FIRE CONTROL NOTES

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FIRE CONTROL NOTES

A quarterly periodical devoted to forest fire control

CONTENTS

COVER—Fire lookout trainee sights smoke during a simulator exercise and gains practical experience. See article on next page.

Fire Simulation Livens Lookout Training

James A. Burnaugh and
Ira T. Kittell

Provided a simulated smoke sighting and the proper equipment with which to report it, the fire lookout trainee gains valuable "actual situation" experience.

The first use of fire simulation was the "Command Simulator," used to train fire bosses and their supporting staffs. The program was so successful it sparked interest to train others in different fire disciplines.

The Shasta-Trinity National Forest staff considered the possibility of developing exercises in initial attack, fire size-up, or decision making for crew foremen and fire detectors. Fire detection was selected because of the need for a new approach in training detection personnel.

In February 1968, a program called "Advanced Training for Detection Personnel" was prepared utilizing a simulator exercise. The format developed for the detection exercise follows the standards prepared for the Fire Simulator Instructor Training. Marana, Arizona, November 1967.

Smoke Sighted!

The projected scene is a 35 mm. slide view typical of the trainee's area. Smoke manipulation in simulation is critical: The smoke must conform to the fire behavior conditions of the script. The trainee should be unable to see the smoke at first but should gradually see an increase in volume and density.

The trainee, upon discovering the smoke, should "report" the fire to the central dispatcher (Cover). His report is expected to follow the prescribed manner: An azimuth reading of the smoke; its distance, size, and character; legal description; and geographic location. Followup reports are prompted by the central dispatcher.

Emerging situations present opportunities for the lookout to relay messages of importance in a concise, orderly manner and use proper radio code. The exercise has one principal trainee and as many trainee observers as room allows. Trainee observers are encouraged to follow the actions and keep notes. A District Fire Control Officer is assigned to criticize the exercise and evaluate the trainee's performance.

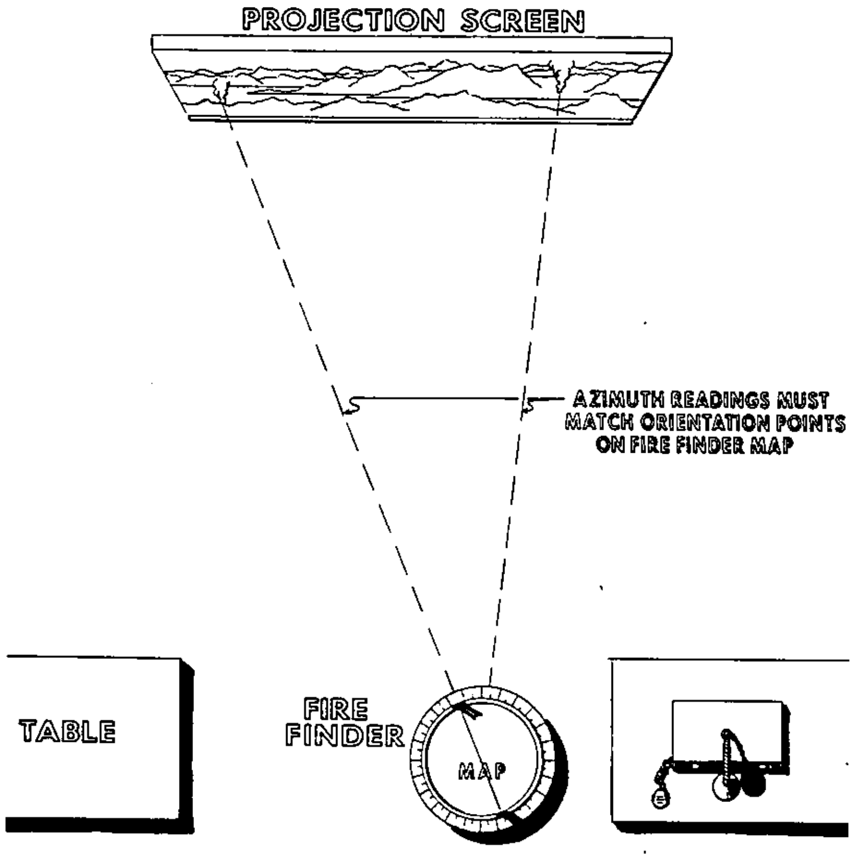

Figure 1—Arrangement of equipment for smoke sighting exercise.

Positioning Important

It is most important to position the "fire finder" so that azimuth readings will correspond exactly with the picture on the screen and the map on the "fire finder." Figure 1 illustrates the arrangement of the equipment necessary to the exercise. Procedure in orienting the alidade to the screen image: From fire finder map, select an orientation point that is recognizable on the screen and identifiable on the map.

[1] Dispatchers in the Shasta-Trinity National Forest, Region 5.

Aluminum Rake Handles Better

William Roberts [1]

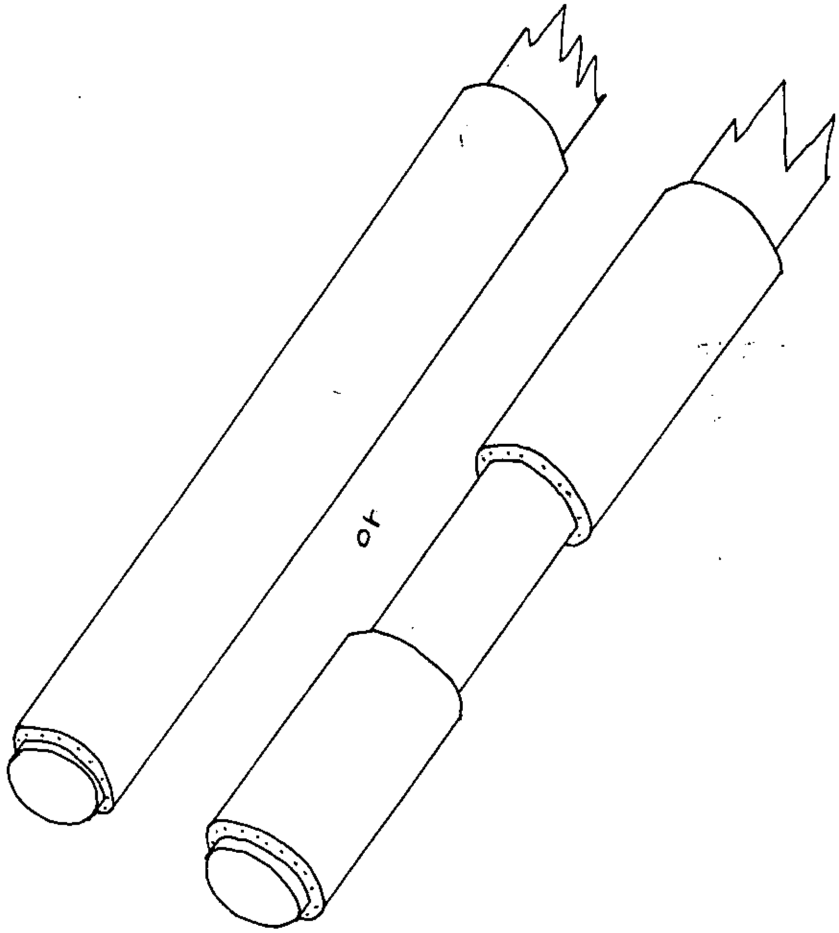

Figure 1—Ways of attaching the hose.

Aluminum broom rakes have long posed a problem to firefighters. Not only do the undersized handles cause blisters because they have to be held tightly, but the metal itself tends to stain the hands black. Firefighters on the Mark Twain National Forest have found that a section of automobile heater hose can solve both of these problems.

A 3/4-inch section of the hose is ideal for the square-handled rakes and a 1-inch section will slide snugly over the round handles (Fig. 2). Increasing the diameter of the handle with a pliable material and covering the metal eliminates both blisters and blackened hands. △

[1] Forestry Aid, Doniphan Ranger District, Mark Twain National Forest, Region 9.

