VOL. 12 JULY 1951 NO. 3

FIRE CONTROL NOTES

A PERIODICAL DEVOTED TO THE TECHNIQUE OF FOREST FIRE CONTROL

FOREST SERVICE • U. S. DEPARTMENT OF AGRICULTURE

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

Volume 12 Number 3

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the TECHNIQUE OF FOREST FIRE CONTROL

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

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. The printing of this publication has been approved by the Director of the Bureau of the Budget (May 17, 1948).

Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., 15 cents a copy, or by subscription at the rate of 50 cents per year. Postage stamps will not be accepted in payment.

Forest Service, Washington, D. C.

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1951

CONTENTS

THE POSSIBLE RELATION OF AIR TURBULENCE TO ERRATIC FIRE BEHAVIOR IN THE SOUTHEAST

George M. Byram and Ralph M. Nelson
Division of Fire Research, Southeastern Forest Experiment Station

["Blowups" and other forms of unaccountable fire behavior, that characterize many of our more disastrous fires every year, were a special topic that was given much emphasis at the fire meeting held in Ogden in January 1950. New research on this problem was urged and all research men were urged too to make available every bit of new information that might be useful to the fire strategist even though this might mean some reporting ahead of final evaluation. I am very happy to present the following report by two members of the research group as new information that I personally believe is highly significant though further confirmation, evaluation, and means of prediction are needed and will require much further investigation. If the degree of local stability in the atmosphere proves to be a key factor in the unexpected and often dangerous behavior of many of our large fires, and it can be identified in advance, one more of the unknowns will be eliminated and skill in control of large fires can be greatly advanced. This preliminary report should be a challenge to all experienced fire fighters and research men alike. Have we been ignoring one of the controlling factors in big fire behavior?—A. A. Brown.]

Fire control men have long suspected that there are unidentified factors that contribute to the strange behavior and spread of some fires. H. T. Gisborne, G. L. Hayes, and A. A. Brown, among others, have believed that atmospheric instability might in part explain some of the western blow-up fires. Brown (1) and Crosby (2) speaking more generally have stated that when sufficient heat is generated by a fire in an unstable atmosphere, erratic fire behavior can be expected. In a report from Australia (3), turbulence is stated to be an important factor in the degree of severity of bush fires and that it is of value in compiling forecasts of fire weather. There is now reason to believe that turbulence may also be associated with certain severe fires in the South. Some evidence on this point was obtained from fires that burned in an unusual manner in the Coastal Plain of South Carolina during a few days of the 1950 spring fire season.

Southeastern States experienced an unusually severe season during that period. A prolonged drought, interrupted only by occasional rains, began in November and persisted in some areas until May. This brought about abnormally low fuel moistures which, combined with high winds, resulted in a large number of fires and a large acreage burned. Apparently there were two rather definite types of severe fires. The first, driven by high winds, was characterized by high rates of spread, especially while crowning. From the standpoint of the safety of suppression crews and their equipment, this type of fire has not been considered dangerous for experienced firefighters in the Southeast. The second type differed from the first in that its peculiar whirling nature and unpredictable behavior made even a flank attack dangerous. It is with the second type that this report is concerned.

THE BUCKLE ISLAND AND FAREWELL FIRES [1]

Following is a description of two whirling fires that occurred on the Francis Marion National Forest in South Carolina. So far as can be ascertained, they had characteristics of behavior common to fires that burned elsewhere in the Coastal Plain of that State during the five or six most severe days of the spring season.

The Buckle Island No. 144 fire burned on March 26 in a densely stocked stand of loblolly pine 10 to 35 feet in height. The day was sunny with little wind during the morning hours. The relative humidity was medium (about 35 percent) and the records of the Weather Bureau airport station, located approximately 40 miles from the burned area, indicated a layer of highly unstable air about 400 or 500 feet deep at 10 a. m. The layer probably had become even more unstable and somewhat deeper at the time the fire started in the early afternoon. However, the increased turbulence may have been partly offset by an increase in wind velocity which took place at about noon. Apparently no large whirl developed until the fire reached a size of 40 or more acres. One then enclosed the head and created trouble for the plow crews. Because the early spread of the fire was nearly at right angles to the road, no short cut to the head was possible. Therefore, a flanking attack on both sides was made. As the plow crews progressed, the fire on the left flank had a tendency to cross in front of the crew, and on the right flank, behind the crew. One large counterclockwise whirl or two such whirls, one on each flank, could account for this strange behavior. It was later found that there was at least one small whirl on the right flank, although from the plane observer Mitchum saw only one large whirl.

The Buckle Island fire differed somewhat from other whirling fires in that it apparently maintained a fairly constant direction of spread. The wind velocity was also greater and steadier than on other fires. Even so, the spread was erratic. At times the fire would quiet down and then suddenly burn with fierce intensity. These bursts may have been caused by the almost simultaneous ignition of several acres by the whirl. In one instance, the plow crew observed flames directly overhead while the main fire was still some distance away.

The most severe fire on the Francis Marion National Forest during the spring season from the standpoint of erratic behavior and its whirling nature was Farewell No. 172. It burned on April 11 with a light but variable southwest wind in a stand of loblolly reproduction 10 to 35 feet in height which contained a scattering of mature trees. Weather Bureau records indicated a high degree of atmospheric instability also on that day. There were three large whirls in this fire and at least two small ones. The paths of the larger whirls were approximately parallel and were separated by less severely burned strips 75 to 100 feet in width. Needles on tree crowns in the strips were not consumed, and in a number of places the tops of crowns of trees 25 feet high remained alive. However, in the paths of the whirls the crown foliage was generally completely consumed, on some trees to a height of 80 feet. Needles are not completely consumed unless they are well within the flames, so it is estimated that the flames may have ranged from 50 to 150 feet in height.

[1] Acknowledgment is made to John T. Koen, formerly ranger on the Francis Marion National Forest, to John T. Hills, Jr., and Aiken Mitchum of the National Forest staff for eyewitness accounts of the fires reported upon.

After becoming established, the whirls moved rapidly ahead of the main fire with sufficient updraft to carry burning embers aloft. These embers are reported to have started fires a considerable distance ahead of the main fire. Airplane observer Mitchum believes that two of the three whirls burned at the same time. He also observed that flames came out of the center of the tops of the cone-shaped whirls. The flames did not spring directly upward but had the same rotary motion, spiralling upward, as the smoke in the outer parts of the whirls.

SOME CHARACTERISTICS OF ERRATIC FIRES

Evidence from the Buckle Island and Farewell fires, and from others that burned in South Carolina during the spring season of 1950, indicates that erratic fires in the Southeast may have some common characteristics. Also, there appear to be certain conditions of weather, fuel, and type—not fully identified—which are conducive to such fires. Although some of the following conclusions regarding fire behavior and possible causes are speculative, they appear reasonable in view of what is known of certain physical laws. Confirmation or disproval will require further observation and analysis.

1. Fires with erratic behavior are most likely to occur on sunny days when there is strong surface heating. There may be little or no wind during the early part of the day, and even while the fire is burning, usually in the afternoon, the general wind is light or moderate. The most favorable wind for this type may be somewhere between 8 and 16 miles per hour as measured 20 feet above tree tops.
2. Erratic fires have a tendency to develop one or more violent whirls after reaching a certain critical size. The size is probably not the same for all fires and may be somewhere between 20 and 75 acres. This, however, is merely conjecture.
3. From the air, the diameter of larger whirls appeared to remain approximately constant and to cover an area of about 10 acres. An increase in size after they had formed was not observed. Possibly they appear suddenly and may be nearly full-size when born. After becoming established, the whirls apparently can move rapidly away from the main fire and take the direction of the light wind prevailing at the time. They can consume strips of reproduction 500 to 800 feet wide. The velocity with which these whirls travel is one of their most dangerous characteristics because their speed may be equal to, or nearly equal to, the velocity of prevailing winds.
4. Field men state that most of the worst fires occur on days with a southwest wind. This indicates a characteristic pressure system which may also account for some of the turbulence. Observers in airplanes have noticed that the air was always bumpy on days when whirling fires occurred. Also, when the flying became smooth in the late afternoon whirls did not occur.
5. It cannot be assumed that whirls will always rotate counterclockwise like large-scale vortex storms such as hurricanes in the northern hemisphere. The counterclockwise rotation of the hurricane is caused by the rotation of the earth. This should have but little effect on small-scale whirls like dust devils or whirling fires. For this reason the chances are probably about equal that the whirls will be in either direction.
6. The depth of the turbulent layer may be a dominating factor in de-

termining the maximum size of the whirls, although other variables such as quantity of fuel should also have some effect.

7. In flat country it is doubtful that large whirls could develop if the air were absolutely calm, regardless of turbulence. Some wind movement would be necessary to move them over fresh fuel. A high wind, on the other hand, would reduce turbulence and might also tend to break up the whirls. This does not mean that fires burning in a high wind will be less intense than fires burning in a light wind. A large majority of severe fires probably burn on days of high wind velocity, and rate of spread will increase with increasing wind velocity.

8. The effects of turbulence in areas of rough or rolling topography would be considerably more complex than in flat country. Turbulence near the ground surface would probably never be as great as in flat country but this would possibly be more than offset by complex topographic effects. For example, large whirls could travel upslope rapidly even in an absolute calm.

9. An important factor in the occurrence of the whirling type of fire may be the fairly recent change in stand type in much of the Southeast. During the past 15 years extensive stands of dense pine reproduction have become established on areas formerly kept clear of pine by repeated fires. This may be one reason why there have not been more of these fires in former years. On the other hand, they may have occurred more often than is supposed. It is difficult for ground crews to recognize large whirls because of smoke and a limited field of view. They can be seen best from the air.

10. Perhaps too much emphasis should not be placed on just the whirling characteristics of fires burning in turbulent air. Turbulence could have a pronounced effect on the draft of a fire long before it reaches the whirling stage. It was noticed that on days when there was high turbulence, even small fires burned with strong drafts. The opposite of this has long been familiar to fire fighters. Fires usually undergo a pronounced change in behavior in late afternoon and evening when the atmosphere becomes more stable. This change has often been attributed to the increase in relative humidity which accompanies the drop in temperature of the lower air layers. It is possible that an increase in air stability may have as great, or greater influence on behavior than a combination of increased fuel moisture and decreased fuel temperature.

THE INFLUENCE OF ATMOSPHERIC INSTABILITY ON FIRES

Unusual fire behavior, not previously experienced, was reported for the Francis Marion National Forest on March 26, April 11, 17, and 24, by suppression crews. This behavior, characterized by one or more whirlwinds and by sudden fierce upward bursts of flames, could not be accounted for by any exceptional conditions of fuel or wind. This led the writers to suspect that some unusual atmospheric conditions existed at the time of the fires. Accordingly, 10 a. m. lapse-rate records for the 4 days mentioned were obtained from the Weather Bureau station at the Charleston airport. These are graphed in figure 1.

The straight dashed lines in the graph represent the dry adiabatic lapse rates, that is, a decrease in air temperature of 0.53° F. per hundred feet in height. At this rate of decrease the atmosphere is neutrally stable. The greater the drop in temperature with height, the greater the air instability. Conversely, the less the drop in temperature with height, the

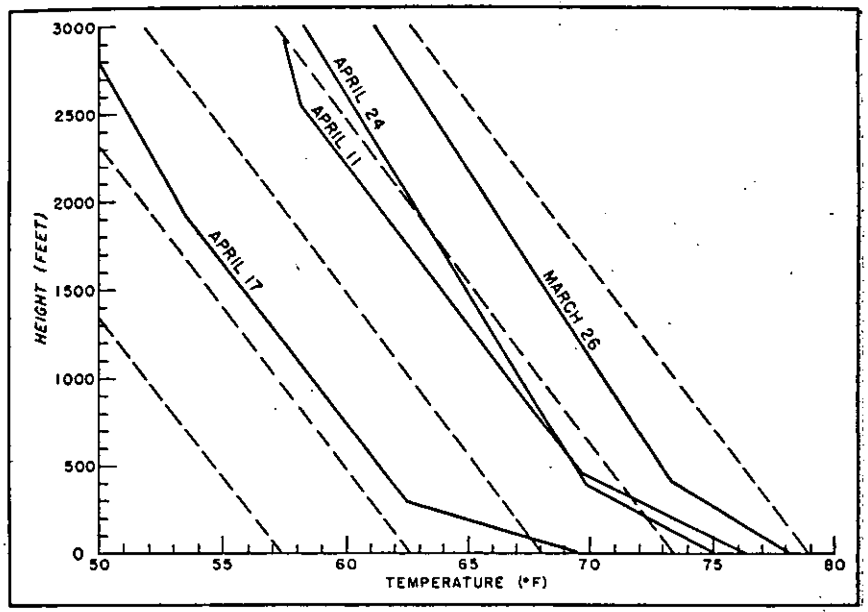


FIGURE 1.—Ten a.m. lapse rates for March 26, April 11, 17, and 24, 1950. The straight dashed lines represent the dry adiabatic lapse rates, i.e., a decrease of 0.53° F. per hundred feet in height.

less the instability. For example, on calm, clear nights, the air temperature often does not decrease with height but even increases. The atmosphere is then highly stable and the upward movement of smoke and heated gas may stop completely after reaching a certain height.

From the graph it will be seen that the unbroken lines, representing lapse rates for the 4 days, inclined sharply to the left of the dashed lines for a distance equivalent to a height of 300 to 500 feet. This means that layers of highly unstable air existed at these depths. These conditions of air turbulence, coinciding with certain fuel and stand conditions, and size of fire or rate of energy output, are believed to explain the strange fire behavior on the days mentioned.

There is usually some turbulence on clear sunny days, but the average value of the turbulence factor [2] is not known for the Coastal Plain in early spring. Its value may be somewhere between 20 and 50. In contrast, the turbulence factors for March 26, April 11, 17, and 24, were respectively 110, 160, 390, and 135. It is possible that there were other days during the spring season that had equally high turbulence factors, but whirls or erratic fire behavior were not observed. If highly turbulent days did occur, it may be that fires were controlled while small or before they

[2] A turbulence factor T will be defined by the equation

$$T = 100\ (\frac{L_e}{L_a} - 1),$$

where L_e is the existing lapse rate and L_a is the dry adiabatic lapse rate. When $L_e = L_a$, the air is neutrally stable and $T = 0$. Whenever T is greater than 0 there is always some turbulence.

reached the breaking point, or that they did not burn under the fuel and stand conditions most favorable to turbulence. Further analysis should clarify this point.

