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FIRE CONTROL NOTES

A PERIODICAL DEVOTED TO THE TECHNIQUE OF FOREST FIRE CONTROL

VOL. 23 NO. 3
JULY 1962

Forest Service
UNITED STATES 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.

UNITED STATES DEPARTMENT OF AGRICULTURE 1862 1962

Growth Through Agricultural Progress

Volume 23 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.

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Forest Service, Washington, D. C.

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Mention of specific products in this publication is necessary to report factually on available data. Use of the names does not imply endorsement by the Department over similar products not named.

HELICOPTER FLIGHT DATA ARE EASY TO USE

HERBERT J. SHIELDS
Mechanical Engineer, Arcadia Equipment Development Center, Arcadia, California

Would you like to know the limitations of load, altitude, and takeoff distance of the next helicopter you hire? This is not as difficult as it may seem now that reliable tests have been conducted.

We have now concluded two tests under a joint program with the Army Aviation Test Office at Edwards Air Force Base and have published reports on the Bell 47G-3 and the Hiller 12E/61. Results will soon be available on the Bell 47G-3b. You can use this information in training, planning payloads, and improving safety. Pilots may use it as good basic material for operating in the mountains.

We have put much of the information into chart form. Before you let the appearance of the charts stump you, however, let's discuss a few basic concepts of how they are set up and why they work.

Hovering performance.—In most of our work in the mountains the ability to hover and lift reasonable loads while in a hover is the most useful characteristic. Since the rotor blades must move a mass of air equivalent to weight lifted, this performance is directly related to the power available from the engine.

Engine power is dependent on atmospheric pressure and temperature, which can sometimes be artificially controlled by supercharging, or "derating;" that is, only allowing use of partial power at low altitude and gradually drawing more reserve as the ship goes up until engine limits are reached.

At any power setting by the pilot, such as full power, the helicopter can lift a greater load when hovering with the skids 5 feet above the ground than it can lift with the skids at 50 feet, because of "ground effect." This effect gradually diminishes up to 20-50 feet depending upon the helicopter used.

Now, let's take a look at curve 1 (fig. 1). The top position shows a scale of temperatures, while at the left, altitudes are marked off. The lines actually indicate engine power limits for the various combinations of temperature and altitude. The warmer it gets, the less engine power is available.

Assuming an operating altitude of 9,000 feet, and a temperature of 25°C. (77°F.), we start at the 9,000-foot point on the altitude scale and go to the right until we reach the 25°C. point (1 circled), then draw a line straight down until we visually follow in between the short curves at the bottom. The helicopter can

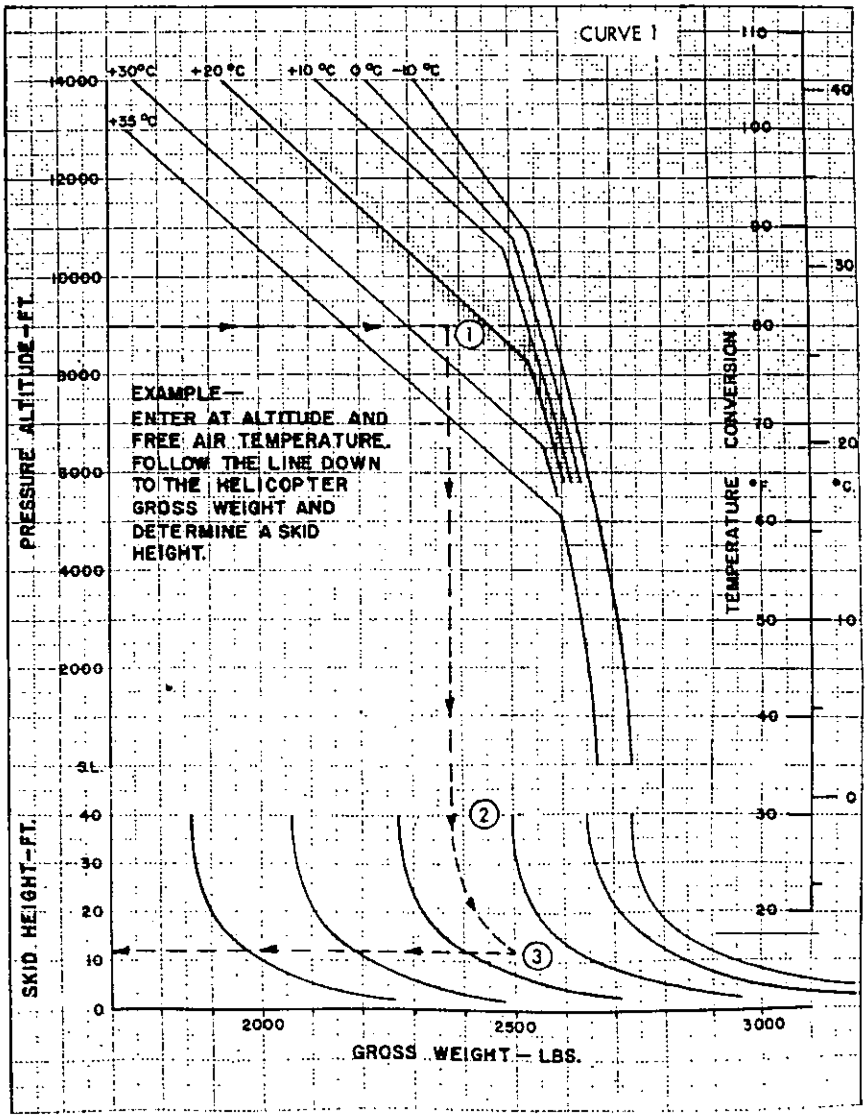

FIGURE 1.—Hovering performance, Bell Model 47G-3 (N6783D).

perform anywhere within the area to the left of this imaginary line.

