving is restricted.

OPERATIONAL LIMITATIONS

Airplanes operating near the ground, as in air tanker work, have an additional hazard if strong or gusty winds are encountered. This can be caused by normal orographic lifting of an air mass around most ridges, mountains, and canyons, an unstable air mass causing cumulus cloud activity, or rising heated air from a hot rolling fire.

The conditions can become critical. For example, a tanker plane being positioned and slowed for a drop run can encounter a strong gust of wind striking only one side of the airplane. This gust can destroy the lift of that wing by disrupting the flow of air over it, causing the plane to roll toward that wing with a loss of altitude. This could be disastrous on low-level flights. All personnel involved should be constantly alert to dangerous atmospheric conditions.

Pilots must be aware of what to expect when operating near or around thunderhead type clouds. They must be able to analyze quickly the type of thunderhead, its stage, whether it is building, mature, or dissipating, and what to expect in surface effect. They should also be able to make a quick decision of whether to continue flying or to get back on the ground. This is true for all adverse atmospheric conditions, contributing to visibility or turbulence.

The performance of aircraft is also affected by density altitude as determined by temperature and atmospheric pressure (pressure altitude). For each increase of 9° F., or 5° C., above standard (59° F., or 15° C.), the density altitude change is 550 feet.

SUMMARY

Efficient and safe air tanker operations are dependent in a large degree upon aircraft capabilities and operational limitations. With ever-increasing types and numbers of air tankers, particularly the large, fast, military-type aircraft, it is important that the basic capabilities of each type is known and that this knowledge is applied in planning and operation. Operational limitations, as affected by pilot ability, weather conditions, and topography must also be recognized.

☆ ☆ ☆

Fire Risk From Road Project Flares

The use of flambeaux (oil flares) to illuminate road construction warning signs is a cause of fires in forested areas. On several occasions we have found these signs partially burned because of their being blown across a lighted flambeau. Where flammable vegetation extends within reach, the risk is obvious. The risk can be eliminated by substituting portable electric lighting.

Battery-powered, transistorized flashers are being used by many road construction and maintenance organizations. The flashes are brief but readily seen at night. Cost is $13 plus two batteries at $0.65 each. Since battery life is 800 to 1800 hours, overall cost is small. Bulb cost is negligible. These flashers require much less servicing than do flares.

The savings that are possible plus the elimination of the fire risk should promote the use of transistorized flashers by more road construction and maintenance men.—CLIFFORD R. FAULKNER, *District Ranger, Pisgah National Forest.*

PUBLICIZING SMOKEY BEAR FIRE PREVENTION

Ranger John O. Kirby, U. S. Forest Service, Southern Region, has attempted to capitalize on Smokey Bear at a local, more personal level. Following are three ways in which this was done:

1. All children in Franklin County between the ages of 5 and 10 received personal birthday greetings from Smokey. Some children wrote a thank you to Smokey. In preparation for this program, the

. . . a note from the DISTRICT RANGER

Meadville, Mississippi
April 17, 1958

Miss Dorothy Keeney
c/o Mr. J. D. Keeney
Meadville, Mississippi

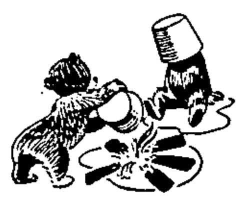
Dear Dorothy:

Happy Birthday on May 15th when you will be 8 years old.

From your very good friend,

Sincerely yours,

SMOKEY BEAR



P.S. My pal, "SMOKEY," would like for me to add: "Many thanks for your help in PREVENTING WOODS FIRES!"

superintendent of schools was contacted and a list of children in this age bracket was secured and copied on cards. These cards were then sorted and indexed by birthdays. Three days prior to the birthday a standard greeting letter was mailed. Children who wrote back to Smokey received an additional packet of fire prevention literature.

2. Local announcements informed the public that children would receive a Junior Forest Ranger badge if they wrote Smokey (in care of the local District Ranger) telling Smokey why they

think he should make them Junior Forest Rangers and what they had done to prevent forest fires. There was enthusiastic response, letters were interesting and, in some cases, helpful in appraising the local fire prevention effort.

3. A local bank furnished the District Ranger a month's supply of their statement envelopes. Smokey Bear stamps were affixed to the envelopes and returned to the bank. This same procedure was followed for the monthly statements of large business concerns in the vicinity.

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INFORMATION FOR CONTRIBUTORS

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

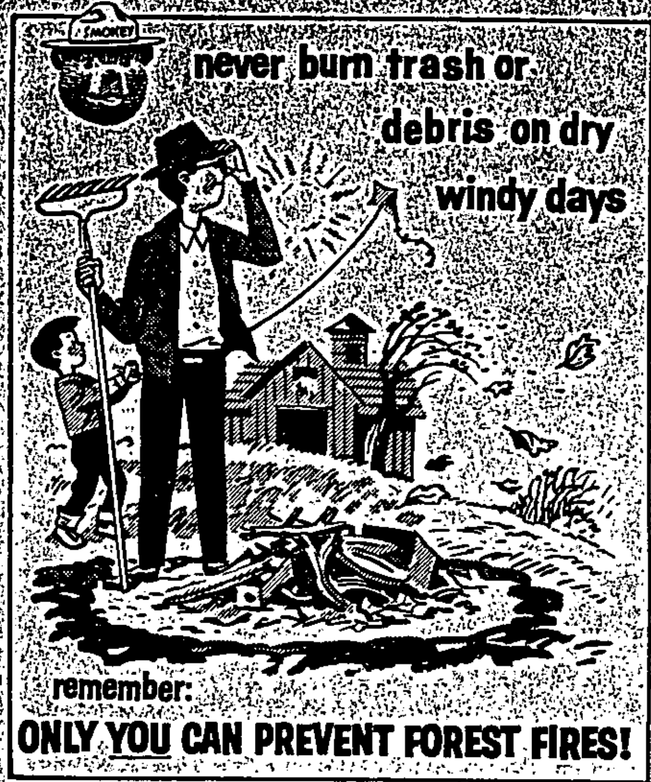
The title of the article should be typed in capitals at the top of the first page, and immediately underneath it should appear the author's name, position, and unit.

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

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

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

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


SMOKEY
never burn trash or
debris on dry
windy days
remember:
ONLY YOU CAN PREVENT FOREST FIRES!