As has been pointed out previously, very severe fires can occur on days when the atmosphere is relatively stable. On March 27 the turbulence factor was only 16, but this was a severe fire day. As a result of high wind velocity—30 to 40 miles per hour with gusts reaching almost 60 miles per hour at the Charleston airport—there were intense, fast-spreading fires which did great damage. There was nothing erratic or baffling in their behavior, however, that could not be explained in terms of wind and fuel conditions.

When a fire burns in a stable atmosphere, the hot gases must not only expend energy as they lift their masses through the stable air, but they also expend part of their energy in dragging a part of the surrounding air upwards. The stable air acts like a ceiling so that on a calm clear evening the smoke rising above a fire will reach a certain height and then level off. The conditions are entirely different when a fire burns in an unstable atmosphere. The gases do not expend energy as they rise but in their ascent they may even acquire energy from the atmosphere. Their path upward creates a chimney into which the surrounding unstable air is drawn. The potential energy of the unstable air is then converted into kinetic energy as it enters the chimney created by the fire. When the total rate of energy release (rate of energy output of fire plus rate of energy change in the unstable atmosphere) is great enough, then whirls should develop.

ATMOSPHERIC INSTABILITY AND DUST DEVILS

There appears to be similarity in some of the conditions which favor the development of whirls on some erratic fires and dust devils. These are strong surface heating on clear days, and winds of not more than moderate velocity. Ives (4) gives the following account of the conditions favorable for their formation.

> "In geographically favorable areas dust devils occur most frequently in clear weather, when the surface has been heated for some hours, and there is little surface wind. Under these conditions the surface air is very hot with respect to that a few hundred feet aloft . . . Typically favorable conditions, measured during a 'Great-Basin-High regime' are: surface temperature, 160° F.; one foot above surface, 142° F.; five feet above surface, 116° F.; 500 feet above surface, 100° F.; 2,000 feet above surface, 92° F. . . . "

Such a pronounced drop in temperature means, of course, an extremely unstable atmosphere near the ground. Ives further states that the upward velocity of the air in a dust devil may exceed 35 miles per hour and that measured horizontal winds within the whirl can accelerate from near zero to speeds of from 50 to more than 90 miles per hour and then return to their former velocity within 30 to 100 seconds. Velocities within the whirls on the southeastern fires are not known, but they are strong enough to carry burning embers for considerable distances ahead of the main fire.

Williams (5) gives the range in size for dust devils as varying from 20 to 200 feet in diameter and from 10 to 4,000 feet in height. It thus appears

that the largest dust devils occupy an area only about one-tenth as great as the area of the larger whirls on the South Carolina fires. The main difference between dust devils and whirls on fires is that the former must obtain all of their energy from the potential energy of the atmosphere, whereas the latter obtain their energy from burning fuel as well as the atmosphere. In the same article Williams states:

> These occurrence times were from 1 to 5 hours before the times of maximum temperatures. The reason for this fact is that the wind speeds normally increase as the times of maximum temperatures are approached and certain critical speeds are reached beyond which the dust whirls cannot exist. These critical speeds have not yet been determined, but vary with lapse rate, topography, and probably other factors.

Brown (1) states that dust devils are an ominous sign to fire fighters. Whirls of a similar nature on fires may account for many blow-ups.

LAPSE RATE IS RELATED TO FIRE CONTROL

If the conclusions reached regarding the effect of air turbulence on fire behavior are substantiated by additional work, a new aspect of fire control in the Southeast will have been recognized. Although erratic fires in this section may not be common, their potential danger to suppression crews and damage to timber stands, particularly in the younger age classes, will justify the taking of extra precautions during especially hazardous periods. Radiosonde observations, where available, will be helpful but the extent of the adjacent area to which these apply will have to be determined. Forecasts of high impending turbulence a day or two in advance would be most useful, although a forewarning of even a few hours might mean considerable for the safety of men and equipment. Suppression crews during such periods could be alerted to make the fastest possible attack so as to restrict any fire to the smallest possible acreage and before it reached the breaking point. In short, they could be warned to expect crowning and the sudden formation of large whirls, unusual backfire behavior, exceptional rates of spread considering existing wind velocities, gustiness and quick changes in wind direction, and the likelihood of danger even in making flank attacks.

It should be emphasized again that the changing fuel and stand types occurring in the Southeast may be a necessary condition for the large whirling fires which burned in South Carolina last year. These fires burned in dense stands of reproduction (predominantly loblolly pine) in which the compact crowns constituted the main source of fuel. In turn, the availability of this green fuel for combustion was increased by an unstable atmosphere plus a high rate of energy release in the ground fuels.

[Since this report was written, data have been obtained from the Weather Bureau which give the upper air temperatures at the Charleston airport for all days in the period from March 20 to April 30. Although a complete analysis has not yet been made, these data indicate that there were only eight days in this period with a highly unstable atmosphere. Four of these days were March 26, April 11, 17, and 24 when severe whirling fires occurred. On the other four unstable days, no whirling fires were reported. April 27, the atmosphere was very unstable at 10:00 a. m., but 0.41 inches of rain fell later in the day before 5:00 p. m. Similar turbulent conditions existed on April 6 and 27, but 0.33 inch

of rain fell on April 5 and 0.60 inch on April 27 and 28. The chances were very slight for fires starting and building up to a high rate of energy output on these days, especially in dense stands of young loblolly pine. On April 19 there was a highly unstable layer of surface air but it was only 150 feet deep. In addition, the next layer above was deep and stable. It is doubtful if large whirling fires could develop on such a day. However, the shallow layer should have had a marked effect on the behavior of small fires. This additional evidence appears to corroborate some of the ideas advanced in the report.]

LITERATURE CITED

(1) Brown, A. A.
1950. WARNING SIGNS FOR FIRE FIGHTERS. U. S. Forest Serv. Fire Control Notes 11(3): 28-30.

(2) Crosby, John S.
1949. VERTICAL WIND CURRENTS AND FIRE BEHAVIOR. U. S. Forest Serv. Fire Control Notes 10(2): 12-15.

(3) Foley, J. C.
1947. A STUDY OF METEOROLOGICAL CONDITIONS ASSOCIATED WITH BUSH AND GRASS FIRES AND FIRE PROTECTION STRATEGY IN AUSTRALIA. Commonwealth of Australia, Bureau of Meteorology, Bul. No. 38: 51-52.

(4) Ives, Ronald L.
1947. BEHAVIOR OF DUST DEVILS. Bul. Amer. Met. Soc. 28(4): 168-174.

(5) Williams, Nelson R.
1948. DEVELOPMENT OF DUST WHIRLS AND SIMILAR SMALL-SCALE VORTICES. Bul. Amer. Met. Soc. 29(3): 106-117.

Smoke-Eaters at Work

A lot of people talk about forest fires. Down Joplin way, some people are doing something about it, under the supervision of that city's Natural Resources committee of the Chamber of Commerce, and under the leadership of Don Hunsaker, assistant manager of the Chamber.

The group of fire fighters, known as the Smoke-Eaters was organized in the spring of 1950, for volunteer forest protection and fought several fires last year. Last February, it was reorganized on a larger basis to help handle this year's burns. It now includes 30 men, divided into "telephone groups" of five or six under a group captain who calls up his team on instructions from Hunsaker. In addition, there are 50 to 100 emergency volunteers, while, for serious fires, arrangements have been made to mobilize the Boy Scout and Explorer Scout troops of Joplin.

All fire fighting is done under the jurisdiction and at the call of the Conservation Commission's forestry personnel. The Smoke-Eaters fight not only forest fires but field blazes also, and their creed is based on prevention of fires where possible.

Among the Smoke-Eaters are doctors, lawyers, bankers, newspapermen, Boy Scout heads, sporting goods retailers, salesmen, a retail store manager, a veterinarian, printer, publisher, florist, manufacturer, and many other professions. All of them are bound together by their interest in the natural resources of southwest Missouri; all have had some training under Martin Grau, farm forester from Monett, and District Forester Joe Range of Pineville.—From MISSOURI CONSERVATIONIST *April* 1951.

SAFETY DEVICE FOR LOOKOUT TOWER LADDERS

SETH JACKSON

Administrative Officer, U. S. Forest Service, Washington, D. C.

Tower ladder accidents are not frequent, but when one does happen it is usually serious, if not fatal. A new development in the safety field offers protection from this danger. It is a device which can be fastened to any tower ladder to protect the climber from a fall.

FIGURE 1.—Safety device in normal climbing position.

It consists of a 1-inch steel pipe bolted to the center of the rungs running the full length of the ladder. This can be fastened to a 100-foot tower by three men in about 2 hours. A bronze sleeve travels up and down the pipe when it is attached to the safety belt of a climber. The pipe is notched at about 6-inch intervals (fig. 1).

Operation of the device is very simple: The climber snaps his safety belt to the sleeve. He climbs in a normal position which automatically holds the lock open. In case he starts to fall, the device automatically locks in the next 6-inch notch, positively preventing the fall. The pipe does not interfere with climbing the ladder in the usual manner, if a person does not have a safety belt with him.

In the Northern States when there is ice danger, a car exhaust or propane tank and burner can be attached to the bottom of the pipe for de-icing, since the pipe is air-tight to the top. After attaching his belt to the sleeve, a towerman can then climb the icy rungs with perfect safety.

The installation costs about $225 for a 100-foot tower. It is manufactured in Burbank, Calif.

RAILROAD TANK CAR

A. B. Everts

Division of Fire Control, Region 6, U. S. Forest Service

Railroad tank cars, which have wide and varied use throughout the United States, make effective fire suppression equipment. Many of the tank cars on logging operations use steam-operated piston-type pumps, and it is necessary that a locomotive be on hand to furnish the steam. The White River Division of the Weyerhaeuser Timber Company at Enumclaw, Wash., has three 8,000-gallon tank cars, each equipped with an independent pump and motor (fig. 1).

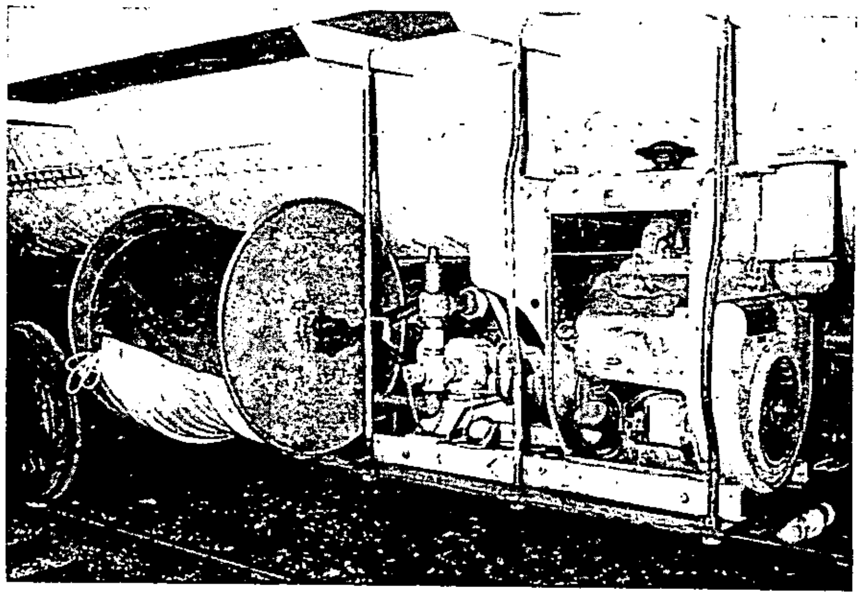


Figure 1.—Details of White River 8,000-gallon railroad tank car. Hose is carried on a dummy reel.

The advantage of the independent pump and motor is that a tank car can be spotted near a fire and used while the locomotive is doing other work. In addition, the pump is capable of delivering up to 89 gallons per minute at 100 pounds pressure. This means that three or four 1½-inch hose lines can be used, a much greater capacity than ordinarily can be obtained from piston-type steam pumps.

The 8,000-gallon tank cars are equipped with gear type pumps driven by 4-cylinder, V-type, air-cooled engines. The bypass is set at 150 pounds.

Pipe-line strainers are used to keep foreign matter out of the hose line, and 1,500 feet of 1½-inch CJRL hose are mounted on two or three dead reels. Also carried are three 1½-inch combination fog, straight-stream, and shut-off nozzles and two 1½-inch siamese valves. Other equipment to round out the tank car as a fire-fighting unit includes six shovels, six adz hoes, three axes, two saws, one backpack pump, and one pulaski. Extra gasoline, oil, pipe wrenches, and tools complete the unit (fig. 2).

[Fire Warden Monte Rodie, to whom the writer is indebted for the information for this article, insists that all fire equipment (the railroad tank cars are only a small part of the total in use) be kept in first-class condition and that woods crews know how to operate the various kinds.]

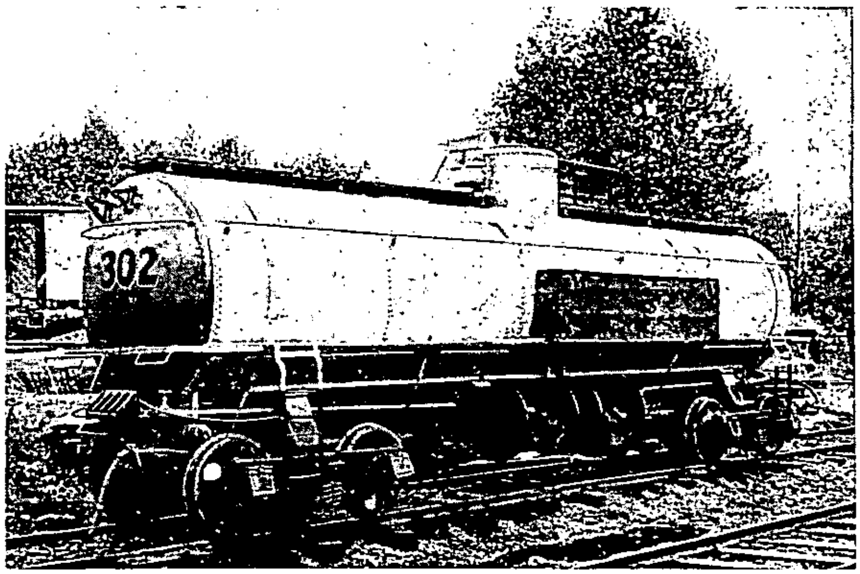


FIGURE 2.—White River tank car with dead reels and tool boxes. Pump and engine are on other side.

HOSE TESTING AND DRYING RACK

Roy O. Walker
Division of Fire Control, Region 6, U. S. Forest Service

The regional fire cache in Portland, Oreg., carries a supply of fire-fighting equipment to back up project fires on the national forests in Oregon and Washington. Our plan calls for a minimum of 59,000 feet of 1½-inch hose. There have been times when all this hose has been out on fires. The job of washing, testing, drying, rolling, and storing this hose is a big one. The layout for doing this job is shown in figure 1.