If the hover condition must be 40 feet or more, *drop straight down* from point 2 (circled) to the gross weight line and read 2,380 pounds. If you only need to hover at 12 feet, follow along the curves to point 3 (circled) and then down to read 2,500 pounds. Similarly, for a 5-foot hover, read 2,650 pounds.

Now let's work backwards and see what happens. Let's say we have to hover at 15 feet in order to hook up some cargo that weighs 500 pounds. Assume the helicopter, fuel, pilot, etc. weigh 1,900 pounds. This gives us a gross weight of 2,400 pounds. Starting at 2,400 pounds and moving straight up to the 15-foot level, we then follow the reverse procedure until the 40-foot line is reached, then go straight up. We could hover at 15 feet at 10,000 feet at 22°C., or at 6,000 feet, out of ground effect (OGE). If we remove 100 pounds we can hover at 11,000 feet at the same temperature, or we can add 100 pounds and hover at 9,200 feet.

These values were obtained from tests conducted in *zero wind,* and therefore are conservative for most cases. Tests show that even 4 or 5 knots of wind can improve performance data, particularly under marginal conditions.

To keep from getting lost on this curve, just remember—adding weight decreases hovering performance or altitude.

Takeoff performance.—In cases just shown where the helicopter cannot hover more than a few feet off the ground, a takeoff can still be made. However, some distance must be covered parallel to the ground to accelerate to enough speed to climbout. This is normally the safest takeoff procedure even when a "straight up" takeoff could be made.

Takeoff performance is commonly expressed in terms of distances to clear a 50-foot obstacle. This distance includes both the acceleration and climbout runs. The length of run depends on several variables: piloting technique, weight, temperature, altitude, and air speed selected for climbout.

Now, notice that weight, temperature, and altitude also directly affect the hovering performance which we discussed. By making takeoff tests at various weights and speeds, the data can be prepared into various "nondimensional" factors so that the hovering and takeoff performance can be directly plotted as shown on curve 2 (fig. 2). In other words, our engine power also directly affects the takeoff distance.

Let's look at curve 2 more closely. On the curves at the right are noted "skid height" values. These are *hovering capability* values regardless of all other factors. One way of finding this value would be to bring the helicopter to a hover using *full power* and estimate skid height to the ground. Let's say you come up with 12 feet. If you decide to climbout at 30 knots, follow the 12-foot line from point 1 to point 2 and read across. You will need 280 feet to clear a 50-foot obstacle. You don't have to takeoff from 12 feet, but from a normal 2 feet or so, since we were only determining the capability for entry into the curve.

Another way of finding this value would be from the skid height obtained from curve 1 after knowing temperature, altitude, and gross weight. Again, you could work backwards to find your safe load if you have only a small takeoff space.

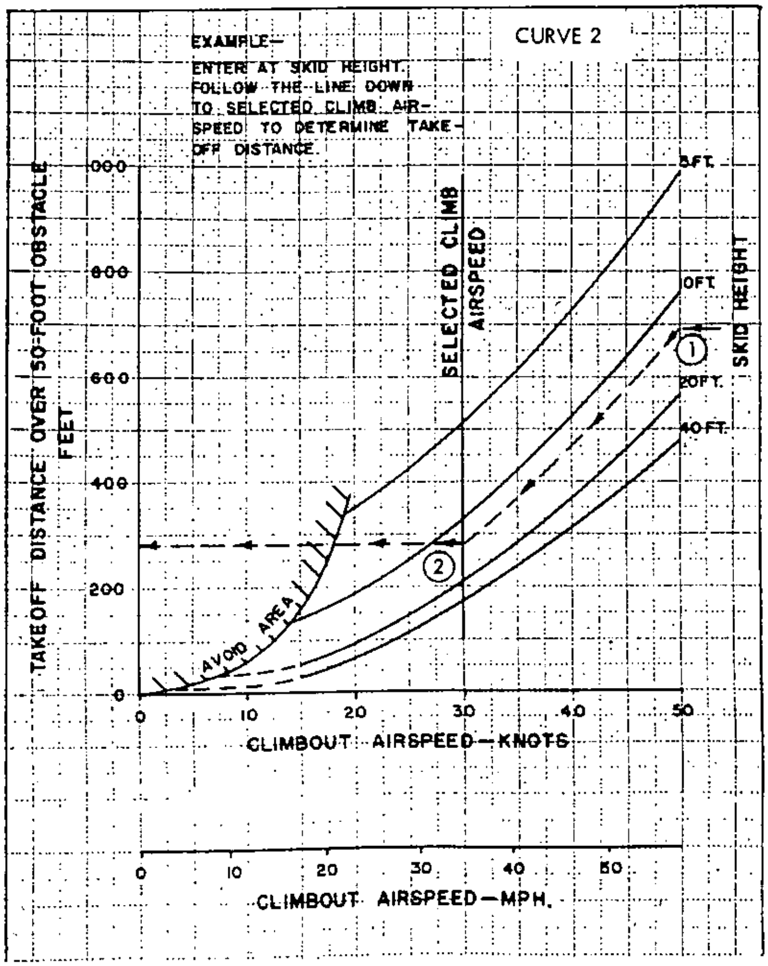

FIGURE 2.—Takeoff performance, Bell Model 47G-3 (N6783D).