→

Compute the azimuth from the map. Holding alidade sight set on the computed azimuth, move alidade until orientation point lines up in the sights. The reference line is now established along which the alidade must remain.

To complete the orientation, select another orientation point recognizable on the map and the screen. Again measure the azimuth; now set the sights on the new azimuth. Move the alidade along the reference line until the second orientation point lines up in the sights. When both orientation points line up in the sights on the proper azimuths, the alidade is properly oriented in the exact relationship the lookout tower would be to its seen area. Therefore, any other point in the projected image will agree with the fire finder map.

Color slides taken from other than established lookout locations can be used provided the point where the picture was taken can be accurately plotted on a map and orientation procedures described above are followed.

Simulation Educates

There are two types of communication training practiced during this session: (1) The procedural type, when the lookout relays coded or non-coded messages, (2) the interpretive type, when the lookout accurately interprets what he sees.

The lookout simulation exercise provides the trainee an opportunity to actually practice the standard procedure of reporting a fire. It gives the trainee a chance to develop good habits or to correct bad habits.

Knowledge and experience are gained by trainees and instructors alike while working under the stress created by this simulator exercise. △

Drying Rates of Some Fine Forest Fuels

C. E. VAN WAGNER [1]

In a series of laboratory tests, removing waxes and resins from the cuticles of pine needles and aspen leaves greatly increased their drying rates.

It seems reasonable to expect that the thinner a bit of dead vegetation is the faster it will dry. The experiments described in this article were prompted by the doubt that this assumption is true of all important fine fuels in eastern Canada.

Set-up

The dead, natural materials tested were pine needles, aspen leaves, pine twigs several inches long, grass, and reindeer moss. Also included were two forms of prepared white pine wood that have been used as standard fine fuels in Canadian forest fire research, namely, match splints (2 1/2 in. long by 1/8 in. diameter) and slats (10 x 1/4 x 3/32 in.). First, parts of some samples were boiled in xylene to remove wax and resin; then they were warmed gently to expel all xylene. Next, all materials were soaked in distilled water for three days, and several grams of each were allowed to dry, individual pieces well separated. The drying materials were weighed at intervals for 8 to 10 hours and again the next morning. The room during the tests was 78 ± 2° F. and 35 ± 5 percent relative humidity; air movement was negligible. Finally, the samples were oven-dried for 24 hours at 100° C., and the percent moisture content was calculated for each weighing.

Analysis Procedure

To analyze each drying run, the final or equilibrium moisture content (E) was subtracted from each successive moisture content (M) and the resultant free moisture content (M-E) was plotted against time (t) in hours on semilog paper. This treatment produced a descending straight line for material that dried

Rates, page 7.

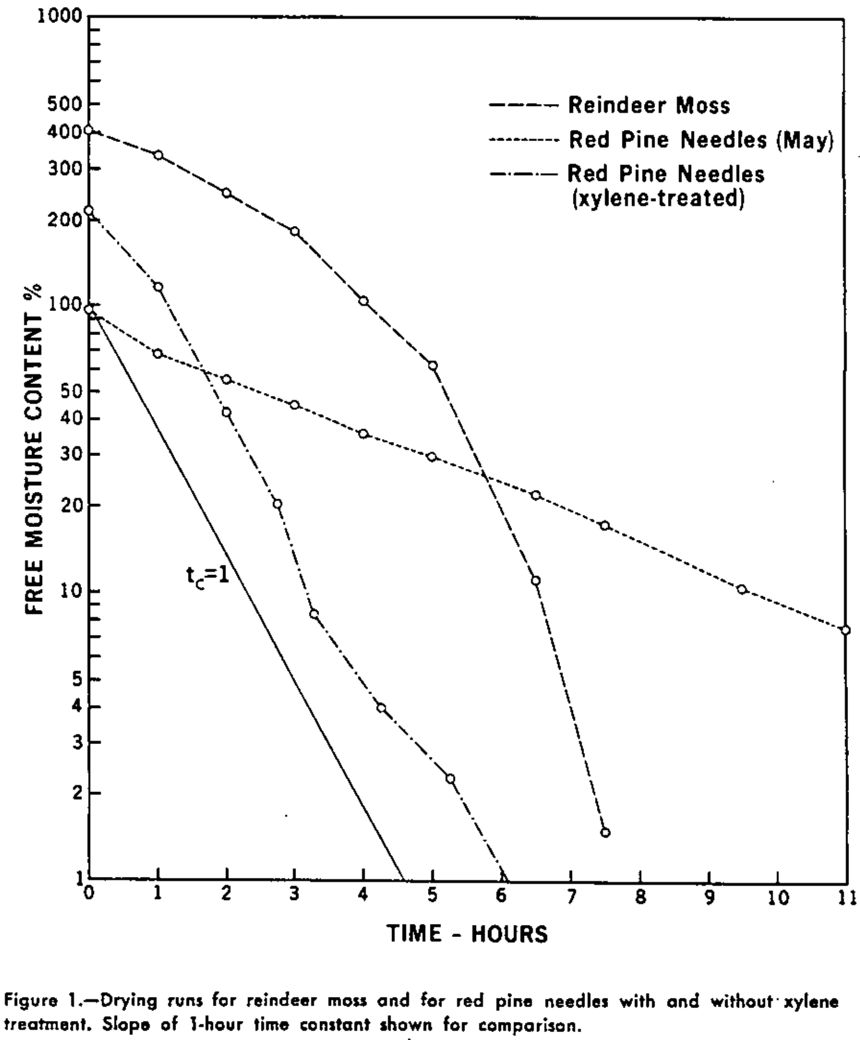

Figure 1.—Drying runs for reindeer moss and for red pine needles with and without xylene treatment. Slope of 1-hour time constant shown for comparison.

[1] Forest Fire Research, Department of Fisheries and Forestry of Canada, Petawawa Forest Experiment Station, Chalk River, Ontario.

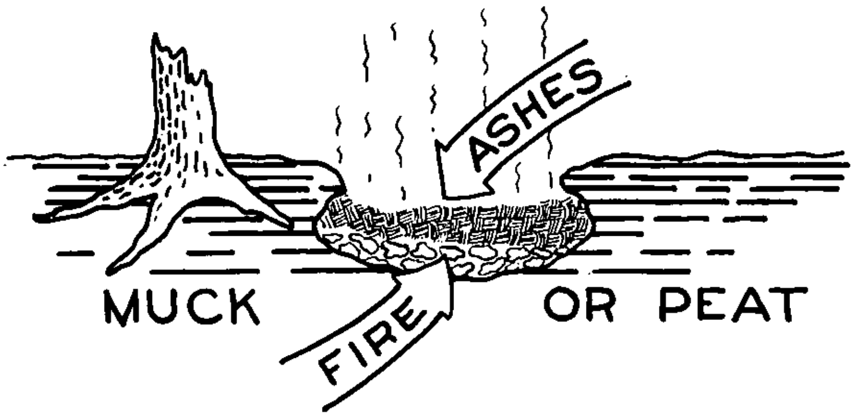

Figure 1—Cross section view of typical muck or peat fire.

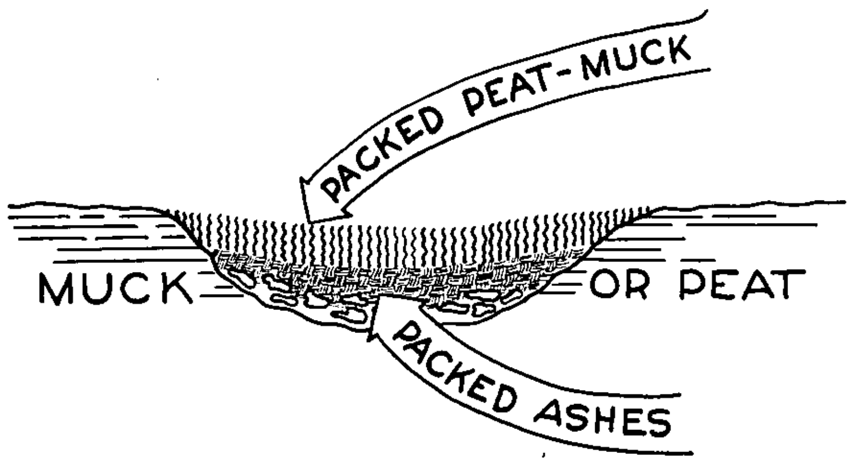

Figure 2—Cross section view of a fire suppressed with a bulldozer.