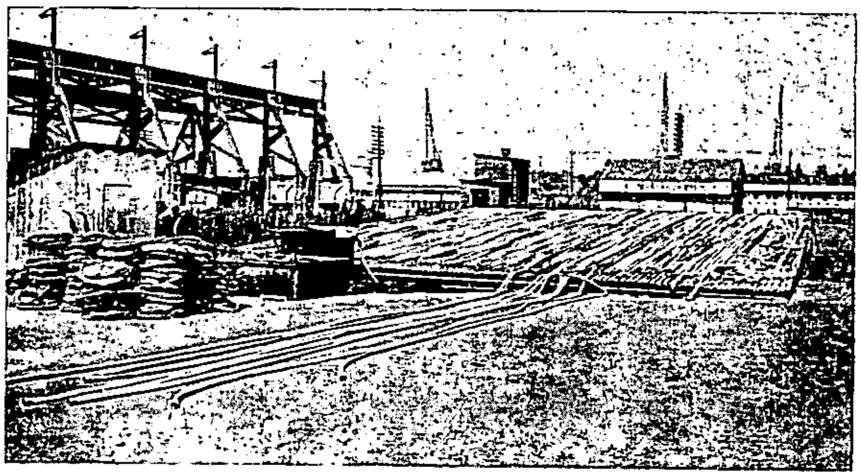


FIGURE 1.—Over-all layout and arrangement of hose washing, testing, and drying rack.

The steps in the process are as follows:

1. Dirty hose, loosely rolled, comes in from the fires.
2. The hose is then soaked in one of two 6- by 6-foot galvanized tanks, 27 inches deep, to loosen the dirt and grime.
3. After soaking, tie strings are removed and the female end is threaded through a "doughnut" hose washer and pulled out on the rack. The washer operates at 150 pounds' pressure, and hose is washed by the simple process of pulling it through the doughnut. [1]
4. The female end of the hose is then attached to the tester head shown in figure 2. It is not necessary to screw the coupling on to the water discharge; once the "gripper" arm is placed over the coupling and the cam lever pushed forward, the hose is held in place. The hose is tested at 225 pounds' pressure, read direct from the pressure gage.

[1] For details of the doughnut hose washer, see January 1949 issue of FIRE CONTROL NOTES, p. 28.

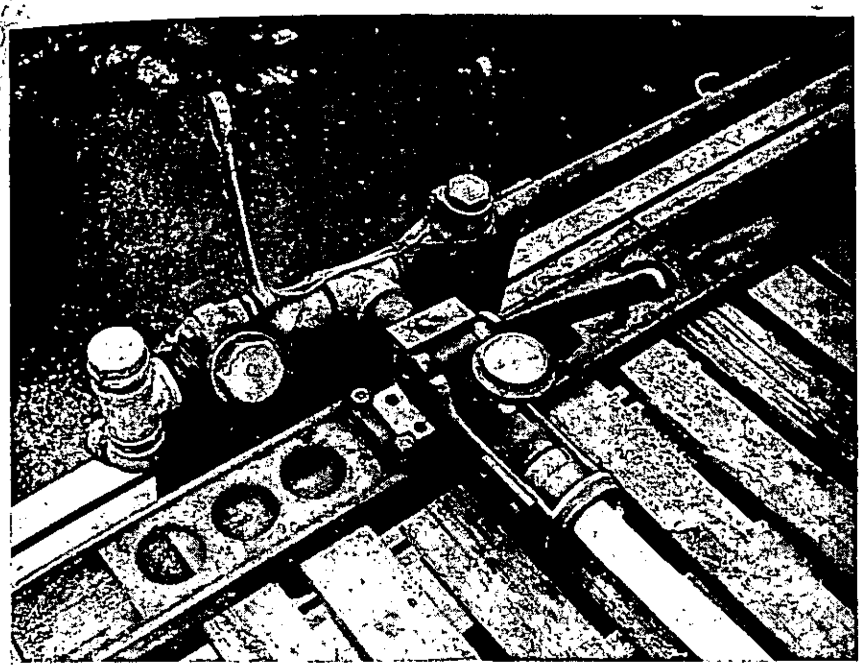


FIGURE 2.—Tester head. Cam lever in foreground operates "gripper" which holds female end of hose tight against discharge port. Coupling is not screwed on. Lever on left operates intake valve. Lever on right operates the release.

5. At the lower end of the rack, one man screws on 1½-inch caps, usually having a half dozen with which to work. These caps have 1/16-inch holes drilled in them to allow the air to escape.

6. The entire tester head moves on a track. Thus it is possible to start at one edge of the rack and work across as the male ends of the hose are capped at the bottom of the rack.

With this arrangement, two men can wash and test 15,000 feet of hose in 8 hours.

The hose rack is 58 feet long and 50 feet wide.

Pressure for testing is provided by a 2½-inch, electric-driven pump hooked up to the city water supply. Water from the pump goes direct to a high pressure booster tank equipped with a relief valve and by-pass. One-and-one-half-inch hose runs from this booster tank to the tester head.

More detailed information is available for interested persons from Regional Forester, Post Office Building, Portland, Oreg.

EJECTOR SUCTION BOOSTER

ARCADIA EQUIPMENT DEVELOPMENT CENTER
Region 5, U. S. Forest Service

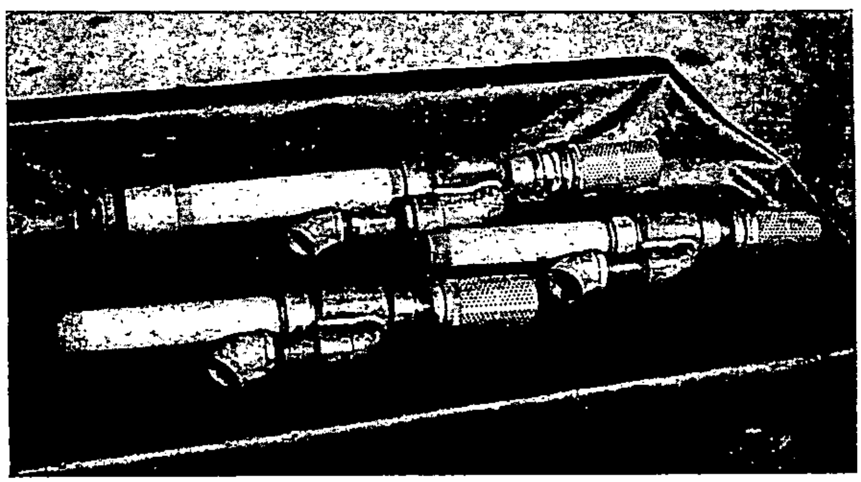
"Water, water everywhere, but not a drop to drink." By changing the last word to "draft," we have a condition which is common to fire fighting in forest areas where numerous streams and lakes exist, but whose resources cannot be utilized without undue delay, because fire trucks cannot approach sufficiently close to draft water.

By using a very simple, inexpensive gadget, which we choose to call an eductor, but known also as an ejector or jet pump, matched to the pumper on the fire truck, water can be lifted 100 feet vertically; reservoirs 200 or 300 feet away can be tapped; or tanks can be refilled at twice the output of the pumper. In some instances, dirty sand-laden water from an existing sump could be utilized for pumping onto a fire at triple the pump's output, with no damage to equipment.

Eductors for operation with portable pumpers can be purchased at $7 to $25. They weigh 1¼ to 14 pounds, and have no moving parts to wear out or get out of order.

Eductors have been used in industry for years for elevating or mixing liquids by use of water under pressure as motive power. In 1949, the Arcadia Equipment Development Center secured numerous makes and sizes of eductors to determine their adaptability to forest fire fighting activity, and select the types best suited to pumpers commonly used (fig. 1).

Since eductors are not in common use on fire equipment, it might be well to explain the principle on which they operate. Water is pumped



F-464376

FIGURE 1.—Three eductors used on tests.

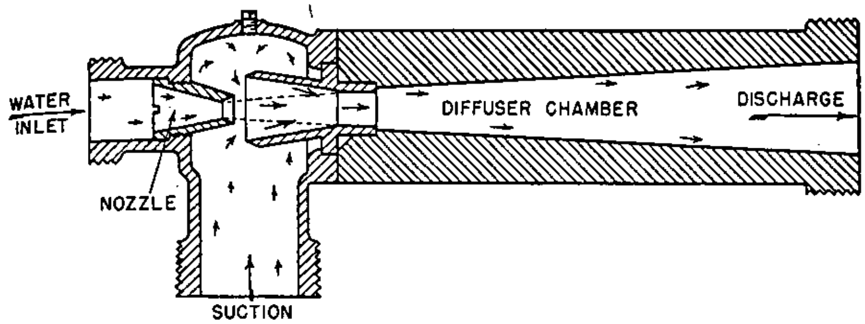


FIGURE 2.—Cross section of eductor.

through a built-in nozzle at high pressure into a diffuser chamber where extra water is picked up or entrained by the high velocity stream (fig. 2) just as a person's hat is dislodged by the passing of a fast-moving vehicle, due to so-called suction.

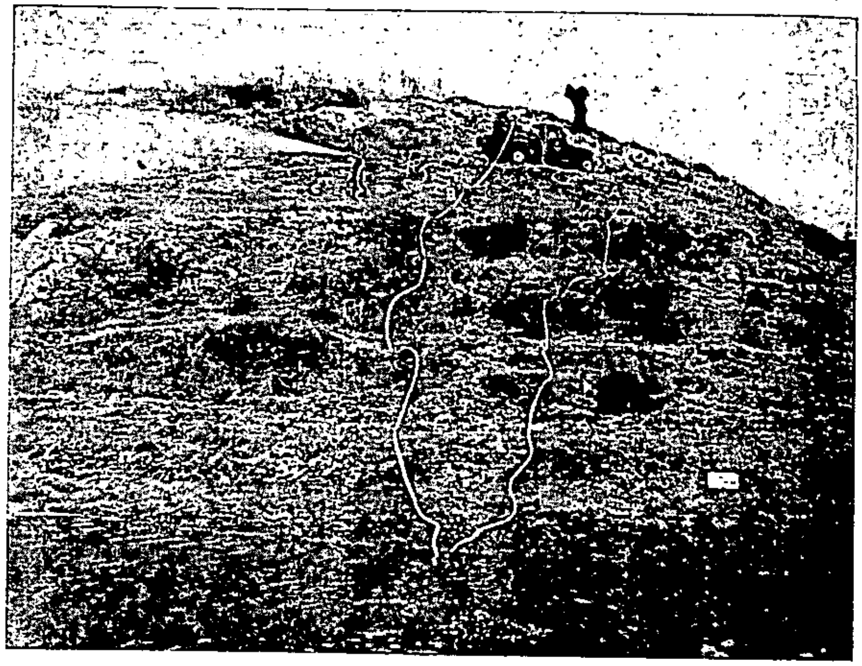
The eductor should be submerged in the pickup water for most efficient operation. However, a suction pipe or hose from the eductor to the water source will provide pick up of water at a reduced rate, depending on the suction lift. For trouble-free operation, the former operation method is recommended because no suction leaks are present to cause failure, all lines and connections being under pressure.

Recent checks of field operation of pumpers show that difficulty with suction is one of the most common field failures. In spite of manufacturers' claims, it is obvious that soon after use, pump suction ability drops off. As wear increases, a 10-foot lift is not uncommon as the maximum ability of a dry positive displacement pump. Add to this, failures due to leaky suction hose, loose connections, poor or wrong size gaskets, and losses due to elevation, and the drafting operation can present an infinite source of trouble.

In contrast to this, an eductor could minimize suction difficulties, since it operates under pressure. Suction hose might be eliminated. Leaks, if any occurred, would not cause failure.

Figure 3 shows the use of an eductor with the 160-gallon, ½- to 1-ton, slip-on pumper-tanker. The vehicle is located 80 feet above the water source, and the pump operating at 200 p.s.i. is delivering 20 g.p.m. Of the water pumped, 9½ g.p.m. is being delivered down hose line "A" to the eductor. The eductor is delivering 20 g.p.m. to the tank through line "B." Fog nozzle on line "C" is delivering 9 g.p.m. The unit will operate continuously under this condition, with occasional throttling of flow in line "A" to prevent overflow of the tank.

In order to operate without the eductor, a portable pumper would have to be set up at the water source. Not having a portable pumper would, in this particular location, require a round trip of 4¾ miles to allow the tanker to reach the water source and draft with usual hard suction hose. An alternative would be the use of two more tankers of the same size shuttling back and forth in order to keep the unit supplied with water for continuous operation.



F-464377
FIGURE 3.—Eductor being used with 160-gallon, ½- to 1-ton, slip-on pumper-tanker.

Under test conditions, and on larger pumper-tankers, two eductors spaced along line "B" have been used to lift 180 feet.

Table 1 gives values obtained for two of the eductors tested and is an indication of the variation in operating conditions obtainable.

TABLE 1.—*Maximum output-lift for two eductors*

EDUCTOR E

Pressure	Lift	Water to jet	Water from jet	Pickup water
P.s.i.	*Ft.*	*G.p.m.*	*G.p.m.*	*G.p.m.*
150	35	13	44	31
200	46	15	46	31
250	70	17	47	30
250	100	17	22	5

EDUCTOR C

Pressure	Lift	Water to jet	Water from jet	Pickup water
150	45	13	34	21
200	57	15	36	21
250	80	18	37	19
250	100	18	33	15

The table shows that a pumper that is capable of pumping 17 g.p.m. could deliver 30 g.p.m. to the water tank, using water from supplies considerably beyond the range of suction drafting. It also indicates that

if an eductor were wanted for rapid refill of a fire truck, eductor E would be the proper one to select for lifts up to 70 feet, but C would be selected for lifts of 100 feet.

If the local conditions were such that the primary use was for drafting from, say, a river which was beyond the range of suction lift, and pumping onto fires considerably higher in elevation, another eductor would be selected whereby approximately half of the pumper capacity would run the jet to keep the tank full, and the balance could be pumped onto the fire.

From this short discussion, it is quite evident that selection of "the best eductor" is dependent on certain basic conditions. Adjustable jets are manufactured which permit limited adjustments to overcome these obstacles, but they are complicated and expensive. It might not be out of reason to carry two, or even three, eductors on a fire truck, in order to get maximum performance for all conditions.