Summary.—Curve 1 gives an overall picture of hovering performance by tying together altitude, temperature, and helicopter gross weight. Curve 2 shows takeoff run required at various hovering performance values for usable climbout speeds. Tables prepared from the same data used in constructing the curves are available in existing reports on the Hiller 12E/61 and Bell 47G-3. However, once you have mastered the curves you will find them giving you a more useful picture of performance.

DEHAVILAND BEAVER WATERDROPPING TESTS

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Lake States Forest Experiment Station

Aircraft are important tools in the management and protection of the Superior National Forest in northern Minnesota. This is particularly true in fire detection and suppression activities. Float-equipped aircraft figure more prominently each year in handling these vital jobs.

In line with this increased use has been an equipment development program headquartered at Ely, Minn. Work here has been directed toward the development of equipment and techniques for increasing the effectiveness of waterdropping on going fires. Testing of this equipment has been under the general supervision of the Ely Service Center. The Lake States Forest Experiment Station has cooperated by providing assistance in design and analysis of waterdrop experiments.

Calibration tests conducted at Ely in June 1959 were summarized in *Fire Control Notes*, July 1961.[1] During each flight a DeHaviland Beaver dropped 125 gallons of water over a prescribed target area. Water concentrations and drop patterns were recorded.

On the basis of the 1959 tests, the water tank and release gates on the Beaver aircraft were modified and the tests were repeated in July 1961 (fig. 1). This report will show that the design changes produced marked improvement in waterdropping characteristics as compared to the 1959 test. It also will provide a comparison of these latest results to those obtained in a California experiment, conducted 1955-59.[2]

Test Conditions and Equipment

The 1961 tests were conducted over level, open ground at the Ely airport, using essentially the same procedures as in the 1959 tests. The airport site provided a convenient location for a network of cups in the target area to catch water for drop calibration purposes.

Only plain water was used during the 1961 tests, while both plain water and "wet" water were used in 1959.

Both morning and afternoon drops were made. The temperature averaged in the low 70's, relative humidity varied between 64

[1]Strothmann, R. O., and McDonald, L. J. Water-bombing with the DeHaviland Beaver. U.S. Forest Serv. Fire Control Notes 22 (3): 93-95. 1961.

[2]Davis, James. Air drop tests, Willows, Santa Ana, Ramona, 1955-59. Calif. Div. Forestry.

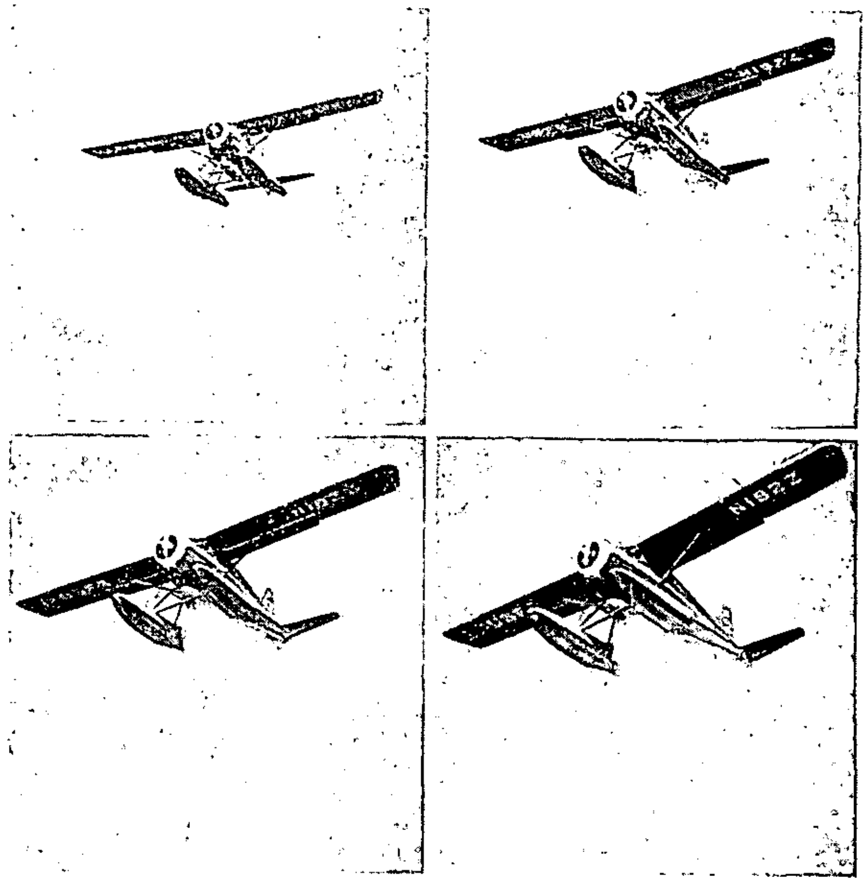

FIGURE 1.—Sequence of a test waterdrop from a DeHaviland Beaver aircraft.

and 89 percent, and the winds were generally from the southeast averaging 4 to 6 m.p.h. Three drops were made during perfectly calm wind conditions.