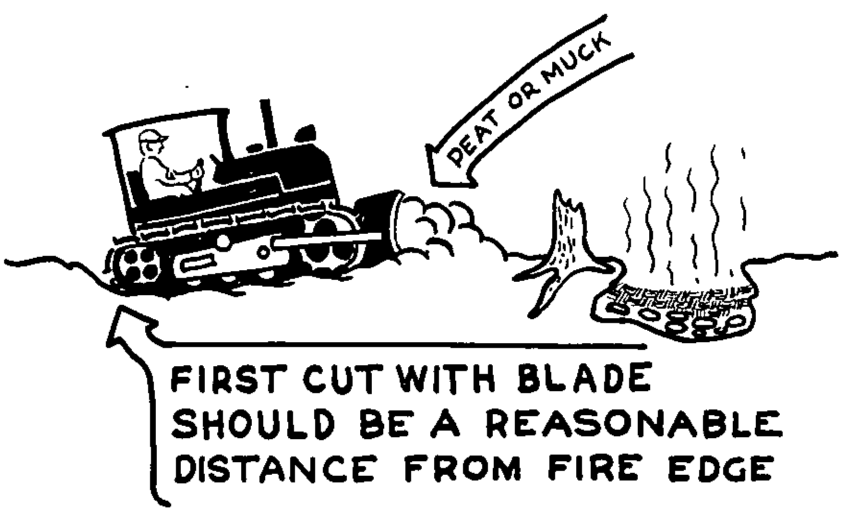

Figure 3—Start of the attack on a muck fire.

New Answer To Suppressing Muck Or Peat Fires

LYMAN BEACH [1]

Muck fires can be controlled by smothering them with bulldozed muck. Water trapped underneath the cover also helps suppress the fire.

Have you ever shoveled too much coal onto a fire and nearly caused it to go out? Remember when the oven became too hot in the old coal or wood burning stoves, and Grandmother shoveled on ashes to cool the fire?

Same Techniques Used

This is the basis for the techniques developed to suppress muck and peat fires without pumping water. Tests indicate that muck or peat will sustain combustion even when it contains 70 percent moisture by weight.

This is a lot of water that can be put to work. The new answer to muck fire suppression is simply to bulldoze unburned muck over the ashes and compact them in place. The layer of ashes acts as insulation between the fire and the muck spread over the top. The insulating layer of ashes must remain as undisturbed as

[1] Forest Fire Officer, Forest Fire Division, Michigan Department of Natural Resources.

possible. The muck over the ashes acts as a lid. This lid traps many of the gases vaporized by the burning muck. Condensation forms under the bulldozed lid of unburned muck, and the fire dies. The muck or peat bulldozed over the fire also drastically reduces available oxygen.

Figure 1 illustrates a typical muck or peat fire.

Bulldozer Action

Figure 2 illustrates a cross section view of what the fire should look like after suppressing it with a bulldozer. A dozer with a blade that can be angled works best. This enables the operator to drift the unburned peat or muck over the perimeter of the fire in long passes. A straight blade makes the operator spend too much time in back and forth motions.

The dozer operator must be cautious when working at the edge of a muck fire. If he should break through one of the tunnels of fire usually around the fire's edge, he is in danger of mixing more fuel directly with the fire. When hot spots develop, they usually occur along the former fire perimeter. For this reason, the perimeter of the fire requires a generous supply of well compacted peat.

Figure 3 illustrates the beginning attack on a muck fire. Note the first cut with the blade should be a reasonable distance from the fire's edge.

Rates, from page 5.

exponentially, i.e., whose instantaneous drying rate was proportional to the instantaneous free moisture content. The slope of the semilog graph, called the log drying rate, was a measure of the speed of the drying process. Many of the test runs followed this pattern closely enough for practical purposes; two that did and one that did not are illustrated in figure 1. When straight, these graphs have empirical equations of the form:

$$\log \frac{M_O - E}{M - E} = Kt \quad (1)$$

Where M_O is moisture content at time zero, M is moisture content after t hours, and K is the log drying rate in log M per hour.

The exponential drying process can also be described by the time constant (t_c), which is the time required to accomplish 1 — 1/e, or 63 percent of the expected change in M. The log drying rate K (in logarithm to base 10) is related to the time constant by the expression

$$K = \log_{10}e/t_c = 0.43/t_c (2)$$

The two measures of drying speed are thus interchangeable and are worked out for each tested material in table 1. Included in figure 1 is a line showing the slope of a drying process with a 1-hour time constant. Some materials, e.g., reindeer moss in figure 1, do not have a true log drying rate or time constant except as an average over the whole run.

Wax Slows Drying

The relatively slow drying rates of pine needles and the marked effect of the xylene treatment suggest that, for some leaf materials, diffusion through the waxy cuticle is the limiting step in the drying process. Once this diffusion step exerts its influence, the

Rates, page 12.

Figure 4 illustrates that the supply of peat or muck should be taken behind the first cut with the dozer blade.

Covered Fires Die

Covering muck fires is much faster and more efficient than using water. It requires less manpower, and all the equipment and work involved in pumping is eliminated.

The only requirement in using a bulldozer is that the peat or muck must be able to support a working dozer. △

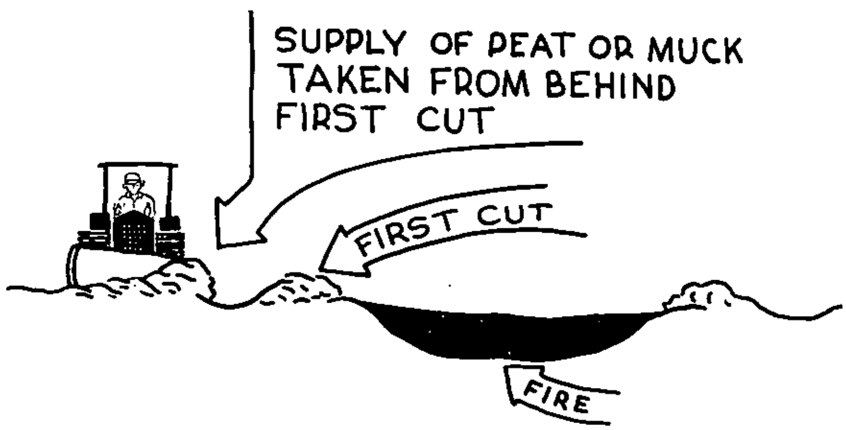

Figure 4—Supply of peat or muck is taken behind first cut.

Railroad Spark Arresters Tested

DONALD G. DOWDELL [1]

Although there is no written standard for spark arresters for large engines, the State of Washington has recently approved two spark arresters tested and developed by the Great Northern Railway. Use of these arresters will reduce fires caused by carbon particles.

During the last 2 years, there have been many advances in the development of spark arresters for locomotives. Several public agencies, railroads, and spark-arrester companies have acted aggressively in developing efficient arresters.

[1] Prevention & Training Officer, Fire Control Division, Department of Natural Resources, State of Washington.

The Washington State Department of Natural Resources has participated in many meetings and tests and has been the catalyst for the development of efficient spark arresters for locomotives.

No Written Standard

There is no written standard for spark arresters to be used on large engines. The Society of Automotive Engineers is currently working on a standard, but it has not yet been accepted. Washington State has developed its "abbreviated standard" for testing locomotive spark arresters. This standard closely resembles USDA Forest Service Standard 5100–1, which is used for testing spark arresters for medium-sized engines.