One difficulty which exists with the use of eductors for drafting is that some water must be available in the fire truck to start the operation of entraining pickup water. This can be accomplished by installing an auxiliary tank either in the tank or outside, which could be tapped for this purpose; or the internal dip pipe could be equipped with a valve which would not allow the tank to be drained in regular pumping operation, but which could be closed, so that the remaining water could be used for operating the eductor.

SUMMARY

1. By using an eductor properly designed for the pumping unit, water can be pumped from a stream or reservoir which is 100 feet below the fire truck, or from sources 300 feet from possible accessibility because of soft ground, impassable terrain, fences, etc.
2. Output of pumpers can be increased considerably for filling the tank where lifts are 70 feet or less.
3. Where lifts are within range of drafting operations (15 to 20 feet), pumpers could utilize local water sumps and deliver two or three times the pump capacity onto a fire at low pressure.
4. Drafting failures can be minimized by using eductors.
5. Suction hose might be eliminated as necessary tanker accessory.
6. Eductors are inexpensive, simple to operate, and long lived.

Further details concerning the Ejector Suction Booster project and information concerning makes and types of eductors which can be used with pumpers up to 30 g.p.m. at 250 p.s.i. are available at the Arcadia Equipment Development Center, 701 N. Santa Anita Ave., Arcadia, Calif.

PAPER-COVERED PILED SLASH

LOWELL W. ASH

District Assistant, Rouge River National Forest

Each fall the Forest Service is likely to experience difficulty in burning piled slash. This is particularly true in the pine-fir transition forests of southern Oregon. Much depends upon favorable weather before, during, and after burning to insure a successful operation. Much labor and equipment has often been necessary to control fires which have gotten away as a result of drying weather conditions after too early slash burning. On the other hand, unsuccessful and expensive burning often occurs because of early and continued rainfall, or postponement of burning until conditions are unquestionably safe late in the fall.

It occurred to the author that this problem could be lessened if some form of inexpensive covering could be provided to protect the piles against excessive moisture until all normal danger of fire spreading to surrounding forest land was over. Hence, an experiment was carried out during the 1950 season, whereby piles were covered with paper as they were made during the summer period. The paper used was Kraft No. 30-30-30, long fibre, waterproof, double-coated, 72 inches wide, with 4,500 square feet per roll. It cost $14.25 per roll at Medford, Oreg.

The slash piles, averaging 6 by 8 feet in size, were covered with the paper when the pile was about three-fourths completed. The piece of paper was not extended down the sides of the pile; it was only large enough to extend to the perimeter at the point where the paper was added. No more than usual care was taken in making the piles compact. However, piles were well rounded before paper was placed on them to insure against low places which might serve to hold water in pockets rather than shed it. The additional slash, that is, the top one-fourth of the pile, held the paper firmly in place. The 600 slash piles constructed in this manner required two rolls of paper. The cost of paper was $28.50, or 4¾ cents per pile.

The 1950 fall precipitation was unusually heavy for southern Oregon, with a total of 6 inches in the slash area by October 19, the day the piles were burned. Two inches of this total precipitation fell the day before burning. Twenty of the piles were purposely left until December 7, at which time light snow was present and the total precipitation had reached 15 inches. While the latter piles started a little more slowly, all 600 burned up clean with little to no chunking. To burn the 600 piles required 4 man-days and 1½ barrels of planer shavings soaked with diesel oil.

It is felt the experiment has demonstrated that this method of protecting piled slash until safe burning conditions are assured promises substantial savings in the over-all job of slash disposal. These savings will result from the following factors: (1) Fewer man-hours are required to burn piled slash. (2) It eliminates present risk of fires escaping, which destroy trees or property and frequently result in excessive control costs. (3) The burning

operation can be completed at a more convenient time for the forest manager, without the need for week-end overtime or the hiring of larger crews to do the job before the piled slash becomes too wet. (4) Planned slash disposal in the partial cut areas can be kept current, with resultant lowering of the over-all hazard, as there will be very little carry-over or unburned slash as a result of extremely wet burning season.

Metallizing the Interior of Water Tanks As A Rust Preventive

The large number of water-using units that have come into the picture in recent years in forest fire control pose all agencies owning them with a problem of eliminating, as far as possible, corrosion and deterioration in the metal tanks themselves.

An item in the April 1951 issue of Fire Control Notes stressed the possibility of using rust preventive solutions or special paints for coating the interior of tanks. A method which has not yet been mentioned covers a metal spraying process known as "metallizing," which is available commercially under a number of different trade names.

The equipment required consists of a sand blaster, driven by compressed air; a metallizing gun which admits compressed air, oxygen, and acetylene; a three-line hose unit to control these gases; a wire holding stand which contains reels of the particular kind and size of wire being used, and from which it feeds into the gun; a set of three gages to control flow of the various gases; and a magnetic thickness gage, which determines the thickness of the metallized coating.

A continuous wire is fed through the heat of the oxo-acetylene flame, which at the proper temperature volatilizes the metal wire that makes up the spray material. The metal is driven onto the surface to be treated in the form of a liquid or molten spray. It cools and solidifies on the surface and makes a permanent coating. Through the use of copper, zinc, or stainless steel, the interior of water tanks can be made practically corrosion proof, and the cost is far less than rust resistant metals in the body of the tank itself.

The purpose of the sandblasting is twofold. It removes all oxides, dirt, greases, or other foreign material from the surfaces to be coated, leaving them clean and in proper condition to receive the metal coating; it also pits and roughens the surfaces assuring proper bonding of the spray as it strikes the treated surface.

Cost of treatment varies with the thickness of the coating, the metal being used, and the technique required for any particular job. Owner of the full kit of equipment can treat steel surfaces for 12 cents per square foot. Work can be done commercially at costs ranging from 19 cents to $1 per square foot. These figures are based on applications of zinc to a thickness of 0.010 inch.

Surfaces treated in this way become highly resistant to corrosion. Coatings of zinc on steel, thickness 0.010 inch, assure metal life of 30 years without further treatment. Almost any firm material can be metal-sprayed, including wood, leather, certain fabrics, glass, and ceramic materials.

The method is now in common use in the oil and chemical industries and has extended to uses such as coating of ships' hulls exposed to corrosive waters. In any case, surfaces so treated have a life of almost indefinite periods.—G. I. Stewart, *Supervisor, Forest Fire Experiment Station, Michigan Department of Conservation.*

FUEL WEIGHTS ON THE OSCEOLA NATIONAL FOREST

David Bruce

Forester, Southern Forest Experiment Station

Fire damage and the fire suppression job are determined in part by how much flash fuel there is in an area. In the southern pine region, heavier fuels (over 1 inch in diameter) increase mop-up but have relatively small effect on the initial control job. In the longleaf-slash pine type, age of rough and stand density are commonly used as general indicators of amount of small fuel. Fuel samples collected in longleaf or slash pine stands on the Osceola National Forest in the winter 1944-45 show how variable the amount of fuel less than 1 inch in diameter can be when thus classified (table 1). Despite the variability, there are well-defined trends that show that these are useful categories.

Table 1.—*Average weight of fuel per acre for open and dense stands, Osceola National Forest,* 1944-45 [1]

Brush type	Open stands,[2] age of rough—				Dense stands,[3] age of rough—			
	1 year	2 years	3-5 years	10-15 years	1 year	2 years	3-5 years	10-15 years
	Tons	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
Palmetto and gallberry	2.5	7.5	4.8	8.4	6.8	8.9	9.7	10.5
Palmetto only	3.7	6.3	4.1	7.2	6.3	8.3	9.0	20.8
Gallberry only	4.4	5.8	5.1	7.5	8.0	8.8	8.2	13.0
Average	3.5	6.5	4.7	7.7	7.0	8:7	9.0	14.7
No palmetto or gallberry	1.5	3.3	3.4	6.9	7.5	4.4	9.4	10.5

[1] Averages were based on air-dry weight of two samples of all material less than 1 inch in diameter that usually burn in headfires under dry conditions. Burnable material included dead palmetto leafstalks, but excluded green leafstalks, and living stems of shrubs and their branches 1/10" or larger in diameter. Each sample included all burnable material on a representative area 1 yard square.

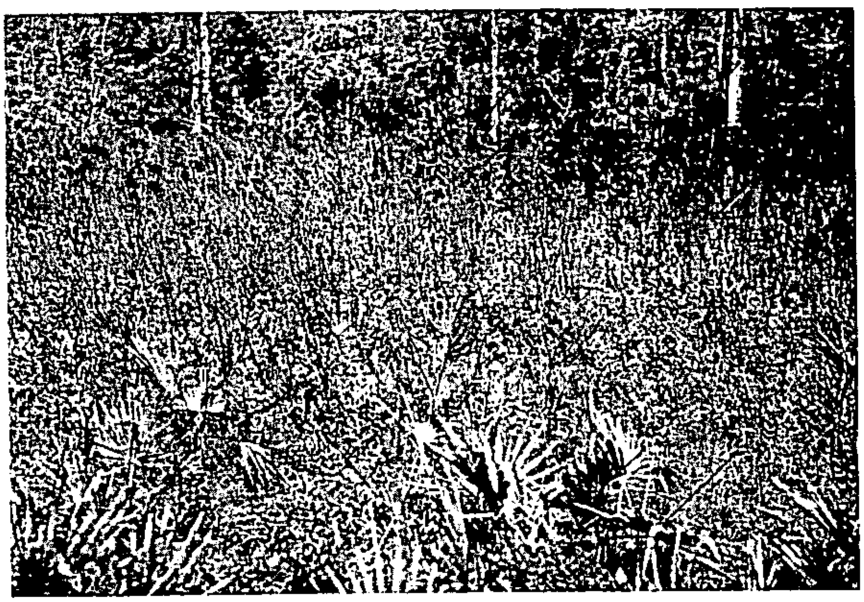
[2] Light stands had no pines over 5 feet tall within 20 feet of the sampling area.

[3] Stands were classed as dense if within 10 feet of the sampling area there were at least four pines 4 inches d.b.h. or larger.

Dense pine stands (see footnotes to table I) had on the average 4 tons per acre more fuel than open stands. For all density and brush classes, there were about 5½ tons per acre more fuel on the 10- to 15-year-old roughs than on 1-year roughs. Where palmetto or gallberry were present, there were 2 tons more fuel per acre than where these brush species were absent (figs. 1 and 2).

F-255987, 431395

FIGURE 1.—*Top,* Palmetto (*Serenoa repens* or *Sabal* spp.) when unburned for many years produces maximum amount of fuel. *Bottom,* One growing season after prescribed burning, palmetto has not built up a dangerous accumulation of fuel. The new growth comes from underground rootstocks unaffected by fire.



F-431349, 431388

FIGURE 2.—*Top,* Gallberry (*Ilex glabra*) unburned for many years is the plant associated with the next heaviest accumulation of fuel. *Bottom,* Like palmetto, gallberry sprouts vigorously the first season after prescribed burning, but it requires many years to regain the level in the upper view.

The highest and lowest average weights in the table, 20.8 tons and 1.5 tons, agree well with other measurements which indicate maximum fuel accumulations in dense stands of 25 tons per acre, and grass growth in the open of as much as 1 to 1½ tons per acre per year.

Within this range, however, there appear to be several inconsistent measurements. For example, there were greater fuel accumulations in some 2-year roughs than in some 3 to 5 years old, and in the 1-year roughs in dense stands there was more fuel with no palmetto and gallberry than with palmetto. This inconsistency arises in part from the fact that only 2 samples were taken per condition, but probably is even more due to differences in site and past fire history. Moist sites usually produce more vegetation than dry sites and hence accumulate more fuel, even though their decay rates may be slightly higher. For a given period after a fire, areas that have burned hard and often will accumulate less fuel than areas that have not burned frequently.

Where gallberry or palmetto were present they comprised over 40 per cent of the fuel in dense stands and about 60 percent in open stands. With no gallberry or palmetto, more than half the fuel in dense stands was pine needles, and two-thirds of the fuel in open stands was grass.

It is estimated that 50 to 90 percent of the total weights (of fuel less than 1 inch in diameter) sampled in open stands were rapid-drying flash fuels, that is, well aerated dry materials including material up to 1/10-inch diameter that burn rapidly in dry weather, while in dense stands the proportion was 40 to 70 percent. Little or no fuel was found more than 1 foot from the ground on one-year roughs or in areas with no palmetto or gallberry. The biggest increase in fuel more than 1 foot from the ground appears to come in the second year.

Chemical composition of fuel, its arrangement, and rate of change in moisture content were obviously different in the various tabulated conditions. These variables were not measured, but may be as important in their effects on fire intensity as the measured weights.

LIGHTNING FIRES IN THE NORTHERN ROCKY MOUNTAINS

J. S. Barrows

Chief, Division of Fire Research, Northern Rocky Mountain Forest and Range Experiment Station

Lightning fires are a major problem in the northern Rocky Mountains. In the national forests of Region 1 over 75 percent of the fires are lightning-caused. An annual average of nearly 1,200 lightning fires occur on the national forests, and over 400 more occur on lands protected by other agencies. During the last 20 years these fires have burned nearly three-quarter million acres of forest and range land.

In some 40 years of organized fire protection in this region the various fire control agencies have made encouraging progress in their ability to deal effectively with this great load of lightning fires. Continued progress is essential and will depend largely upon gaining a thorough understanding of the nature and peculiarities of these fires. Recently, in an effort to provide this type of information, the Division of Fire Research made an analysis of over 25,000 lightning fires. In accordance with standard Forest Service procedure, essential data on these fires were coded and placed on punch cards to permit machine sorting and tabulating. By this method many factors influencing ignition, behavior, and control could be analyzed singly and collectively. The following are a few of the highlights of the study.

THUNDERSTORM OCCURRENCE

Lightning produced during thunderstorms provides a violent source of heat to ignite forest fires. A lightning stroke may reach a temperature of 30,000° Centigrade. In the northern Rocky Mountains this tremendous surge of heat is seldom accompanied by the downpour of cooling and dampening rain normally associated with thunderstorms. During the summer months "dry" lightning is to be expected. These peculiarities of the storms, coupled with rough topography and large areas of dangerous fuels, are the underlying causes of the severe lightning fire problem in this region.

Thunderstorms cause fires during a 7-month period from April through October. As shown in table 1, during the 15-year period 1931-45 the region had an annual average of 88.13 thunderstorm days, counting only those storms which actually caused fires. In 1944 thunderstorms produced fires on 119 days between May 11 and October 28. During the summer months thunderstorm activity may be almost a daily occurrence. In 1940 lightning fires were started on 53 consecutive days from June 17 to August 8.