Airspeed averaged 80 m.p.h. Drop altitude averaged 100 feet, although one load was released at a height of 150 feet. Accuracy was excellent. Only two of the 14 drops partially missed the target area.

Ten drops were made on a grid system identical to that of the 1959 tests. Distance between cups along the 500-foot length of the grid was 50 feet. Along the 100-foot width of the grid, cups were spaced at 10 feet.

On the third day of testing, the grid length was reduced to 250 feet—one-half the original length—when it became evident that only a small portion of the 500-foot grid was being utilized. The grid width remained the same. This more compact pattern arrangement made it possible to plot the waterdrop concentration contours more accurately.

Design changes were made in the tank, pickup tube, and release opening. In 1959 a fuselage tank was used with a snorkel tube extending into the water beneath the plane. This arrangement was inconvenient, and in 1961 the fuselage tanks were replaced by streamlined exterior tanks, mounted below the fuselage and between the pontoons (fig. 2). These tanks were modified surplus wingtip fuel tanks cut down to hold 125 gallons of water. The snorkel tube was also redesigned for the 1961 tests.

The most important changes were made in the drop openings. The three openings on the 1961 model total 754 square inches, compared to only 225 square inches of opening on the tank tested in 1959. According to Arcadia Equipment Development Center standards, 500 square inches is satisfactory. The same volume of water (125 gallons) is now released through three gates that total three times as large as the drop openings in the 1959 equipment. This larger opening allows a sudden rush of water to be cascaded from the tank (fig. 3), eliminating the slow, extended release of water characterized by the smaller tank opening.

Results

Contour maps were constructed for each drop to show the water concentration and pattern. Iso-lines were drawn indicating areas having water concentrations equal to or in excess of 0.4 gallon per 100 square feet. The square-foot area within each contour was determined and averages were computed. The results are summarized in table 1.

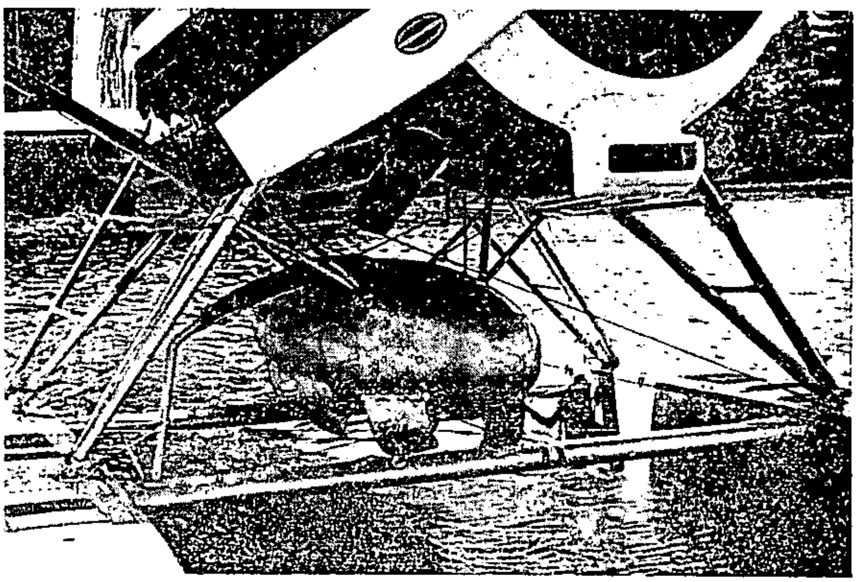

FIGURE 2.—New water tank assembly on Beaver aircraft has three release openings and modified snorkel tube for filling tank.

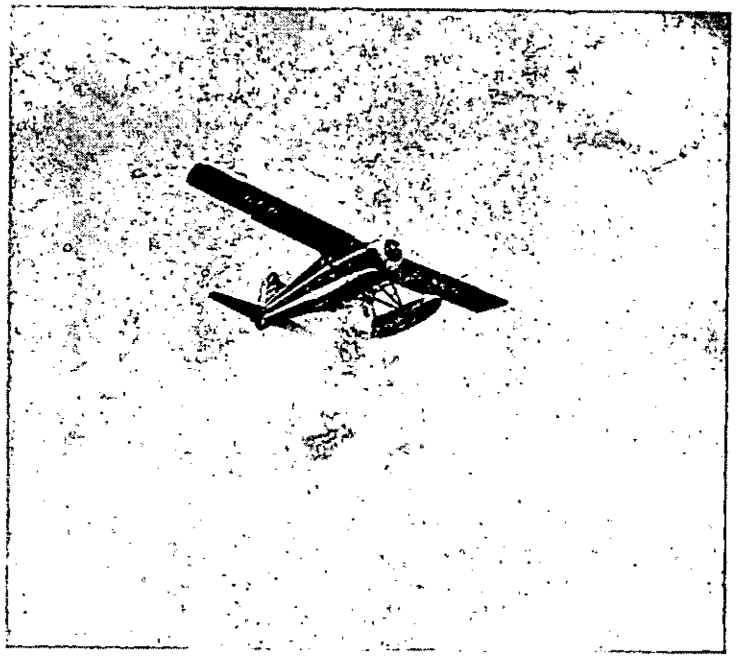

FIGURE 3.—Water cascades freely from enlarged gates in the redesigned 125-gallon tank.