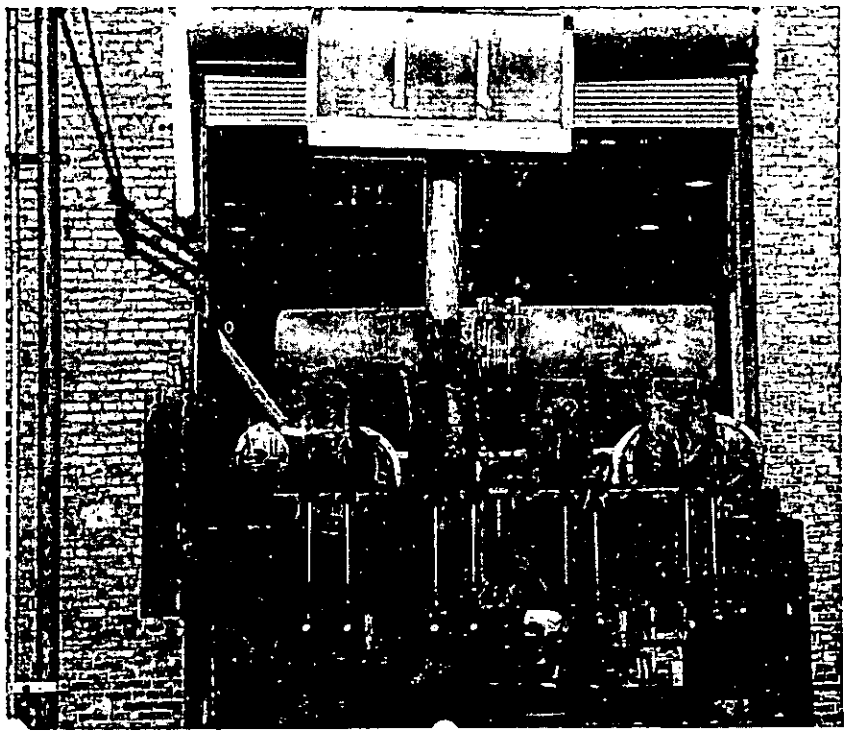

Figure 1—Test manifold mounted on the air tank with carbon feeding mechanism in foreground. Each clear plastic tube contains 100 grams of carbon. Scavenging blowers are in background. The large enclosure trap on the exhaust stack traps particles more than 0.023 in. in diameter.

The Washington Standard

The Washington "standard" requires the arrester to be at least 80 percent efficient in retention or destruction of all carbon particles 0.023 in. in diameter and larger, for 25-100 percent of the locomotive's engines exhaust flow rate. With the arrester added, the total back pressure on the engine cannot exceed 3 in. of mercury.

Meetings with railroads and the protection agencies have been taking place since the early 1950's, with little improvement of spark arresters for locomotives.

Breakthrough in Arresters

The first breakthrough in efficiency was achieved in 1967 when an arrester was developed that had great potential in carbon retention, but its back pressure was too high. Through further testing and development, the back-pressure problem was solved with no reduction in efficiency.

Another major spark-arrester development occurred in January 1968. A modification for a cyclonic spark arrester was developed, increasing its efficiency to more than 80 percent. Also in 1968, the Great Northern Railway Company led in developing test procedures and in conducting tests for locomotive arresters. This company has conducted bench tests and locomotive tests on many spark arresters. Great Northern tests were conducted in April, July, and August, 1968. This series of tests showed that many of the previously accepted arresters were less than 50 percent efficient. The Great Northern tests showed three arresters to be more than 80 percent efficient for carbon 0.023 in. in diameter and larger throughout the flow rate range of engine idling to maximum r.p.m. The three arresters also maintained the back pressure at less than 3 in. of mercury at full throttle on a GP–9 locomotive.

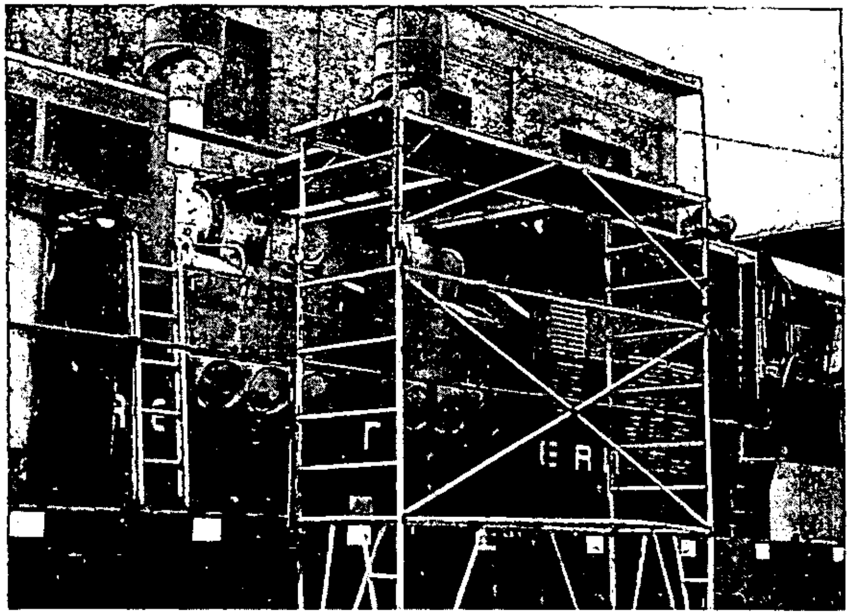

Figure 2—Test manifold mounted on a GP-9 locomotive. The spark arrester developed by the Great Northern is mounted on the manifold exhaust stack. The spark arrester is topped with a modified 55-gallon barrel that has a screen at the top to trap particles more than 0.023 in. in diameter so arrester efficiency can be determined.

Two Large Locomotives

Great Northern used GP–7 and GP–9 naturally aspirated locomotives in their tests. They also developed a bench operation capable of producing the airflow of a locomotive. The bench test used two scavenging blowers (Root's locomotive blowers) driven by electric motors to produce the large volume of air needed for the tests (fig. 1).

Procedures

The procedure developed for the locomotive spark arrester testing is quite simple, but it does produce results that can be measured and evaluated to determine arrester efficiency. Night observation tests were tried but were quickly proven unreliable.

The reliable tests consisted of injecting a known amount and size of carbon into the eight legs of the manifold while the locomotive was running. About 15 minutes was required to feed 100 grams of carbon into each leg. Above the arrester a large, 28-mesh wire-screen enclosure trap was placed to catch everything greater than 0.023 in. coming through the arrester. The amount of carbon that escaped through the arrester was compared to the amount injected into the arrester to determine its efficiency. Tests were run at various throttle settings on both the bench and on locomotive engines (figs. 2 and 3).

Two Approved

The Washington Department of Natural Resources has approved two spark arresters for use in Washington. By using either of these arresters, the railroads will greatly reduce or eliminate fires caused by expelled carbon particles. △

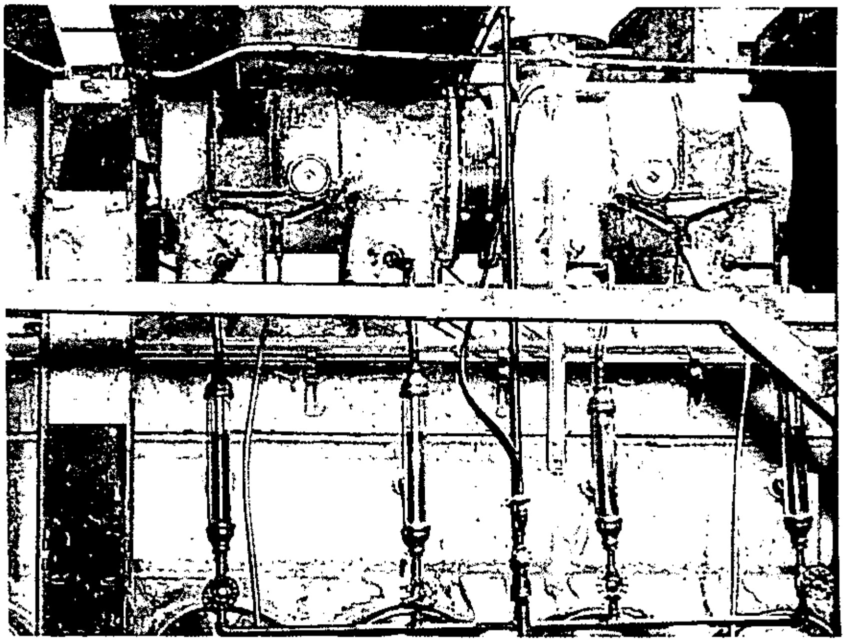

Figure 3—Close-up of manifold mounted on locomotive showing carbon feeding mechanism. Manifold shows a modification of the Farr Company "pocket".