Thunderstorm activity reaches its peak in July when lightning fires occur on an average of 24.87 days. August is close behind with an average of 23.00 days, and June is third with 15.33 days. Occasionally a large number of storms may occur in May and September. During a 15-year period there were 2 years when May produced lightning fires on 15 or more days,

and in September there were 5 years with this storm frequency. However, July and August are clearly the most dangerous months from the standpoint of lightning occurrence as well as more critical burning conditions.

TABLE 1.—*Number of days in each month, April through October, when lightning fires have occurred on National Forests in* R-1, 1931-45

Year	April	May	June	July	August	Sept.	Oct.	Total
1931	3	9	21	27	23	11	0	94
1932	0	5	9	15	22	6	1	58
1933	1	2	17	22	21	9	1	73
1934	5	16	17	25	14	8	1	86
1935	0	7	9	23	15	9	6	69
1936	1	13	18	25	27	12	1	96
1937	0	3	19	25	14	14	2	77
1938	0	5	15	21	18	17	3	79
1939	3	10	9	19	17	12	0	70
1940	0	9	23	31	26	26	0	115
1941	4	15	20	29	27	6	0	102
1942	0	8	9	28	30	20	4	99
1943	0	1	5	27	31	17	8	89
1944	0	9	20	30	29	23	8	119
1945	1	6	19	26	31	13	0	96
Total ..	18	118	230	373	345	203	35	1322
Average.	1.20	7.87	15.33	24.87	23.00	13.53	2.33	88.13

OCCURRENCE DENSITY

Variability is the outstanding feature of lightning fire occurrence. In the national forests the 15-year average is 1,164 fires, but annual variations were found to run from a low of 270 to a high of 3,109 fires. More fires may occur in a 10-day period than normally occur in an entire year. In 1940 an all-time record of 1,488 fires occurred in the middle ten-day period of July. During the same period 335 lightning fires occurred in a 24-hour period—a greater number than occurred in the entire year of 1948.

Over 75 percent of the lightning fires occur in July and August. Normally, on about the tenth of July lightning fire activity increases rapidly and continues until a seasonal peak is reached about July 28. After this peak a remarkable midseason slump in occurrence during the first 10 days of August was noted in 11 out of 15 years. Then comes another build-up during the last 10 days of August reaching a peak slightly below that of July. During exceptional years there are great variations to this pattern. On two occasions well over 100 lightning fires occurred during the last 10-day period of May, and on one occasion over 300 fires occurred during the middle 10-day period of June. Late season peaks may likewise occur. Twice in 15 years loads of nearly 200 fires in 10 days came during September.

The bunching of great numbers of fires in a 24-hour period is a critical feature of lightning fire control. Regional loads of 50 or more fires in one day may occur in every month from May through September. During a 15-year period such loads were observed 2 times in May, 5 in June, 35

in July, 30 in August, and 4 in September. In July 1940 a regional load of 50 or more lightning fires occurred for ten consecutive days. On individual national forests loads of ten or more lightning fires in a single day were observed on 354 occasions in a 15-year period. In July 1938 the Kaniksu National Forest had 118 lightning fires in 24 hours. In July 1940 the Kootenai National Forest had more than 50 lightning fires on 3 days in a 10-day period.

The great variations in lightning fire occurrence and the peak loads dictate that flexibility be an essential feature of the fire control organization. Suppression forces must be capable of rapid mobilization to meet off-season loads and expansion to handle peak loads within the normal season. As in warfare, mobility and concentration of force are essential. To meet these requirements fire control planning must be on a regional basis. The cost of manning and equipping an individual forest to meet peak detection and suppression loads throughout a fire season would be prohibitive. Thus a pooling of forces is called for in a regional fire plan incorporating speed, coordination, and great flexibility of action.

LIGHTNING ZONES

The old adage that lightning never strikes twice in the same place doesn't hold true in the northern Rocky Mountains. Contrary to this false belief lightning has struck hundreds of times in several distinct zones within the national forests. Some of the mountain tops are literally covered with the scars of lightning strikes.

In the national forests lying west of the Continental Divide the annual average is 51 lightning fires per million acres. However, in the zones of peak occurrence the annual average is over 175 fires per million acres. In one small zone of approximately 2,300 acres lying on the mountain tops of the Clearwater National Forest lightning fires have occurred at an average annual rate of 440 per million acres over a 15-year period.

These distinct lightning zones are caused by a combination of fuels and elevation. In general, high mountain areas covered with flammable fuels have much greater lightning fire occurrence than similar fuel areas lying at lower elevations. The most intense lightning fire occurrence zones in the high mountain areas are found in the national forests of northern Idaho. As shown in table 2, four of the five national forests in this part of the region have an average annual lightning fire occurrence greater than 100 fires per million acres in the 6000- to 7000-foot elevation zone.

TABLE 2.—*Average annual number of lightning fires*[1] *per million acres by elevation zones, national forests of northern Idaho,* 1936-44

National forest	Elevation zone							Forest average
	1000-1999 feet	2000-2999 feet	3000-3999 feet	4000-4999 feet	5000-5999 feet	6000-6999 feet	7000 feet & over	
Clearwater	....	21.64	77.26	136.41	177.12	177.05	440.92	136.79
Coeur d'Alene	....	26.76	49.78	83.96	85.89	156.21	....	57.49
Kaniksu	7.36	29.60	53.11	62.70	87.30	123.19	....	53.93
Nezperce	10.76	26.78	39.75	74.57	109.78	98.56	66.90	74.46
St. Joe	....	52.01	39.95	60.51	80.49	190.59	....	63.93

[1] Basis: 7,377 fires.

The importance of fuels in governing lightning fire occurrence is illustrated in the national forests lying east of the Continental Divide. Here the most intense lightning fire zone is at the lowest elevation where fuels are principally ponderosa pine and grass. In this part of the region the mountain top areas often have only scattered areas of flammable fuels interspersed with rocky outcroppings and alpine meadows. The average annual lightning fire occurrence per million acres in the national forests lying east and west of the Continental Divide is as follows:

	Average annual lightning fire occurrence per million acres	
Elevation zone (feet):	*Eastern Forests*	*Western Forests*
1000-1999	....	10.95
2000-2999	....	32.53
3000-3999	30.45	50.79
4000-4999	8.10	66.99
5000-5999	10.12	73.72
6000-6999	6.96	69.26
Over 7000	5.53	36.00

Snags are highly vulnerable to lightning fires. In a study of nearly 12,000 fires it was found that over three times as many fires started in snags as in green tree tops. The ratio of snags to green trees is not known. However, there are obviously a much larger number of green trees than snags in the forests of this region. Therefore, in view of the higher ignition rate in snags, they are clearly an important factor. This relationship is further illustrated by the fact that old burns where snags predominate have an average annual occurrence rate of 190 fires per million acres as compared to 40 in green forests.

LIGHTNING FIRE DETECTION

In planning detection operations the daily period of peak fire occurrence is an important consideration. Lightning may strike and cause fires at any hour of the day. However, in the northern Rocky Mountains the late afternoon and early evening hours are clearly the period of greatest lightning occurrence, while the midmorning hours have the least lightning activity. The most important 8-hour period is from 2 to 10 p. m. In the national forests west of the Continental Divide over 60 percent of the lightning fires occur during this period. Concentration during these hours is even more intense on the forests east of the divide where 75 percent of the lightning fires occur between 2 and 10 p. m. Peak occurrence in both zones is from 4 to 6 p. m. Night detection is more important than generally recognized. More lightning fires occur during the hours of darkness than during the morning daylight hours.

Lookouts are more efficient in detecting lightning than man-caused fires. Over 83 percent of the lightning fires falling within the seen area of manned lookouts are first discovered from those stations as compared to only 43 percent for man-caused fires. However, speed of detection is slower for lightning than man-caused fires. Elapsed time from origin to discovery is greater than 12 hours for 45 percent of the lightning fires as compared to only 25 percent for man-caused fires. Likewise, nearly twice as many lightning fires are hangovers with a discovery time of over 48 hours.

This study of lightning fire detection has shown the importance of taking a fresh look at hours of work for detectors and general detection methods. The afternoon and early evening hours are normally the most important for detectors to be on the job. To increase the efficiency of night as well as daylight detection fire finders equipped with accurately calibrated azimuth and vertical scales need to be used in conjunction with matched panoramic photographs. Because of the difficulty of night detection a thorough scanning of the country is essential in the early daylight hours and especially during periods of critical fire weather. On aerial detection units it is important for aircraft and pilots to be capable of making safe flights after storms during the late afternoon and early evening hours when turbulent air may prevail. In all cases it is essential to correlate the detection plan with a system of measuring and rating fire danger in order to economize on detection costs and to promote efficiency.

LIGHTNING FIRE SUPPRESSION

On the national forests over 84 percent of the lightning fires are held to class A size. In spite of this good record lightning fires present many special and difficult suppression problems. The average size per lightning fire is 46 acres. Only 4 percent of these fires can be reached by roads. The balance requires at least a part of the travel by other means. Only 34 percent of the lightning fires are reached within 1 hour. Over 22 percent of the lightning fires require more than 4 hours travel time, and 11 percent require more than 8 hours. Nearly 50 percent involve travel distances of over 5 miles and 25 percent over 10 miles.

The smoke jumper organization, designed primarily to control backcountry lightning fires, has made a good record in holding burned area to a minimum. The average size per smoke-jumper lightning fire is 11 acres. However, it is recognized that this record has been made during a 10-year period of phenomenally easy fire danger. In every dangerous or critically dry season in the region's history lightning fires have escaped control to burn large areas. On two occasions during the past 20 years individual lightning fires have reached sizes of over 75,000 acres, and on one occasion over 175,000 acres. During the same period over 100 lightning fires reached class E size.

While the smoke jumper has reduced the probability of disastrous burns in the future, the lightning fire suppression problem is far from being solved. The smoke jumper is primarily a hand-tool firefighter and operates under the same handicaps as any smokechaser. Ten years' experience has shown that 18 percent of the smoke jumper lightning fires are in high or extreme rate-of-spread fuels and that 11 percent of these fires are running, spotting, or crowning at first attack. Successful control of such fires demands something more powerful than hand-tool firefighting. The backcountry fire control man, like the infantryman, needs help. Future fire research and equipment development must point toward the improvement of basic fire suppression methods.

A TEMPLATE FOR PREPARING AND CHECKING FIRE REPORTS

G. M. Wilkinson
Assistant Forest Supervisor, Kisatchie National Forest

In the Southern region of the U. S. Forest Service the dispatcher gathers the pertinent information and prepares the individual fire report, Form 929. The report is approved by the district ranger, forwarded to the supervisor's office where it is checked for errors, and then sent to the regional office for completion.

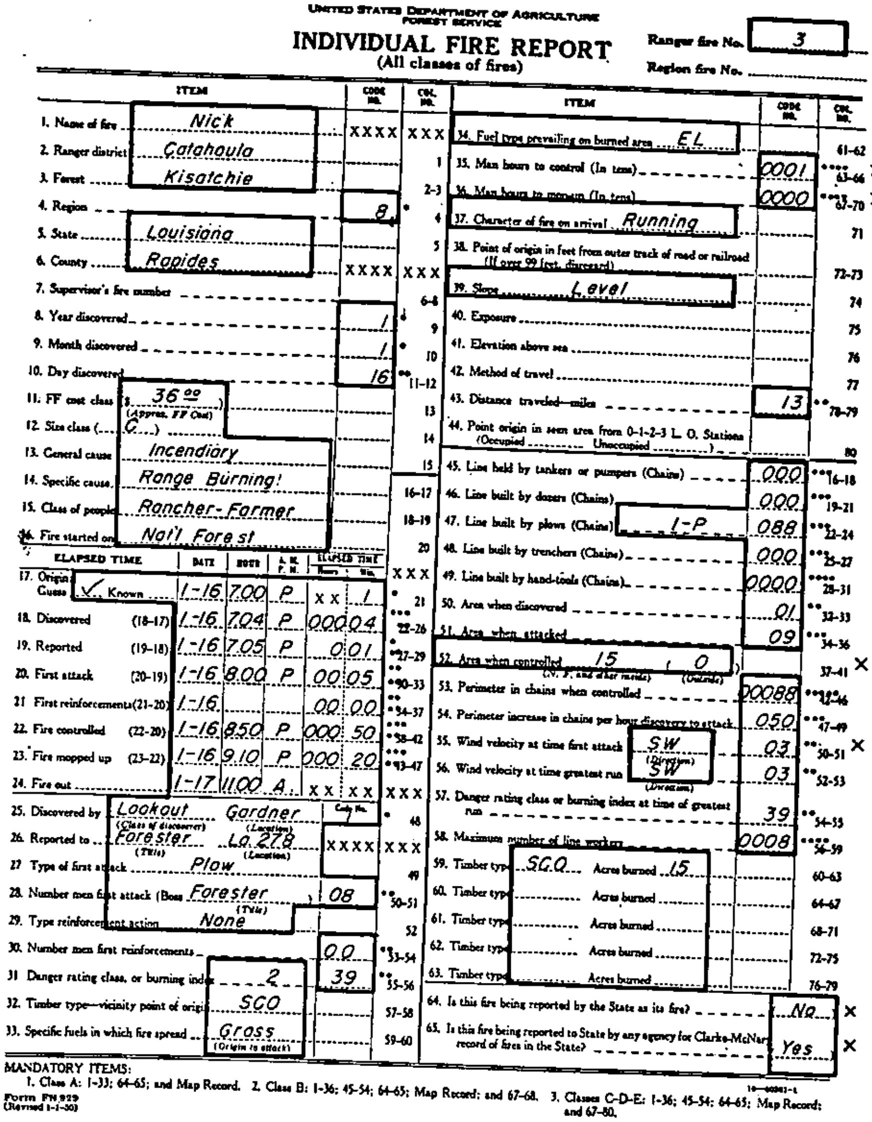
The fire report carries a "Code Number" column where information is coded for use on an IBM punch card machine. All national forest fire statistics are maintained on punch cards in the Washington office. Some of the information coded is placed on the report in the field offices and some at supervisor or regional offices. This made fire reporting by the field offices rather difficult and time consuming since it was necessary to constantly refer to voluminous instruction.

To assist field officers with this problem a template of clear plastic was designed with openings in the "Item" and "Code Number" columns where entries were to be made by the reporter. This template can also be used in the supervisor's office for checking reports prepared on the ranger districts. This device proved to be satisfactory and, while no studies have been made locally of time saved by its use, it has saved some time, and fire reports from the field are generally correctly prepared.

Directions for using template.—Place template over blank Form 929. Complete only the spaces where there is an opening in the template. Where the opening occurs over a line in the "Item" column, the information is written there; where the opening is in the "Code Number" column, the information, coded, is placed there. In one or two instances, openings occur in both columns and in such cases both entries are made.