TABLE 1.—*Area covered and concentrations in three tests*

Item	Beaver tests		California Stearman
	1959	1961	
Average *total* pattern length—feet	400	211	(1)
Average *effective* pattern (over 0.4 gal. water per 100 sq. ft.):			
Length—feet	150	157	202
Width—feet	45	61	(1)
Average total coverage for:			
0.4-0.5 gal./100 sq. ft.—square feet	4,086	5,802	6,530
1 gal./100 sq. ft.—square feet	400	2,198	3,100
2 gals./100 sq. ft.—square feet	0	507	94
Average maximum concentration per 100 sq. ft. at pattern center[2]—gallons	0.9	3.3	(1)

[1]No record.

[2]Average maximum amount of water measured in any one cup in the pattern.

1. The *average total pattern length* for the 1961 tests was about half the average length recorded in 1959. This is an improvement because now more water is concentrated into a smaller area, making each gallon more effective.

2. The *average effective pattern length* proved to be about the same for both years, while that of the California Stearman air-

craft was about 33 percent longer. The 1961 effective pattern *width* was about 30 percent wider than that of 1959.

3. *Surface area covered* and *average concentrations* were the most significant improvements noted. In concentrations of 0.4-0.5 gallon per 100 square feet, the Beaver covered an average of 1,700 square feet more per drop in 1961 than it did in 1959.

The biggest improvement came in the total area covered by 1 gallon of water per 100 square feet. In 1961 this coverage was five times as large as it was in the 1959 tests; it was only slightly smaller (900 square feet average) than the area covered by the Stearman.

4. Results of the 1961 Beaver tests were superior to both the 1959 tests and the Stearman tests in area covered by a concentration of 2 gallons per 100 square feet. The Beaver tests in 1959 *never* attained this concentration during any of the 15 drops using plain water. The Stearman tests averaged 94 square feet coverage at this concentration, compared to the Beaver's 507 square feet coverage recorded in the 1961 tests.

Water-bombing with the DeHaviland Beaver in the Superior National Forest lake country has already proved successful as a supplementary fire suppression measure. The present tank and drop opening equipment allows a sufficient volume of water to reach the ground to be effective in knocking down small fires or cooling hot spots on large fires. The waterdrop is now considered to be a routine fire suppression measure on the Forest. Properly equipped airplanes are available throughout the fire season—ready to take off at any time on a suppression mission.

HAZARDS TO GROUND PERSONNEL FROM AIR DROPS OF FIRE RETARDANTS

Arcadia Equipment Development Center
Arcadia, California

In June 1960, tests were conducted in an effort to obtain data that would establish hazards and defense procedures against the dangers of direct drops on personnel from air tankers. Five different air tankers were used—TBM, N3N, F7F, SNB, and Vega—to obtain differences from capacities and tank design. Direct water drops were made on an instrumented dummy. Our dummy, "Sierra Sam," equivalent in stature and build to a husky man, was equipped with accelerometers inside his chest.

The dummy was placed in a standing position for drops at decreasing increments of altitude until significant damage was evident. Drops were then made on the dummy in the prone position. This procedure was followed for each of the five air tankers (fig. 1).

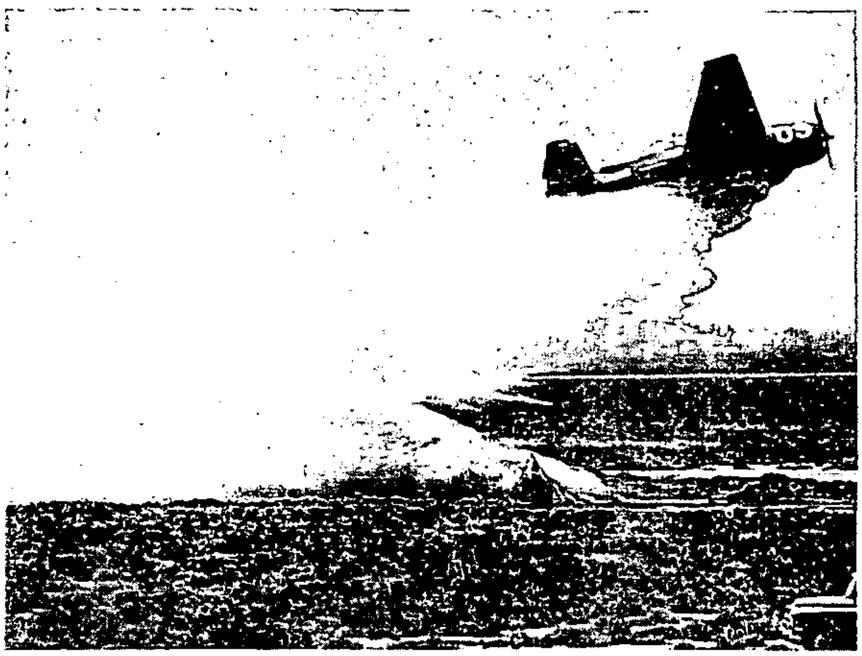

FIGURE 1.—TBM dropping 600 gallons. Height 35-44 feet, speed 150 knots. Dummy lower center at moment of impact.