Do Smog Reducers Increase Fire Hazards?

ROB HARRISON [1]

Because exhaust pollution devices might increase exhaust pipe surface temperatures, thereby increasing fire hazards, investigative tests have been run. Based on the exhaust system's "first bend" temperature, the Equipment Development Center at San Dimas found the smog reducers do not greatly raise exhaust pipe temperatures. However, other factors were found to increase fire hazards.

Fire Control officials have expressed concern over the possible increase of vehicle exhaust pollution (smog) devices on all new sedans and pickups. Any temperature increase could lead to serious fire hazards. The Equipment Development Center at San Dimas has conducted tests to measure surface temperatures of pickup and sedan exhaust systems to determine if such a hazard exists.

Tests on Vehicles

Tests were conducted with Forest Service pickups and sedans, approximately half of which were equipped with smog control devices. The exhaust system of each of the vehicles was instrumented to find its surface temperature. Each vehicle was subjected to a series of test runs on a road course and on a chassis dynamometer. The dynamometer tests indicated the maximum temperature that could be reached by the vehicle, while the road test served to indicate the temperature that would be reached under normal operating conditions.

The Road Course

The road course used consisted of 7 miles of an average grade of 3 percent used for the warmup section and approximately one-half mile of about 7 1/2 percent grade used for the test section. When a 40 mile per hour vehicle speed was used, this 7 1/2 percent grade section was long enough to ensure reaching the maximum equilibrium exhaust system temperature.

Dynamometer

For dynamometer testing, the engine was run at the same speed as for road tests and was loaded to its maximum horsepower. In addition to "heating tests," the exhaust pipe cooldown times were noted, both with engine idling and with engine shut off.

"First Bends" As Indicators

It was found that the most critical area was the "first bend," that bend closest to the exhaust manifold likely to come in contact with ground cover. Table 1 shows the results of tests on 20 Forest Service vehicles of three different makes. Vehicles were equipped with comparable engines and transmissions. The table shows in every category that for only one manufacturer are smog device equipped vehicles likely to develop significantly higher temperatures than those not equipped. However, all the temperatures shown under "Road Test" are well above the combustion temperature (re-

TABLE 1.—*Average first bend temperatures*

	Manufacturer 1	Manufacturer 2	Manufacturer 3
ROAD TESTS			
Equipped	954°F	873°F	1080°F
Unequipped	947°F	855°F	849°F
DYNAMOMETER TESTS			
Equipped	1080°F	1050°F	1210°F
Unequipped	1070°F	1062°F	1002°F

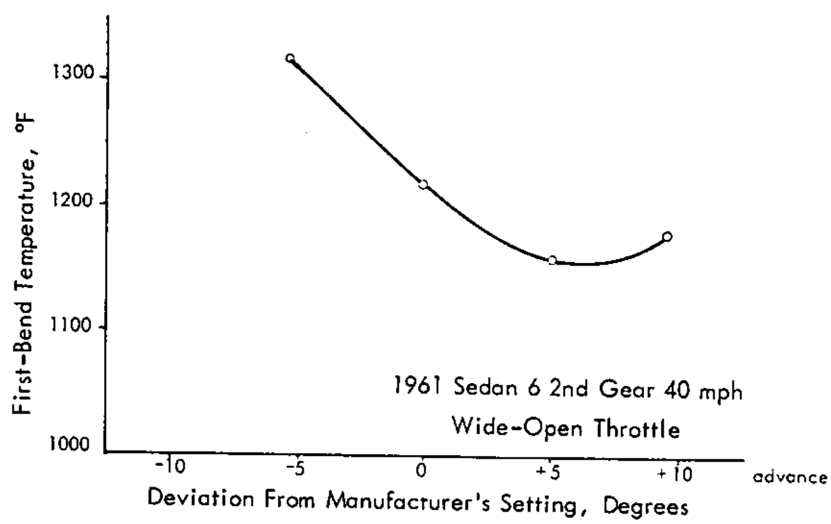

Figure 1—First Bend Temperature as a Function of Ignition Timing.

[1] Mechanical Engineer, Equipment Development Center at San Dimas.

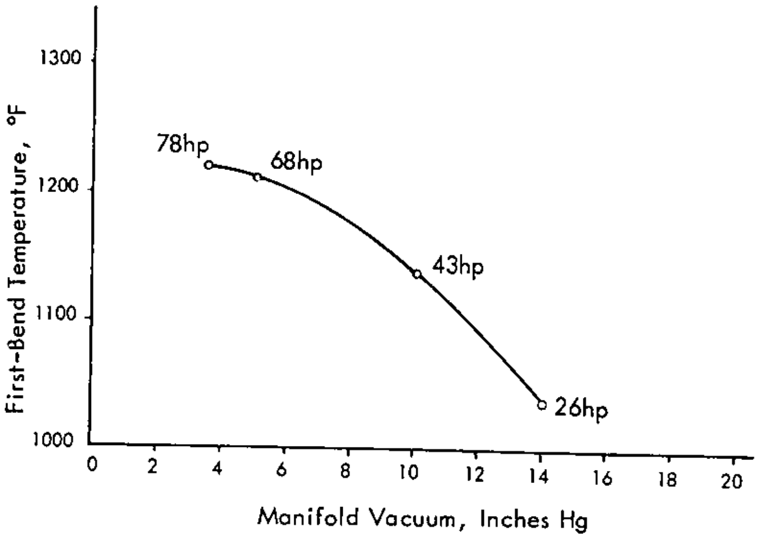

Figure 2—First Bend Temperature as a Function of Engine Load.

ported variously as 750°F and 660°F) for dry grass or pine needles.

Phase Two Tests

The second test phase determined the effect of varying engine adjustments on exhaust system temperatures. This was done by changing such variables as back pressure, ignition timing, etc., on one vehicle and testing to determine the effect of these changes. This provided valuable information about the relationship between engine "tuneup" settings and exhaust pipe temperatures. Figure 1 shows the "first bend" temperature as a function of ignition timing. Note that retarding the timing significantly increases the temperature. It was noted that a 1-psi increase in exhaust back pressure raised the exhaust pipe temperature only 5°F. Changing fuel-air ratio did not cause significant differences.

Results

As expected, engine speed and load had a marked effect on the system temperature. Figure 2 shows the variation in temperature as a function of load (manifold vacuum) and Figure 3 shows temperature variation as a function of the engine speed at three different constant loads.

Another interesting fact developed is that the highest exhaust pipe temperatures are found in situations similar to the road test, involving long, straight, fast, steep pulls. Table 2 shows temperatures encountered on five different types of roads. Note that the temperatures occurring on Forest Service land utilization roads are the lowest seen, because of the slow speed and light load dictated by the nature of the road surface, grade, and turn radii.