The black dots at the right of the template openings in the "Code Number" column indicate the number of digits required for proper coding. For instance, item 10 requires two digits in the code column; item 53 requires five. The only exception occurs in items 18 to 23. These items require a code number in both the hours and minute columns. The black dots for these items are in two lines, the upper row indicating the number of digits (code) required in the hours column, the lower row indicating the number of digits required in the minutes column. Thus, if elapsed time on line 20 is 1 hour 55 minutes, it would be coded 01 in the hours column (two dots), and 55 in the minutes column (two dots).

For Class A fires complete all uncovered items on left side of template (items 1-33) and all items marked X on the righthand side (items 35, 36, 52, 55, 64, 65). For Class B, C, D, and E fires complete all items uncovered by the template.



UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

INDIVIDUAL FIRE REPORT
(All classes of fires)

Ranger fire No. 3
Region fire No.

Item		Code No.	Col. No.
1. Name of fire	Nick	XXXX	XXX
2. Ranger district	Catahoula		1
3. Forest	Kisatchie		2-3
4. Region		8	4
5. State	Louisiana		5
6. County	Rapides	XXXX	XXX
7. Supervisor's fire number			6-8
8. Year discovered		1	9
9. Month discovered		1	10
10. Day discovered		16	11-12
11. FF cost class	$ 36.00 (Approx. FF Cost)		13
12. Size class	(C)		14
13. General cause	Incendiary		15
14. Specific cause	Range Burning!		16-17
15. Class of people	Rancher-Farmer		18-19
16. Fire started on	Nat'l Forest		20

Elapsed time		Date	Hour	A.M./P.M.	Elapsed time Hours	Min.	Col. No.
17. Origin: Guess / ✓ Known		1-16	7.00	P	XX	1	XXX / 21
18. Discovered	(18-17)	1-16	7.04	P	000	04	22-26
19. Reported	(19-18)	1-16	7.05	P	0	01	27-29
20. First attack	(20-19)	1-16	8.00	P	00	05	30-33
21. First reinforcements	(21-20)	1-16			00	00	34-37
22. Fire controlled	(22-20)	1-16	850	P	000	50	38-42
23. Fire mopped up	(23-22)	1-16	9.10	P	000	20	43-47
24. Fire out		1-17	11.00	A.	XX	XX	XXX

Item		Code No.	Col. No.
25. Discovered by	Lookout (Class of discoverer) Gardner (Location)	Code No. 7	48
26. Reported to	Forester (Title) La. 278 (Location)	XXXX	XXX
27. Type of first attack	Plow		49
28. Number men first attack (Boss	Forester (Title))	08	50-51
29. Type reinforcement action	None		52
30. Number men first reinforcements		00	53-54
31. Danger rating class, or burning index	2	39	55-56
32. Timber type—vicinity point of origin	SCO		57-58
33. Specific fuels in which fire spread	Grass (Origin to attack)		59-60

Item		Code No.	Col. No.	
34. Fuel type prevailing on burned area	EL		61-62	
35. Man hours to control (In tens)		0001	63-66	×
36. Man hours to mopup (In tens)		0000	67-70	×
37. Character of fire on arrival	Running		71	
38. Point of origin in feet from outer track of road or railroad (If over 99 feet, disregard)			72-73	
39. Slope	Level		74	
40. Exposure			75	
41. Elevation above sea			76	
42. Method of travel			77	
43. Distance traveled—miles		13	78-79	
44. Point origin in seen area from 0-1-2-3 L. O. Stations (Occupied ...... Unoccupied ......)			80	
45. Line held by tankers or pumpers (Chains)		000	16-18	
46. Line built by dozers (Chains)		000	19-21	
47. Line built by plows (Chains)	1-P	088	22-24	
48. Line built by trenchers (Chains)		000	25-27	
49. Line built by hand-tools (Chains)		0000	28-31	
50. Area when discovered		01	32-33	
51. Area when attacked		09	34-36	
52. Area when controlled	15 (N. F. and other inside) (0 (Outside))		37-41	×
53. Perimeter in chains when controlled		00088	42-46	
54. Perimeter increase in chains per hour discovery to attack		050	47-49	
55. Wind velocity at time first attack	SW (Direction)	03	50-51	×
56. Wind velocity at time greatest run	SW (Direction)	03	52-53	
57. Danger rating class or burning index at time of greatest run		39	54-55	
58. Maximum number of line workers		0008	56-59	
59. Timber type	SCO Acres burned 15		60-63	
60. Timber type	Acres burned		64-67	
61. Timber type	Acres burned		68-71	
62. Timber type	Acres burned		72-75	
63. Timber type	Acres burned		76-79	
64. Is this fire being reported by the State as its fire?		No		×
65. Is this fire being reported to State by any agency for Clarke-McNary record of fires in the State?		Yes		×

MANDATORY ITEMS:
1. Class A: 1-33; 64-65; and Map Record. 2. Class B: 1-36; 45-54; 64-65; Map Record; and 67-68. 3. Classes C-D-E: 1-36; 45-54; 64-65; Map Record; and 67-80.

Form FS 929 (Revised 1-1-50)

FIGURE 1.—Template in place for checking fire report prepared in field. Note error in the code number column disclosed by template; item 51 should be coded 009.

Directions for making template.—(1) Prepare a pattern by blocking out on a blank 929 each line in the "Item" column and each line in the "Code Number" column which, under existing instructions, is to be reported on by the ranger district.

(2) With knife or razor blade, remove blocked out sections, leaving sufficient marginal material so the pattern will remain in one piece. Recheck pattern for accuracy before cutting template.

(3) Select a piece of clear plastic the same size as Form 929. Plasticiele, 30/1000 inch in thickness, is entirely satisfactory. In this weight, the

material is sufficiently rigid for the purpose, and yet is not too difficult to cut. Place the sheet of plastic over the pattern, lining up the edges of the plastic and the pattern. Then fasten to a table or drawing board with tape. Using a straightedge, score the outline of each opening in the pattern on the plastic. A sharp ice pick makes a good tool and the scoring should be deep. After this has been completed on one side, turn plastic sheet over and score the reverse side. If the scoring on each side is deep enough, the section to be removed can be broken out. Edges should be smoothed with an emery board or small file.

(4) If desired, the number of digits needed in the "Code Number" column can be indicated by dots, as shown on the template illustrated in figure 1. This information is also available in the "Column Number" column on the 929 and may be read direct. For instance, opposite item 10, the figures 11-12 appear in the "Column Number" column indicating two digits required in the "Code Number" column; opposite item 53 the numbers 42-46 appear, indicating 5 digits required. We have found the use of dots to indicate the number of digits to be more satisfactory.

This device has been tested under field conditions in Region 8 and approved for region-wide use. It can be adapted easily to the needs of the several Forest Service regions by changing the pattern to coincide with regional instructions. Its use should save time and improve accuracy in preparing and checking fire reports in the field.

While this discussion has been devoted to the use of the template in conjunction with Forest Service fire reports, it is possible that the idea could be applied to preparation of reports by other fire control agencies.

BATTERY CONSUMPTION BY LOOKOUT-REPEATER TYPE RADIOPHONE

WILLIE I. HAYNES
Radio Technician, Region 7, U. S. Forest Service

"It must take an awful lot of batteries to keep these things in operation," is the usual remark after someone inspects the "works" of the new FM radiophones with automatic repeaters now in use on the Jefferson and George Washington National Forests. The "works" is comprised of 13 or 14 relays, many transformers, resistors, etc., and from 28 to 30 tubes that range in size from that of a half-burned cigarette to the size of an average thumb.

Actually, the FM lookout station radiophones with automatic repeaters are conservative battery consumers. This point could have been proved in a scientific manner with fancy graphs, but due to many factors, such as variations in battery quality, shelf life of batteries, and atmospheric conditions that affect batteries, it was felt exact information might be misleading. Therefore, our method was simply that of comparing the number of battery replacements with the general use the radiophones received from time of installation in 1949 (two installed in 1948) until the close of the 1950 fall fire season on the two forests.

In Region 7, FM radio equipment is not used as it is in some of the other regions of the Forest Service. For example:

1. It is not used on a year-round basis for both administrative and fire control purposes. It is used only for fire control which includes presuppression and suppression communications in the regular forest fire seasons.

2. Radio, on the two national forests equipped with FM radiophones, is used intermittently during approximately 4½ months each year. The period of forest fire danger is divided into two seasons, one beginning in the spring about March 1 and ending about May 15, and the other beginning in the fall about October 15 and ending about December 15. The lookout stations are manned during these seasons on days of Class 3 and higher fire danger. The number of these days in the spring season varies, but the usual number is from 50 to 60 while in the fall it may be as high as 32. In other words, radio is used between 80 and 90 days each year.

3. Radio, of course, is only used when the lookout towers are manned. If the day starts with a Class 2 fire danger and increases to a Class 3, the stations on continuous stand-by operate on a schedule until the fire danger reaches a Class 3 day. This sometimes reduces the continuous stand-by period to 4 hours per day of Class 3 danger.

4. As a rule only key lookout stations on each district are on stand-by on Class 3 and higher fire dangers. The lookout stations of secondary importance are operated on a schedule. They go on stand-by for 10-minute periods every 30 minutes to receive messages from the key stations or to transmit when necessary. These stations go on continuous stand-by when (a) the fire danger reaches Class 4; (b) when personnel working in the vicinity need the station as a means of contacting the district offices.

5. Coded signals of the ten-series type are used on two districts of Jefferson National Forest. The forest plans adoption of these signals over the entire forest by the spring of 1951. Because of their brevity, coded signals permit the transmission of routine messages but reduce transmission time and resulting battery consumption.

To the outsider who is not familiar with Region 7, it may appear that the use of radio is considerably restricted. This is actually not the case. The forests using the FM equipment were responsible for developing the systems and methods in use, and have adopted them to meet their needs. Their objective is to conserve the batteries until they are needed most, which is on a forest fire.

With the foregoing information on how radio is used in Region 7, it is easier to evaluate the results of the survey made at the close of the 1950 fall fire season. Table 1 shows only the number of replacement batteries and does not include the original batteries when the radiophones were installed. If a replacement is not indicated opposite the name of a station, the original batteries are still in use.

On the basis of the survey of the number of battery replacements, we believe it can safely be said that even though the FM lookout radiophones have approximately four times as many tubes as the AM lookout station radiophones, they are twice as easy on batteries.

TABLE 1.—*Number of battery replacements for FM lookout station radiophones with repeaters, after installation in 1949 until close of 1950 fall fire season, at stations on two R-7 forests*

GROUP A[1]

Station	Radiophone installation date	Receiver A	Audio A	Receiver B sets	Transmitter A	Transmitter B sets
On continuous stand-by:						
High Knob	Aug. '49	0	0	0	0	0
Quebec	Mar. '49	1	1	2	1	1
Walker Mountain	Nov. '48	2	1	1	1	1
Apple Orchard	Mar. '49	1	0	1	1	1
Bald Mountain	Sept. '49	1	0	0	1	0
Duncan Knob	Oct. '49	0	2	2	0	2
On a schedule:						
Olinger Top	Aug. '49	0	0	0	0	0
Jasper Cliff	Aug. '49	0	0	0	0	0
Feathercamp	Mar. '49	1	0	0	1	0
Flat Top	Nov. '48	1	0	1	2	1
Jones Knob	Mar. '49	1	0	1	1	1
Allen Field	Sept. '49	0	0	0	0	0
Brushy Mountain	Oct. '49	0	0	0	0	0

GROUP B

Station	Radiophone installation date	A battery sets	B battery sets
On continuous stand-by:			
Bald Knob	May '49	2	2
Morning Knob	Oct. '49	2	[2] 0.4
On a schedule:			
Earn Knob	Sept. '49	0	0

[1] Because the radiophones are the product of two manufacturers, the battery complements are different, and the table is grouped accordingly.

[2] 10 to a set.

FIRE DANGER MANNING GUIDE

Mervin O. Adams
Forest Dispatcher, Shasta National Forest

During the past 2 years, the Shasta National Forest has been operating its fire force, on off-duty days, through the use of a Fire Danger Manning Guide.

This guide was designed by Dispatcher Adams to eliminate the guess work whenever it was necessary for a district ranger to decide if ground and initial attack forces and lookouts were needed on the off-duty days. The use of the manning guide has eliminated the payment of overtime during those periods when the fire danger did not warrant using overtime.

The manning guide was designed to cover only the man-caused risk and occurrence. During periods of lightning storms or storm predictions, heavy drains on district forces for off-district or forest fires, continual long periods of high or very high danger, or unusual high use, it is necessary for the district office to explain to the supervisor's office the conditions which warrant consideration. The supervisor's office approves all justifiable requests to meet the unforeseen conditions, or obtains approval from Regional Fire Control. During the normal run of the season the district ranger, who has an approved copy of the manning guide, has the authority to hold on duty and work those positions called for by the danger rating.

The manning guide is mimeographed on letter-size sheets (fig. 1). The heading is in three parts: Station location, position, and danger. The first two are self explanatory. The third, danger, is broken into the five classes of danger used in Region 5: Low, medium, high, very high, and extreme. Under each danger class are two blank spaces, one for percent of the season total in that class, and the other the number of off-duty days expected to fall into each danger class.

As this system has not been used for a long enough period to determine a yearly average, it has been necessary to use the preceding year's fire-danger rating to arrive at the percent of time for each class of danger. To arrive at these figures for ground and initial attack forces for the period of July 1 to October 10, we take from the fire-danger rating form for each district the total number of days for each danger class and convert it to percent.

The next step is to determine the total number of off-duty days between July 1 and October 10. This is then broken into the number of days that can be expected in each danger class by using the appropriate percent.

The next step, after arriving at the percent of time and number of days, is to list the location of each station and the position or positions at each location for each ranger district. After these entries are made, we determine when each position is authorized to go on duty, on the off-duty days. No authorization for overtime is allowed for low or medium days as our regular force should and must be able to cope with any man-caused fires during these two classes of danger.