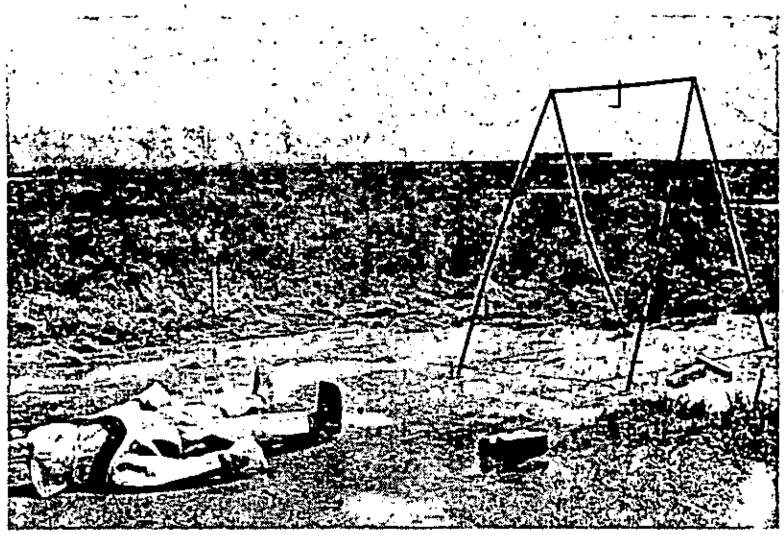

FIGURE 2.—Dummy after being knocked from standing position.

After the first several drops were made, it was obvious that a major portion of the hazard occurred when the dummy struck the ground after being hit with the water. When he was knocked from the standing position, high values of "g" loading were obtained in some cases just from falling down (fig. 2).

When dummy was lying down, he was carried with the liquid on very low drops and thrown to the ground. In other words, it wasn't the fall that hurt, it was the "sudden stop at the end."

The hazard is reduced when the body is in the prone position. It was difficult to obtain much body movement with a drop from above 15 feet. Below this height a veritable wall of water carries the body easily. A hardhat on the dummy, with the chin strap fastened, usually remained in place and afforded good head protection.

On some drops it was observed that a considerable amount of loose ground debris was picked up with the liquid and carried along. For this reason a prone position with the head forward and protected is recommended. If the person can grasp something firmly imbedded and hang on, any movement that can be prevented will help. Handtools, obviously, also present a hazard; therefore, they should be placed at one side.

It is difficult to evaluate injury potential to a human from acceleration figures. The nature of the obstruction against which the victim is hurled and the posture at time of contact are of greater significance. It is like comparing the injury of one who is fatally hurt after slipping on a sidewalk to that of another who survives a two-story fall from a building. Nevertheless, the results showed a deadly potential. On several drops it was noted that definite skull damage occurred, and on one drop the left arm and shoulder were torn completely free.

Conclusions

1. Drops from air tankers of any capacity are hazardous. The tankers used for test all showed that under some conditions a drop on a human can be deadly.

2. Size of load does not appear to be a major factor in initial impact forces on a human, although accuracy of a drop of large size does not need to be as exact as one of small size to obtain a hit.

3. When a human is standing, drops are dangerous at heights under 50 feet. When a human is prone the hazard is reduced and he is probably safe if drop is from a height above 20 feet. The greatest injuries appeared to be caused by the final impact with the ground after a human is carried or thrown by the liquid.

4. The dangerous target area was small, particularly lateral to the drop direction. On some drops a hazard existed from loose debris being picked up and thrown with the liquid.

5. Fatal injuries can be minimized by following these rules:
   a. Lie down facing aircraft, with hardhat in place.
   b. Place handtools off to side.
   c. Grasp something firm to prevent being carried with liquid.
   d. Do not run unless obvious escape is assured.
   e. If in timber stay clear of dead snags, tops, and limbs in drop area. Material such as rocks, live and dead growth, and rolling material on slopes are particularly hazardous.

THE PLACE OF THE FIRE BEHAVIOR OFFICER IN THE FIRE SUPPRESSION ORGANIZATION

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The fire behavior officer on project fires has two primary functions; first, as a forecaster of probable fire behavior for information of the fire boss in making suppression plans, and second, as an aid in assuring safety of personnel from action of the fire. From experience gained during the 1961 fire season, a third probable responsibility has become apparent; working in close cooperation with line overhead to reassure them of fire behavior conditions currently and continuously.

On a recent western project fire, it was observed that line overhead from division boss through the crew boss were sometimes reluctant to make vigorous attack. This reluctance was attributed to the potential blowup characteristics of a fire in heavy fuels which were critically dry, and the inability of line overhead to properly forecast behavior of the fire. The attitude of the overhead was reflected in crew effort and effectiveness of fireline production at critical points and posed a major problem in the control of this fire. Some of the reasons for this reaction, which was exhibited by personnel trained under widely varying geographical conditions, were felt to be as follows:

1. Timber types. Heavy old-growth timber at the lower elevations, approximately 50,000 board feet per acre, restricted visibility to a very short distance.
2. Topography. Steep, rocky terrain made movement of individuals and crews slow and difficult.
3. Atmospheric conditions. Continued nighttime temperature inversions kept immediate fire area filled with smoke well into the active burning period, about 1100-1200 hours. This resulted in poor visibility, coupled with uncertainty of behavior of the fire.
4. Morale. Because of fatigue and repeated loss of suppression line, morale of some of the crews and overhead was low. Repeated fire runs of varying intensity and length caused apprehension and made the men overcautious. Alert and aggressive suppression action became difficult to obtain.
5. Much of the fireline was built well in advance of the fire. This made burning out necessary, and when it was not done promptly, the fire moved and usually crossed the firelines.
6. Fire behavior knowledge. In discussing behavior of this fire with fire suppression personnel, it became apparent that abbreviated types of fire behavior training tend to overstress danger

to personnel from fire action. When personnel safety is overstressed in training of inexperienced men, they do not have necessary background to evaluate the training, and as a result, they become timid and overcautious in face of unfamiliar fire behavior. This attitude further reduces the chance of aggressive attack on the fire.

Solving these problems became paramount in the control of this fire. An overhead meeting was held at which top fire management personnel explained the past and the expected future behavior of the fire, and its relation to personnel safety and choice of tactics needed to safely effect control. This meeting did much to dissipate timidity and fear and to instill confidence. As a followup on this meeting, hourly fire behavior forecasts were made on the fire-net radio frequency to division and sector bosses. With uncertainty about behavior of the fire removed, all subsequent control action was markedly more aggressive. Line overhead said the forecasts were a big morale booster and crews looked forward to the hourly broadcasts.

As a result of this and other experiences during the 1961 fire season, it is felt two things are needed in order to improve effectiveness of fire suppression action.

First, the emphasis in fire behavior training must be shifted from a negative attitude which induces fear of fire. The positive approach will teach fire behavior as necessary knowledge which when properly evaluated will dictate proper tactics for fast aggressive safe control of the fire. In this way, personnel safety will appear in its true perspective.

Second, the fire behavior officer is a key man in the plans section. As a specialist in the factors that influence probabilities related to how this fire will burn in intensity and spread, he furnishes essential information for strategic and tactical planning.

It is important that the fire behavior officer be fully qualified as a line or division boss. Ready access to the fire boss, line boss, or other key line overhead on a critical portion of line will insure that important fire planning and personnel psychology aspects of fire behavior will be adequately evaluated in fire suppression strategy.

FIRE HOSE THREAD STANDARDIZATION IN THE U.S. FOREST SERVICE

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Increasing emphasis on mutual aid in forest fire fighting between Federal, State, and other protection agencies make interchangeability of equipment highly desirable. Hose coupling problems have been serious on major forest fires in the United States. Lack of standard threads has resulted in fires escaping. On one fire two fatalities occurred because of interruption in water delivery due to lack of an adapter. From a civil defense standpoint standardization is highly important.

Fire hose adapters can provide some degree of interchangeability but they do not solve the basic problem. They are heavy and comparatively expensive, and too many are needed to assure full interchangeability of hose and related fittings.

The U.S. Forest Service has adopted the National Fire Protection Association standard fire hose thread for 1½-inch hose and is currently engaged in a 5-year conversion program.

Conversion work in the California Region started this year and is planned for completion by June 1963. Before starting the program they had a fairly complete inventory of thread units to be converted at each station. Because of the large number of units to be converted, it was decided to recut female threads and sleeve the male threads. Most of this work is contracted. Adapters were not used where threads could be recut or sleeves used. Adapters are used on male threads that cannot be machined, such as those on portable pumps and hydrants.

The California Region has developed information and a few guides which may be helpful to others planning similar programs. These are (1) inspect and test all hose prior to conversion, and replace obsolete hose with the new standard coupling; (2) make a complete inventory of job to be done at each station; (3) assign a qualified man to head up the program; (4) plan and budget for the job; (5) if the inventory of thread items is large, consider contracting. If the number of conversions to be made is low, it may be least expensive to use adapters or replace couplings. If desirable, female thread cutting machines may be rented, and male adapters used; or a thread shaving die and insert tool can be purchased to prepare male threads for sleeves. Sleeves may be purchased from fire equipment suppliers or thread conversion contractors. The thread shaving die costs about $117 and the special insert tool about $25.

STAINLESS STEEL HOSE PATCH

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Ontario Department of Lands and Forests

The Department of Lands and Forests as well as the forest industries in Ontario have attempted for years to solve the problem of stopping leaks in fire hose during firefighting operations. To meet this need for an efficient method of stopping serious leakage from ruptured hose on the fireline, the stainless steel hose patch was engineered and perfected.

Testing commenced in 1957. A large variety of materials and designs were tested, including linen, various types of rubber, and finally the stainless steel patch. It was found in testing stainless steel ranging from 20 to 28 gauge that 20 and 22 gauge were too stiff, while 26 and 28 gauge did not have sufficient strength and opened up under pressure. The final patch selected was manufactured from 24-gauge stainless steel.

The patch is of sufficient size (5½ by 3½ inches) to cover all normal ruptures in 1½-inch fire hose (fig. 1). The locking device is very simple; the ends of the patch are folded over so that they snap together and lock securely in position when the patch is wrapped around the hose (fig. 2). This makes a smooth band of steel with no projections to catch while the hose is dragged across the ground.