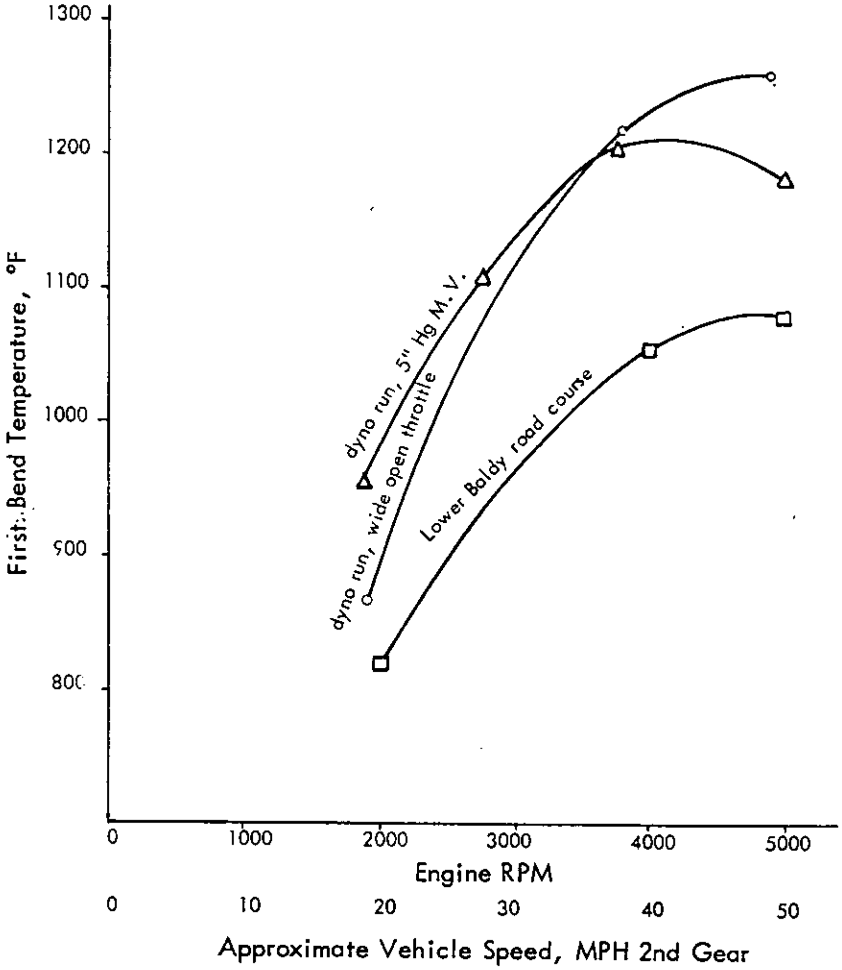

Figure 3—First Bend Temperature as a Function of Engine Speed.

In Summary

1. Under actual operating conditions the exhaust system surface temperature of some pickups and sedans reach temperatures in excess of 1,000°F. This temperature is not greatly affected by the installation of an exhaust emission pollution control device.

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TABLE 1.—*Log drying rates K (log M per hours) and time constants t_c (hours) of some dead, fine materials, untreated and xylene-treated*

MATERIAL	COLLECTION DATE	NUMBER OF RUNS	UNTREATED K	UNTREATED t_c	XYLENE-TREATED K	XYLENE-TREATED t_c
Red pine needles	October	4	.041	10.5	.29	1.5
Red pine needles	May	4	.103	4.2	.41	1.1
Jack pine needles	May	1	.137	3.2		
White pine needles	May	1	.158	2.7		
Trembling aspen leaves	October	2	.201	2.2	.60	0.7
Trembling aspen leaves	May	1	.306	1.4	.60	0.7
Grass [1]	May	1	.22	2.0		
Reindeer moss [1]	May	1	.26	1.7		
White pine twigs 1/16 in. D.		1	.338	1.3		
White pine twigs 1/8 in. D.		1	.274	1.6		
Match splints		2	.226	1.9		
White pine slats 10 x 1/4 x 3/32 in.		2	.277	1.6		

[1] Drying curves of these materials deviated considerably from the exponential; their drying data are therefore questionable.

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2. The maximum exhaust surface temperature is reached after sustained operations at high load and engine speed. Such conditions would be encountered climbing a long grade or operating a tanker equipped with a power take-off pump.

3. Exhaust pipe temperature can be significantly raised by maladjusted ignition timing or other engine tuneup setting.

4. Parking a vehicle off-road on a hot day is equivalent to supplying a sustained "heat-sink" or heat source which can provide the time element necessary for a fire start.

Also in the area of the first bend of the exhaust system are the front axle, steering, and other mechanisms, all of which are potential grass snaggers. Since the hazard can still exist after shut-down, drivers should be extremely cautious during fire weather.

For further information see Equipment Development and Test Report 5100–15, available from the Equipment Development Center at San Dimas. △

TABLE 2.—*Effect of road type on maximum first bend temperature*

1961 Sedan Unequipped

Ambient Temperature 75-92°F

Description of Course	Average Grade (%)	Gear Used	Average Speed (mph)	Maximum First Bend Temp. (°F)
Lower Baldy course described in text	+7½	2nd	40	1140
Freeway, straight and constant	+4	3rd	65	970
Around-town driving	0	2nd, 3rd	35	677
Country road, mountainous terrain	+8	2nd, 3rd	30	930
Forest Service L.U. road	+9-11	1st	15	803

Rates, from page 7.

surface presumably remains at or near equilibrium moisture content, regardless of the amount of moisture within. Such a diffusion mechanism would also explain why the curves exhibit no definite break at fiber saturation point (FSP).

Findings

1. Some fine materials, particularly pine needles, dried slower that wood many times their thickness.
2. Removal of wax and resin with xylene greatly increased the drying rate of pine needles and aspen leaves.
3. Several months of weathering distinctly increased the drying rate of dead leaves.
4. In none of the tests was there any apparent change in drying behavior at the FSP.

Application of Findings

The laboratory test conditions do not exactly fit any specific outdoor situation. They best resemble a fine, calm, summer afternoon in a fully canopied forest. In such a place and in most Canadian weather, the test materials would dry too slowly to reach moisture equilibrium in one day. A satisfactory estimate of afternoon moisture content would therefore require knowledge of the moisture content at some previous time. This principle was followed in the design of the Canadian fire danger rating system, which refers to a forest fairly well sheltered from wind and sun.[2] Specifically, in the analysis of the fuel-moisture data collected in the field, the current moisture content was correlated with the previous afternoon's value as well as the pertinent weather elements. The resulting fine-fuel tracer index[3], used with noon weather readings, provides reasonably good estimates of fine fuel moisture content from day to day. △

[2] Beall, H. W. Research in the measurement of forest fire danger. Proc. Fifth Brit. Empire Forest. Conf. 1947. Reprinted as Inform. Rep. FF-X-8, Can. Dep. Forest. and Rural Develop., Forest Fire Res. Inst., Ottawa, 1967.

[3] Beall, H. W. Forest fire danger tables, provisional. 2nd edition. Forest Fire Res. Note No. 12, Forest. Br., Can. Dep. Resources and Develop. 1948. (Now Forest Fire Research Institute, Department of Forestry and Rural Development) Ottawa.

Portable Retardant Mixing Unit

L. E. Rossi [1]

A portable retardant mixing unit recently has been evaluated by the SDEDC. The unit can be set up quickly at any suitable airport to mix and load retardant in fixed-wing air tankers, or at any heliport or helispot with road access. It can service helicopters equipped with either a tank or a sling-mounted, dip bucket.