GROUND AND INITIAL ATTACK FORCE
7/1 to 10/10
FIRE DANGER MANNING GUIDE

5L-3C

MC CLOUD District

RATING AREA 5

1959 Season

Station Location	Position	DANGER: Low 9 % 3 Days	Medium 20 % 6 Days	High 55 % 18 Days	Very High 16 % 5 Days	Extreme 0 % __ Days
MCCLOUD	FIRE CONTROL ASSISTANT	0	0	0	0	
"	DISPATCHER	0	0	0	0	
"	SUPPRESSION CREW FOREMAN	0	0	0	ON DUTY	
"	TANK TRUCK OPERATOR	0	0	0	ON DUTY	
"	CREWMEN (2)		ALTERNATE DUTY ONLY			
BARTLE	SUPPRESSION CREW FOREMAN	0	0	ON DUTY	ON DUTY	
	CREWMEN (2)		ALTERNATE DUTY ONLY			
HARRIS SPRINGS	FIREMAN	0	0	ON DUTY	ON DUTY	
" "	CREWMAN (1)	COOP. POSITION - NO OVERTIME ALLOWED				
MEDICINE LAKE	FIREMAN	0	0	0	ON DUTY	
	TOTAL DAYS ALLOWED			36	25	
	COST BUDGETED			$571.12	$401.25	

Approved by:
S/ R. C. Langsberg
Acting Forest Supervisor

FIGURE 1.—Manning guide as used for ground and initial attack forces.

To determine what positions are to be on duty on the high days, we first look at the station location. If there is more than one fireman or a crew foreman and a small crew at a given location, no overtime is allowed for a high day, i.e., at a headquarters location there is usually a fire control assistant, dispatcher, suppression crew foreman, tank truck operator, and one or two crewmen. With this manpower available it is necessary for the district to set up tours of duty, by alternating the off-duty days for positions, so that 7-day regular time coverage is given.

At locations where there is only a foreman and a small crew or where there is a single fireman, overtime is allowed on high danger days. This is

necessary to allow for full coverage during high days. If the position is in the high country, or so-called low risk areas, no overtime is allowed on high days.

On very high danger days, we begin to bring our maximum striking force into action. We have reached the point where it is necessary to hit and control a fire in the shortest time possible or have a large fire to fight. At district headquarters the foreman and tank truck operator are authorized to go on duty in this danger class. All single position or small crew stations are activated.

If any days fall into the extreme danger class, all of the striking force is placed on duty. All cooperators are contacted and every means is taken to prevent fire. If a fire should start on an extreme day, we have the total district force ready to roll, plus the power of rapid reinforcement to back up the initial attack force.

The final step is to arrive at the cost of financing this plan. We determine the daily overtime rate for each position, multiply this by the number of days allowed, and come out with the final cost for budgeting purposes.

The only positions that are part of the striking force but are not authorized for lieu day duty are the crewmen. Each district alternates the crewmen's tours of duty so that the maximum possible number are on duty each day of the week. Whenever the danger goes into a prolonged very high period and during extreme days, the Forest fire control officer takes a critical look at the entire Forest resources to determine if it is necessary to place crewmen on duty during the off-duty days. If conditions warrant such a move, approval is requested from Regional Fire Control, with emergency FFF financing such a move.

When a position is placed on duty, because of the danger conditions, the incumbent does not sit at his station and wait for a fire. He is instructed, by his district office, to perform certain duties such as roving patrol, contacts with recreationists, mills, logging operations, railroad officials, and employers, or working on presuppression or project jobs. The only time that a person may be held at his station is during the extreme danger, and then only the suppression crews, dispatchers, and stand-by fire cat operators are so held. The rest of the force is assigned to prevention work.

Although it takes time to figure the determining factors, the end result is that the district office has a readily available form which can be consulted daily to determine what organization is needed to cover the predicted danger for the next day.

The manning guide form is also used to set up the required number of positions needed to furnish detection for 7 days each week. The percentage factor for each class of danger from the opening date of the detection season, usually June 1, to October 10 is calculated. We again determine the number of off-duty days during the detection season and apply the percentage factor in order to set up the number of off-duty days that can be expected for each class of danger.

The difference between ground force and detection is that we need 7-day coverage by lookout. This in turn means that lookouts or alternates are on duty during all classes of danger.

We use the same method for detection as we do for ground forces to arrive at our cost figure for budgeting purposes.

It is said that necessity is the mother of invention. This is very true in the Forest Service. We feel that the Danger Manning Guide is one answer to the policy of maximum reduction of overtime expenditure. The guide

has done away with the former hit or miss method of determining initial attack force needs and manning. It brings about equality of emergency manning among the districts and does away with one being manned Low while one is manned High for a corresponding danger.

Published Material of Interest to Fire Control Men

Are You Burning Dollar Bills?, by P. W. Schoen. Prog. Farmer. Feb. 1951.
A Story of Radio and Forest Fires, by A. B. Meyer. Mo. Conserv. Jan. 1951.
A Way to Prevent Woods Fires; Costs So Little Yet Saves So Much, by L. T. Nieland. Fla. Grower. Feb. 1951.
Observed Effects of Prescribed Burning on Perennial Grasses in the Ponderosa Pine Forests, by Harold Weaver. Jour. Forestry. April 1951.
Fire As An Ecological Factor in the Southwestern Ponderosa Pine Forests, by Harold Weaver. Jour. Forestry. Feb. 1951.
Fire Control at Northwest Bay, by H. Weatherby, Brit. Columbia Lumberman. Jan. 1951.
Fire Effects of Bombing Attack. 45 pp., illus. Published by Civil Defense Liaison Office, Gov. Print. Off.
Fire Protection on Your Outfit, by H. Weatherby, Brit. Columbia Lumberman. Dec. 1950.
Fire, Site and Longleaf Height Growth, by David Bruce. Jour. Forestry. Jan. 1951.
Forest Fire Smoke of September 1950, by Howard W. Lull. Jour. Forestry. April 1951.
Forest Protection, by H. T. Gisborne. *In Fifty Years of Forestry in the U. S. A.* Published by Soc. Amer. Foresters.
Honeymoon Lookout, by Helen McDonald Clark. Amer. Forests. April 1951.
More About Pines and Fire, by H. H. Chapman. Jour. Forestry. April 1951.
Northeastern Logger's Handbook, by Fred C. Simmons. U. S. Dept. Agr. Hdbk. 6. 1951. Chapters on small tools, power cutting tools, and tractor use.
Remember the Ember. Amer. Forests. April 1951.
Slash Problems in British Columbia, by R. G. McKee. Brit. Columbia Lumberman. Jan. 1951.
Slip-On Tanker—One Half to One Ton. A proposed standard. U. S. Forest Service. [Processed.] 1951.
Smokey is Convincing a Nation: Only You Can Prevent Forest Fires, by Clint Davis. Amer. Forests. April 1951.
Teamwork in State Forestry (Fire Prevention in Georgia), by C. Elliot. Amer. Forests. July 1950.
Twenty Years Without Fire Protection, by K. B. Pomeroy. Forest Farmer. Dec. 1950.

COOPERATORS' FIRE FINDERS

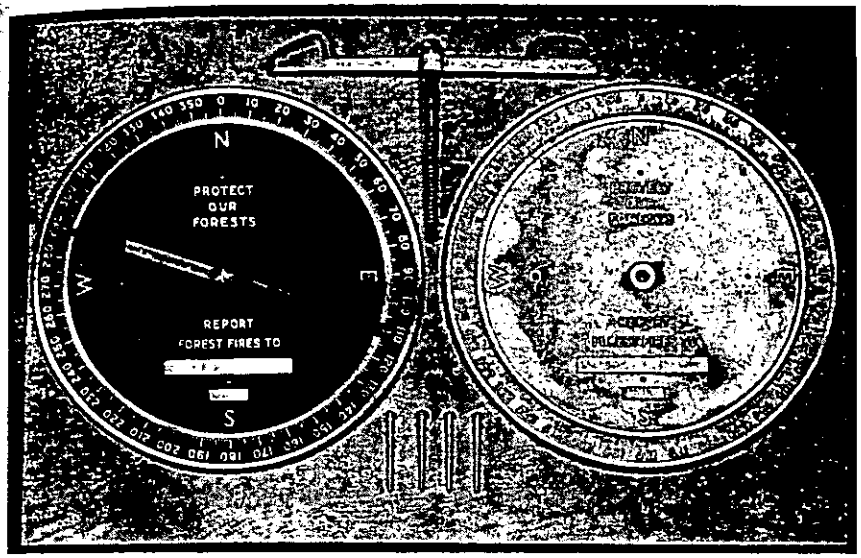
M. C. Howard
Forest Supervisor, Ouachita National Forest

Cooperators' fire finders can supplement a lookout tower detection system or may even replace it. Strategically located to take advantage of good views, telephone service, and cooperative residents, finders are readily manned for fire detection (fig. 1). Properly oriented fire finders, accurately spotted on fire control maps, make accurate fire locations possible without intimate knowledge of the territory or of local landmarks.

Figure 1.—A cooperator taking a bearing.

The cooperator's or warden's fire finder was a $200 project of the 1939 Fire Control Equipment Conference and was assigned to the author, then in Region 7. The pattern and first fire finders were cast in brass by an Indiana firm. The first supply cost $8.15 each and the George Washington National Forest was the distribution and purchasing agent. When the price of brass tripled, arrangements were made with an Arkansas brass works to cast some in aluminum at about the original price (fig. 2). These critical metals have made production difficult and makeshift devices may have to be used for the present. The pattern remains in the custody of the George Washington National Forest.

The Fire Control Equipment Committee in approving the fire finder project made this requirement: "To be attractive, with special emphasis



F-464375

FIGURE 2.—Assembled brass and unassembled aluminum fire finders.

on educational and prevention value." These fire finders are just that when installed at a service station or at a recreation resort. A weatherproof chart identifying prominent landmarks by azimuth reading enhances the value and utility of such an installation.

Discarded Water Tank Converted Into Substantial 50-Foot Fire Tower

We are pleased with the results of our efforts to construct a much needed fire tower out of what was destined to become scrap iron. When we learned that an abandoned water tank on one of our State parks was to be torn down and sold for scrap we immediately made arrangements to obtain the materials by agreeing to dismantle and remove the tank. This initial step was accomplished in short order by two of our fire crews. All of the steel work and most of the cypress tank was salvaged in good condition and later used in tower construction.

The reassembly was relatively simple. Concrete footings were poured to the same dimensions as on the original tank. By marking the steel work as it was dismantled we were able to reassemble the structure without too much difficulty. From here we were on our own in substituting a cab for the original cypress tank that sat on the steelwork. This was finally worked by bolting heavy oak floor joists to the support legs and constructing a conventional size wooden cab on this base. Some of the salvaged cypress lumber from the tank was used here for framing and subflooring. The cab is boxed and sealed inside with center-matched pine flooring. The roof is of composition shingles and the windows are standard industrial steel casements. The stairways and landings are of 2-inch oak and the handrails are 1-inch galvanized iron pipe.

The cost of materials for this construction was approximately $250. This included boxing, flooring, roofing, windows, stairways, handrails, cement and paint. All labor was by regular fire crew personnel.—EARL M. BRADEN, *District Forester, Tennessee Division of Forestry.*

SAFETY ON THE FIRE LINE

C. D. Blake
Safety Officer, Northern Region, U. S. Forest Service

When I look back over my 35 years of experience in fighting forest fires in the Northern Rocky Mountains, I think of the many improvements which have been made in safety practices. Early-day fire fighting used to be considered a "he-man job" where nothing much could be done to prevent injuries or fatalities to fire fighters. Many times it was necessary for the overhead and fire fighters to tough it out for weeks and some times for months, under gruelling conditions without relief or replacements.

Fire fighting is still a "he-man job." But fortunately for the present-day and future forester, specially designed equipment, rapid transportation facilities (including aerial services), better organizations and dispatching, and improved generalship training, make it practical to provide needed relief and replacement for overtaxed overhead and fire-line workers. Fire control agencies are doing a much better job of incorporating accident prevention into planning, training, supervision, and inspection.

More consideration is being given to a potential fire boss's mental, as well as physical, ability to withstand the severe strain which is invariably present when a fire is large and complex. Management has also learned that, after an extended fight to control a severe fire, there may be a letdown on the part of the fire fighters. Under such circumstances it may be advisable to provide relief or replacements for prolonged mop-up action.

Fire control agencies who adopted the "step-up," the "modified step-up," or some other modern method of organizing and controlling fire fighters, have found that much greater and safer work output is possible.

Many fire control agencies are providing for the pooling of their fire suppression resources. This is decidedly a step in the right direction. Such cooperative arrangements provide for a greater number of experienced and trained overhead personnel, who will be available to relieve shortages within hard-hit fire areas. While there has been much progress in methods that reduce injuries and fatalities on the fire line, there are still some phases of the safety job in need of improvement. I, for one, should like to see the following safety points given special consideration in future plans of operation.

1. Established medical requirements and facilities that assure periodic physical checkups of regular overhead personnel subject to call for strenuous fire duty.

2. Critical screening of fire fighters, at the time of hire, again before reaching the fire, and again at the fire line. More critical attention to suitable footwear and other clothes, and to the physical fitness of the fire fighter. (This should be particularly the case if the men are to be assigned to rough terrain, to night work, or to hot fire sectors. Most fire bosses

recognize the fact that physically unfit or improperly clothed men retards rather than increases fire-work output.)

3. Fire-line workers and overhead provided with appropriate safeguards such as suitable tools and equipment, hard hats, and first-aid facilities. Tractor operators protected by canopy guards.

4. Special project fire safety officers used much more often in dangerous areas during critical fire weather, and where 100 men or more are employed on a fire. (A fire safety officer, to serve efficiently, must be planned for, incorporated in the fire organization, and given sufficient training in advance of first assignment.)

State Fire Control Equipment Increased

A combined inventory as of July 1950 shows a substantial increase in State-owned fire control equipment over a similar 1945 inventory. The inventory includes the 43 States engaged in the Clarke-McNary cooperative protection. In 1950 360,264,000 acres of State and privately owned forest lands were included, while in 1945 the area protected was 303,000,000 acres. A comparison of the 1945 and 1950 inventory follows:

		1945	1950	*Percent of change*
Protection roads	miles	33,710	34,309	+ 1.8
Metallic telephone lines	do	22,137	25,041	+ 13.1
Grounded telephone lines	do	17,992	9,937	− 44.8
Steel and stone lookout towers	number	1,867	2,301	+ 23.2
Wooden lookout towers	do	546	631	+ 15.5
Tree lookout cabs	do	105	94	− 10.5
Tanker trucks	do	1,379	2,045	+ 48.3
Transportation trucks	do	1,521	2,468	+ 62.3
Tractors	do	486	935	+ 92.3
Graders, bulldozers, and trailers	do	219	275	+ 25.6
Mechanized plows	do	380	1,093	+187.6
Portable power pumps	do	1,296	1,678	+ 29.5
State-owned airplanes	do	5	24	+380.0
Radios	do	2,172	5,570	+156.4

The 1950 inventory shows that 12 States operate their own aircraft; in 1945 there were 5. Other States use rented aircraft. All but 4 States now use radio. This accounts for the reduced mileage of grounded telephone line. Similarly, permanent towers are replacing temporary lookout cabs.—DIVISION OF STATE AND PRIVATE FORESTRY, *Washington Office, U. S. Forest Service.*

DEVICE FOR TAKING WEIGHT FROM TANK TRUCK SPRINGS

Division of Fire Control
Region 6, U. S. Forest Service

The permanent spring sag which occurs in loaded tank trucks can be relieved by a novel and inexpensive device suggested by John C. Price, Jr., and George Norman of the Gifford Pinchot National Forest. Figures 1 and 2 give the essential details.

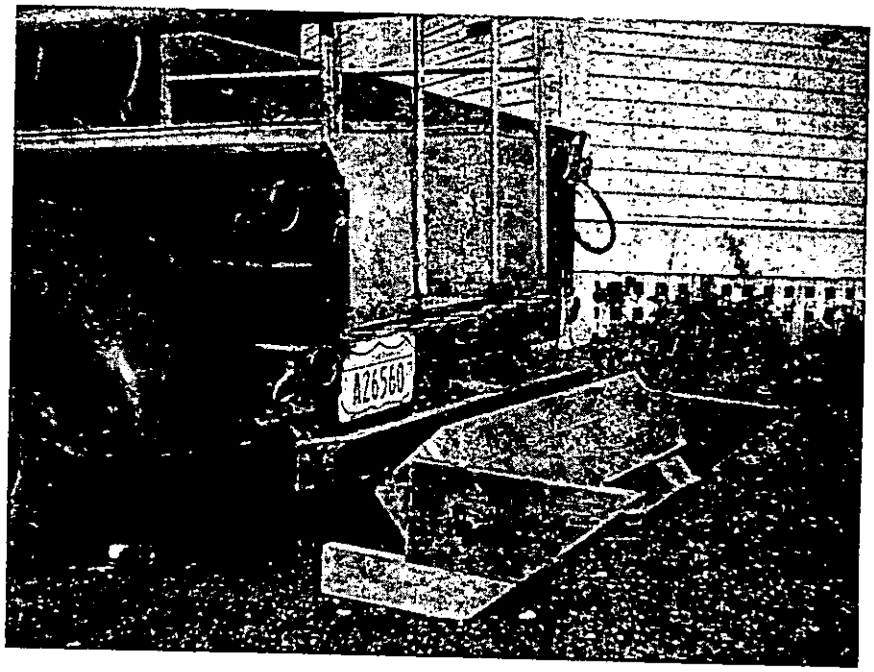


Figure 1.—Rear bumper in contact with blocks. At this stage an acceleration of the gasoline feed will back the truck up on the blocks.

The basic steps are:

1. Cut blocks so that when they are standing vertically they are the same length as the distance from the lower edge of the rear bumper to the ground *when the tanker is unloaded.*
2. *Fill* the tanker. Set blocks at such an angle that the top surface rests against the lower edge of the bumper.
3. Nail 2x6's in place with the blocks at this angle.
4. Join blocks at proper distance (wheel to wheel) by 2x12.
5. To prevent backing over the blocks, attach additional pieces as shown.

The device has several advantages. It takes 3 to 4 inches vertical-load pressure off the springs. No jacks or blocks are needed to accomplish this purpose, and no one needs to hold the blocks. It is portable, and

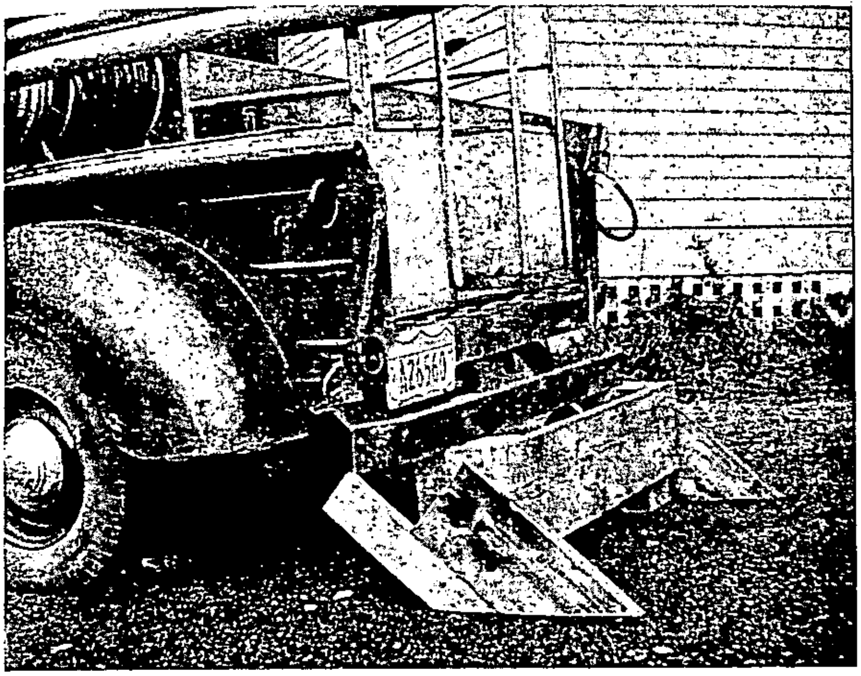


FIGURE 2.—Considerable weight is taken off the springs, tending to prevent permanent spring sag. There is still sufficient traction for the truck to be driven off the blocks.

can be used inside garages or outside in the service yard. The tank truck can be driven off the device with safety and no loss of time.

Sleeping Bag Roller

The cleaning and rolling of sleeping bags has always presented quite a problem in central fire cache equipment warehouses. When rolled by hand the bags are especially troublesome because no two men could roll them to a uniform size. In order to overcome this difficulty a bag rolling unit was designed and put into operation in the Forest Service warehouse at Spokane, Wash., in 1944. Besides rolling the bags to a uniform size, it has proved a great timesaver. We can now store six bags where we formerly stored four loosely hand-rolled ones.

The principles of this bag roller are the same as those reported on the Coski bed roller in the July 1946 Fire Control Notes. The device consists chiefly of a shaft turned by a crank-type handle and a movable platform which holds the bags tight against the shaft by means of springs.

The roller can be operated most efficiently by two men. One man places foot of bed about crank shaft. The other stands at foot of table and keeps bed straight and taut as it is rolled. If bed has no end flaps, the straps are tied before shaft is removed.

The newer type beds with end flaps must be rolled on the machine only until the flaps reach the roller. Flaps must be left free. The crank shaft is then removed and the roll is completed by hand. The flaps are tucked over each end, the head flap completed around the roll, the bed or tie straps tightened and tied around the bed, the flaps tucked in good and snug, and the end or puckering strings tightened and tied.

Detailed plans can be secured from the Regional Forester, Missoula, Mont.—L. E. NOEL, *Procurement Officer, Region 1, U. S. Forest Service.*

A SKYLINE FIRE EXTINGUISHER

A. B. Everts

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

The use of CO_2 as a pressure medium for tank trucks and back-pack units has been previously reported in Fire Control Notes from time to time.

The old soda-and-acid booster tanks, used by municipal fire departments, have been pretty much replaced with CO_2 or by pressure provided by pumps. Most major fire-extinguisher manufacturers now offer water-type extinguishers pressurized with a CO_2 cartridge. Dry chemical, perhaps the most efficient of all extinguishers for certain types of fires, and even carbon tetrachloride and chloro-bromo-methane extinguishers can be purchased with CO_2 cartridges. More recently, one of the large manufacturers has developed a mine-car unit similar to the skyline fire extinguisher described here, except that the extinguishing agent is Karbaloy instead of water.

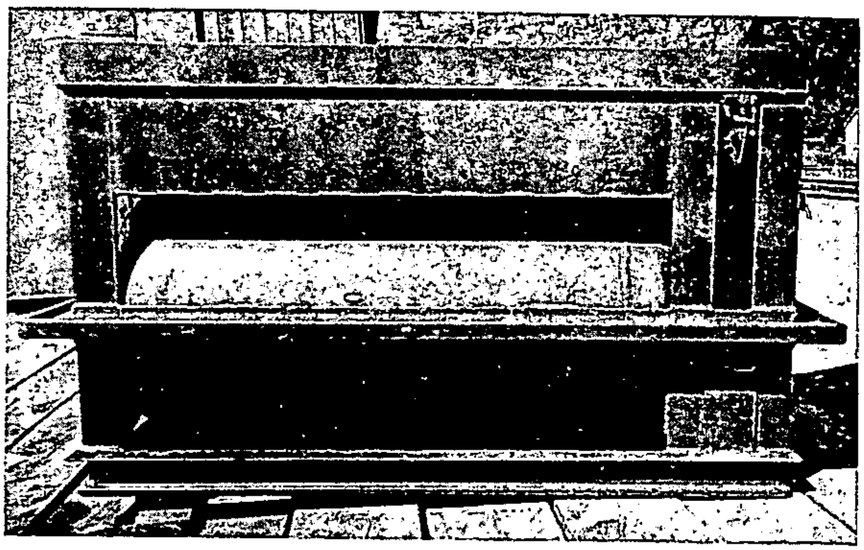


Figure 1.—Side view of the skyline fire extinguisher showing the hose and tool compartment on top. Heavily reinforced with railroad steel, it can absorb considerable abuse without damage. The tank is of 100-gallon capacity.

Two units of the skyline fire extinguisher were constructed by the White River Division of the Weyerhaeuser Timber Company of Enumclaw, Wash., several years ago. Each unit was constructed of heavy material (fig. 1). Weight was not an important factor as a skyline was used to transport the unit over the logging area. For use at log landings or as

slip-on units with speeders, logging trucks, or even tractor arches, they can be of much lighter construction.

Basically, the White River unit is a 100-gallon tank pressurized with a 15-pound CO_2 fire extinguisher of the squeeze-grip type. The inside tube must be removed from the extinguisher, otherwise the liquid CO_2 will freeze the control valve. With the tube removed, the gas instead of the liquid is withdrawn to furnish pressure.

The pressure regulator, which can be set at anywhere from 100 to 150 pounds' pressure depending on the safety factor of the tank, allows constant pressure; when the nozzle is shut off and pressure in the tank builds up to that set on the regulator, the flow of gas is automatically shut off.

A safety release should also be provided for the 100-gallon pressure tank, set to "pop off" at a few pounds over that for which the regulator is set. An inside tube, extending to the bottom of the 100-gallon tank and equipped with a shut-off valve, controls the water to the hose line. A 15-pound CO_2 extinguisher will discharge between 175 and 225 gallons of water (fig. 2). Thus, all the liquid in the tank is forced out of the nozzle since there is sufficient excess of gas to force the water through the hose line. This is not the case when pumps are used.

In the White River unit foam is used. Six gallons of mechanical (liquid) foam is premixed with the water. A 150-gallon-per-minute foam nozzle with a shut-off is used on the end of 500 feet of 1-inch linen hose. This nozzle expends 15 gallons of water a minute, and the total 100-gallon foam-and-water premix will produce approximately 1,000 gallons of foam. In cases where linen hose has too much seepage, rubber-lined hose should be used. Two or three pulaskis and short-handled shovels are carried in the hose basket.

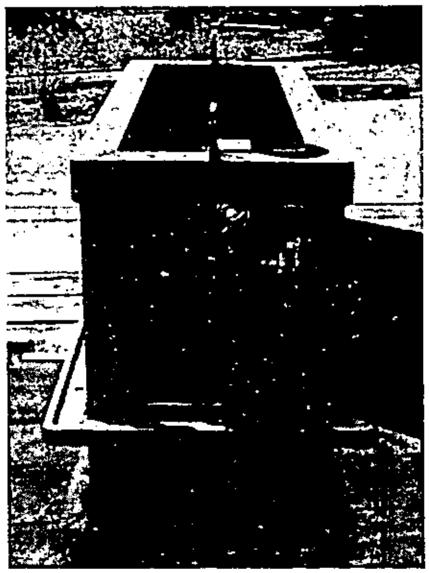


FIGURE 2.—End view with compartment door open. A 15-pound CO_2 extinguisher furnishes pressure for expelling the 100-gallon tank. Pressure is controlled and stepped down to the desired operating pressure by means of a pressure reduction valve.

Wet water, in the place of foam, will work very well in a unit of this kind. The corrosive action of wet water on containers, which some of the wetting agents are said to produce, can be neutralized by the addition of 2 ounces of commercial potassium dichromate for each 100 gallons of treated water. This was reported by Robert S. McBride, California Forest and Range Experiment Station, in the April 1950 Fire Control Notes.

One new method of using wet water, in capsule form, makes it unnecessary to premix the wet-water solution in the tank. A "hydroblender" is installed outside the tank. The hydroblender will hold two capsules, each of which will produce 1,000 gallons of wet water. The untreated water is directed through the hydroblender only when wet water is desired.

Wet water is not cheap, and this new method of mixing the solution would seem to be worth further investigation.

CO_2 pressured units should never be considered for replacing pumps where large volumes of water are needed. The disadvantages are obvious. However, for certain fixed or even semiportable jobs and as extra protection in risk areas, they certainly have a place.

Except for freezing, in cold climates, they can sit for months, or even years, and be ready to operate by simply cracking the CO_2 valve and opening the hose-line valve. Antifreeze can be used in the water if desired. There is no engine to start or to maintain. There are no moving parts except in valves and pressure regulator. Foam, wet water, or Karbaloy can be used without injury to the equipment. An excess of CO_2 pressure makes it possible under certain circumstances to utilize all the water in the hose. Pressure remains constant throughout the operation until CO_2 supply is exhausted.

Tanker Use by the U. S. Forest Service, 1950

Tankers were used on 2,212 fires, or 22 percent of all fires controlled by the Forest Service, in 1950. The California Region led all the others by putting tankers on 973 fires. Tankers were employed in the initial stages of attack on 1,131 fires and assured control of 70 percent of these. On 646 fires tankers were sent in for mop up only. Tankers and pumpers are credited with holding 142 miles of fire line.

Aircraft Use by the U. S. Forest Service, 1950

Some 5,636 flights totaling 8,248 hours were made by fixed-wing aircraft in 1950 on fire control work on the national forests. The 16 airplanes owned by the U. S. Forest Service made 41 percent of the flights, contract operators accounted for 58 percent, and military aircraft 1 percent. Helicopters were used in California for 1,255 hours out of a total of 1,381 hours of flight. Aircraft transported 10,244 passengers and 377 tons of supplies, of which about 174 tons were dropped by parachute. The California Region made the greatest use of aircraft during 1950 while the Northern Rocky Mountain Region ranked second.

INFORMATION FOR CONTRIBUTORS

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

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

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

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

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

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