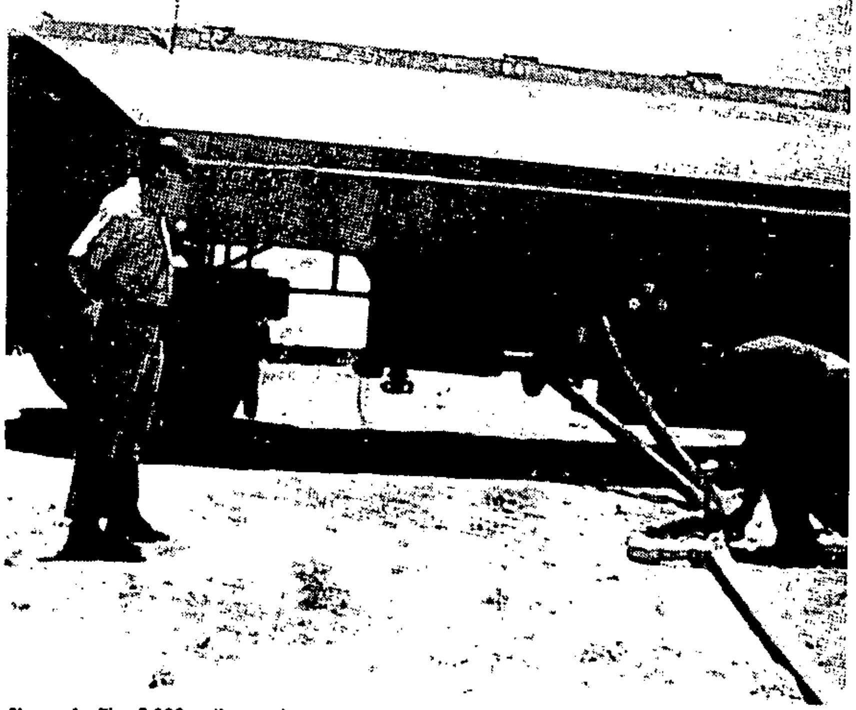
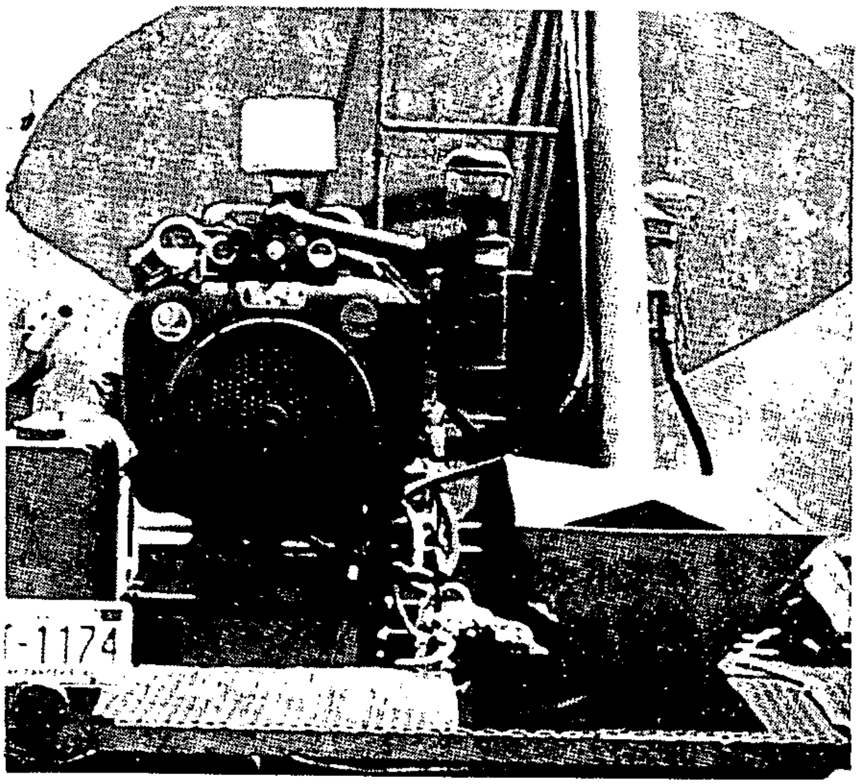


Figure 1—The 5,000-gallon tank trailer is set up to pump mixed retardant.

The Set-up

The unit includes a diesel tractor with a 5,000-gallon tank trailer (fig. 1) and a tractor with a 35-foot flatbed service trailer. The service trailer is used to haul up to 25,000 pounds of dry retardant and all hoses and attachments necessary to load the mixed retardant into any aircraft. An Orland mixer and 200-gallon-per-minute loading pump are mounted on the tank trailer (fig. 2). A 1,500-gallon portable open tank is also included. The tank serves as a reservoir for mixed retardant and as a dip tank if helicopters with sling-mounted buckets are used.

Figure 2—The retardant is mixed in an Orland mixer mounted on the rear of the tank trailer unit.



Ready Quickly

The unit is set up and operated by a 4-man crew. It can be in operation and the 1,500-gallon tank can be filled with retardant within 20 minutes after the unit's arrival at the mixing site. △

[1] Staff Assistant, Equipment Development Center at San Dimas.

Fire Kill In Young Loblolly Pine

Believe this applies to hardwoods also —

ROBERT W. COOPER AND
ANTHONY T. ALTOBELLIS [1]

Mortality in young loblolly pine, following exposure to free-burning fires, appears to be more closely related to crown damage than to bole damage. Kill of young trees varies considerably with the type of fire applied; trees larger than 4 inches d.b.h. are not easily killed by backfires or small head fires under moderate burning conditions.

If foresters are to make maximum use of fire as a silvicultural tool, they need to know more about mortality of trees exposed to free-burning fires. How does fire kill trees? Is it by means of penetrating heat on the bole that raises the temperature of the cambium above the lethal level? Or, is it the result of crown kill from excessive heat, i.e., bud damage, needle scorch, or consumption? Answers to these questions would enable forest managers to make more precise fire prescriptions and perhaps improve predictions of expected mortality following wildfires.

Figure 1—The lower 6 feet of tree boles were protected from heat by asbestos wrappings.

The Search

To find some answers, an exploratory fire study was established in a natural stand of sparsely stocked, young loblolly pine (*Pinus taeda*) in central Georgia. Dominant and codominant trees ranged in height from 8 to 28 feet and in diameter from 1 to 6 inches. Within each of three tracts about 10 acres in size, 36 trees representing three diameter classes (2 inches and less, 2.1 to 4.0 inches, and 4.1 to 6.0 inches) were measured and marked for observation.

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Protection

On each tract, bole protection was provided for one-third of the trees, crown protection for one-third, and one-third were left unprotected. One tract was burned with a backfire, one with a head fire, and the last with a perimeter, or ring, fire.

Protection for the boles was provided by asbestos wrapped to a height of 6 feet (fig. 1). Crown protection was provided by sheets of asbestos-covered plywood at the base of the crowns (fig. 2).

Tracts Burned

The tracts were burned in May during a period considered favorable for prescription fires. Air temperature was about 85° F; relative humidity ranged from 40 to 50 percent; fuel moisture estimates were 8 to 10 percent, and 20-foot open windspeeds averaged 5 m.p.h. Surface fuels consisted mostly of pine litter and grass, typical of old fields in the South. Bole char, crown scorch, and crown consumption were estimated soon after burning; a mortality count followed 3 months later.

Results

Crown damage was apparently more responsible for tree kill than bole damage (table 1). Only one tree that was provided with crown protection died; five of the bole-protected trees died. The greatest kill was experienced where no protection was provided; perhaps there is an interacting effect when both bole and crown are injured. Nevertheless, crown consumption proved to be the best of all the fire-damage indicators in predicting subsequent mortality.

Perimeter burning resulted in the greatest mortality (12 trees); backfiring caused the least (1 tree) (table 2). Only two trees in the largest size class were killed; both of these had unprotected crowns exposed to the perimeter fire. Five trees in the smallest size class and ten trees in the intermediate size class died. The best explanation for the greater kill in the intermediate class is that six of the ten dead trees were located in the center of a developing convection column in the perimeter-burn tract.

Conclusions

This evidence indicates: (1) kill of young loblolly pine varies considerably with the type of fire to which trees are exposed; (2) mortality is more closely related to crown damage than to bole damage; (3) loblolly pine trees larger than 4 inches d.b.h. are not easily killed by the heat from backfires or small head fires under moderate burning conditions; (4) when convection activity develops, perimeter, or ring, burning is capable of killing more and larger trees than it otherwise would.

Although additional research and operational trials are necessary before this evidence finds practical application, some interesting possibilities come to mind. For example, hazard reduction burns in young loblolly pine stands appear feasible where backfires and strip head fires can be applied under moderate weather conditions. Prescription fires may also deserve consideration as precommercial thinning tools (thinning from below) in dense stands of young loblolly pine where diameters range from 1 to 6 inches.

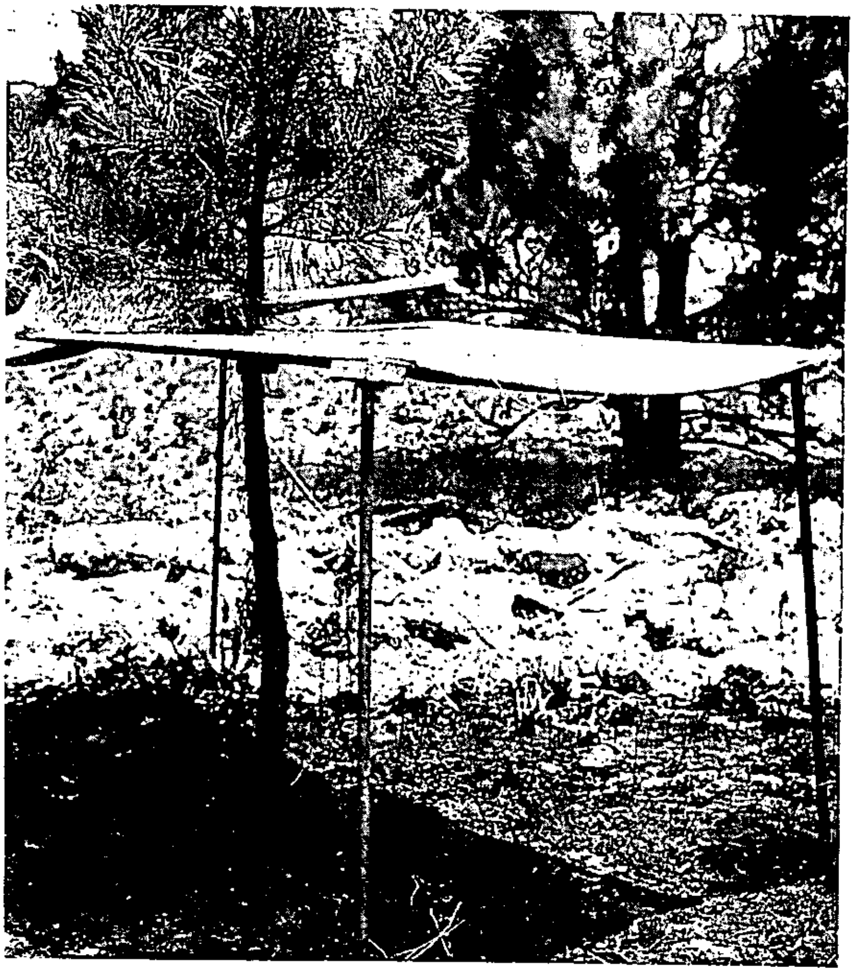

Figure 2—Crowns were protected from direct heat by asbestos-covered sheets of plywood.

In this study, no consideration was given to the indirect effects of fire in attracting insects or enabling disease organisms to become established. These factors certainly warrant study in future work. △

TABLE 1.—*Effects of free-burning fires on young loblolly pines*

Protection provided	Bole bark char	Crown scorch	Crown consumption	Dead
		Number of trees [1]		
Crown	29	22	0	1
Bole	4	31	11	5
None	33	36	19	11

[1] Because some trees exhibited varying degrees of damage in both the crown and bole, number of trees in each protection class will not total 36.

TABLE 2.—*Mortality of young loblolly pine in relation to type of fire, protection provided, and size (d.b.h.) class*

Type of Fire	*Number of trees killed*								
	Crown protection			Bole protection			No protection		
	< 2"	2.1"-4.0"	4.1"-6.0"	< 2"	2.1"-4.0"	4.1"-6.0"	< 2"	2.1"-4.0"	4.1"-6.0"
Back	0	1	0	0	0	0	0	0	0
Head	0	0	0	1	0	0	0	3	0
Perimeter	0	0	0	0	3	1	4	3	1

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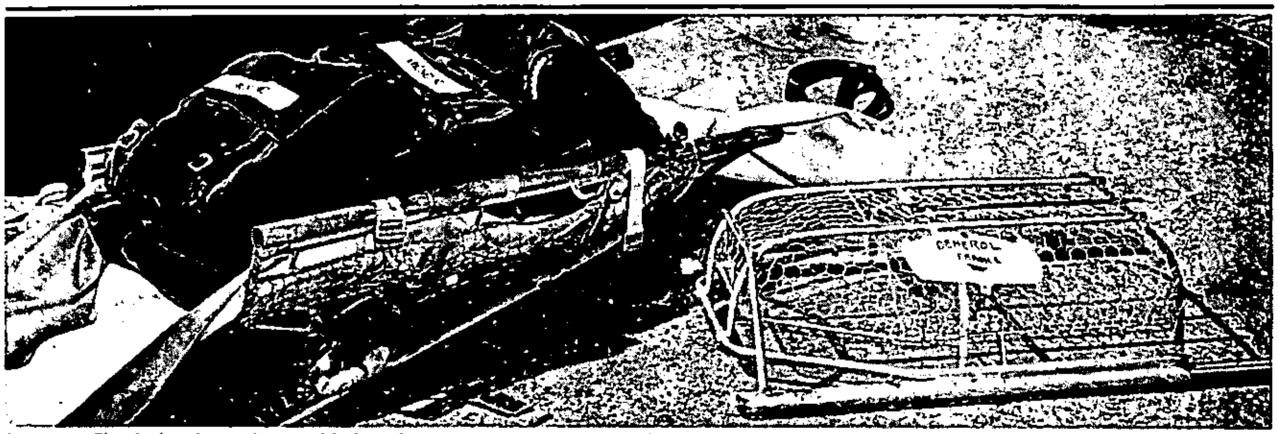

Figure 1—The Stokes litter disassembled, with cargo rigging removed, showing contents stowed in the two parts.

Stokes Litter Modified

KEN SMITH [1]

In order to eliminate hazards in para-dropping the Stokes Rescue Litter, aircraft technicians on the Boise National Forest redesigned the litter by dividing it into two sections for packaging and paradropping.

The Stokes litter was cut into two sections, one 31 inches long and the other 50 inches long, the latter section long enough to mount the wheel yoke assembly (fig. 1). A length of strap metal was formed and welded into place on each section where the cut had been made; wire mesh was spot-welded to these straps. On the shorter end of the litter, a piece of strap was used for added reinforcement, and a bolt plate was attached for mating to the long section. Two sleeves were machined to size and slid into the top rail. These sleeves were 16 inches long, of which 8 inches were inserted and bolted into place in the short length of the litter. After the sleeves were secured, both ends were placed back together and two 1/4-inch bolt holes drilled on each side (fig. 2). Stove bolts with ring nuts were used to speed the assembly.

Color-Coded

All carrying handle extensions were color-coded to speed assembly, and all crew evacuation harnesses were labeled properly so even an untrained crew would have few problems. A quickly attachable package for Demerol, etc., was located on exterior of the bundle where landing impact would not damage the contents. This first aid package also included instructions for assembling the unit.

During training sessions on the Boise, this modified litter has been put together in 5 to 8 minutes by men with no previous experience in assembling it.

Plans for modifying the Stokes litter are available from the Forest Supervisor, Boise National Forest, 413 Idaho Street, Boise, Idaho 83702.

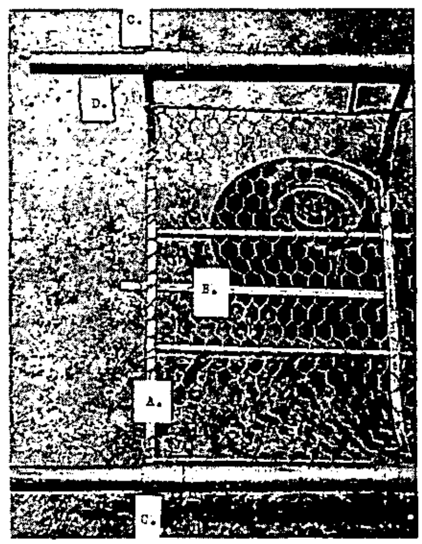

Figure 2—Shorter section of Stokes Litter showing modifications:

A. Metal strap
B. Reinforcement & bolt-plate assembly.
C. Sleeves
D. Sleeve boles.

[1] Smokejumper foreman, Boise National Forest.

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