To use the patch: (1) *Cut pressure.* This can be done by using a Siamese or by kinking the hose. Two men should work together, one cutting off the pressure and the other installing the patch. It is also possible for one man to install patches quickly and easily by using a "hose strangler" to shut off the water flow. (2) *Squeeze hose together* and crease lengthwise to reduce its diameter. This is not absolutely necessary but reducing the diameter makes it easier to close the patch. (3) *Slip patch over hose and lock in position* with the locking device on the opposite side of hose from the hole.

In 1959 the Department of Lands and Forests arranged for the manufacture of 3,000 stainless steel hose patches which were distributed throughout the twenty-two districts in the Province. In 1960 and 1961 additional patches were manufactured and distributed. These have been used with considerable success during the past three fire seasons. They are now considered essential and are carried as standard equipment in every fire pump toolbox. It is recommended that at least ten patches be carried in each toolbox to take care of all emergencies.

These patches have been used on lined and unlined linen 1½-inch hose with equal success, stopping the leak completely on holes up to 2 inches in length. The original tests were carried out using a Wajax Mark I pump running at ¾ speed with two

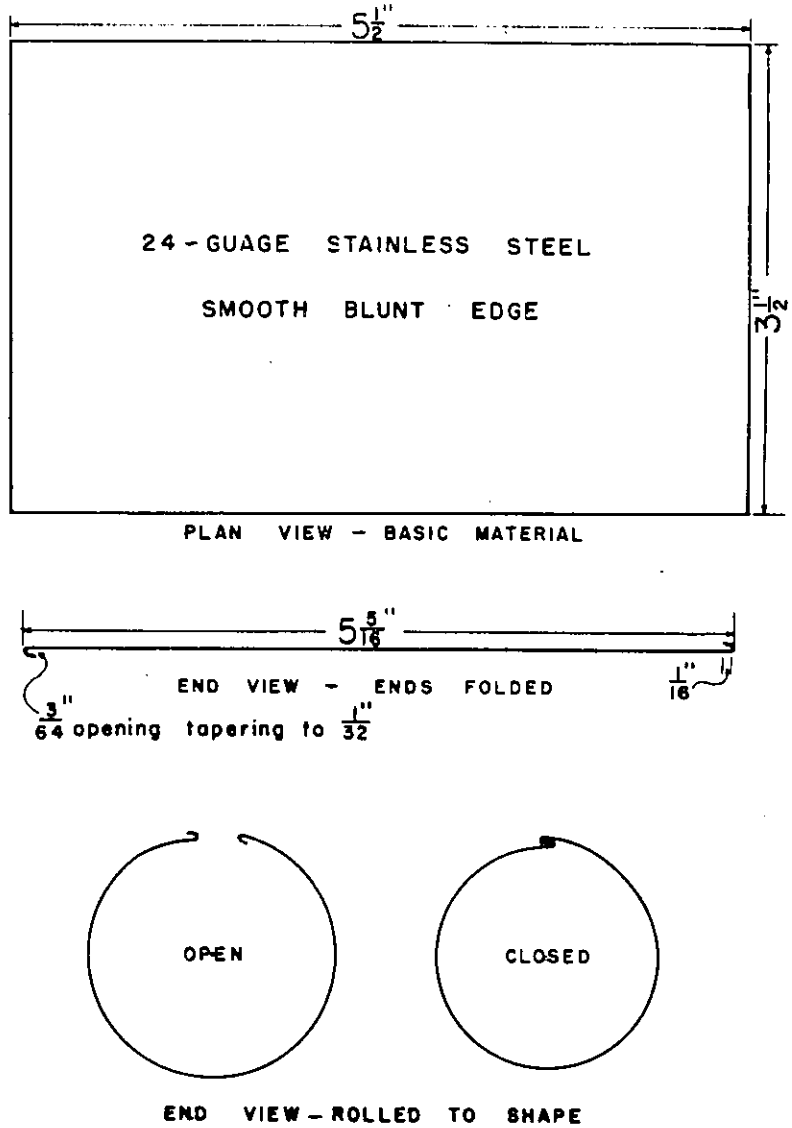

FIGURE 1.—Stainless steel hose patch.

lengths of hose to the nozzle, but in actual field conditions the patches have been used successfully with all makes of pumps, under all operating conditions.

Advantages of this patch are (1) simplicity of design, (2) light weight and small storage space required, (3) no special tools needed, (4) patch remains securely on hose with the pressure on or off and when hose is pulled over ground, (5) patches can be left on the hose to mark holes for repairing when brought in to the repair depot, (6) low cost, approximately $35 per hundred.

FIGURE 2.—Hose patch in open and closed position and installed on hose.

FIRE HOSE ROLLING MACHINE

WILLIAM C. FISCHER, *Forester*, and JAMES F. POTTER,
General Supply Clerk, Boise National Forest

A machine for rolling fire hose developed by James F. Potter of the Boise National Forest is designed for 1-, 1½-, and 2½-inch fire hose of 50- to 100-foot lengths. The resulting rolls are tighter, more round, and more easily handled and cargoed than rolls produced by hand rolling.

The machine includes a metal drum with two side disks, one of which is removable. The drum, attached to a shaft, is turned by a hand crank with a gear reduction drive of approximately a 2-1 ratio and is mounted on a metal stand supported by four tubular metal legs. The hose feeds on the drum through a metal trough and pressure rollers mounted on the front of the machine. This feature eliminates the time-consuming task of untwisting the hose prior to rolling (fig. 1).

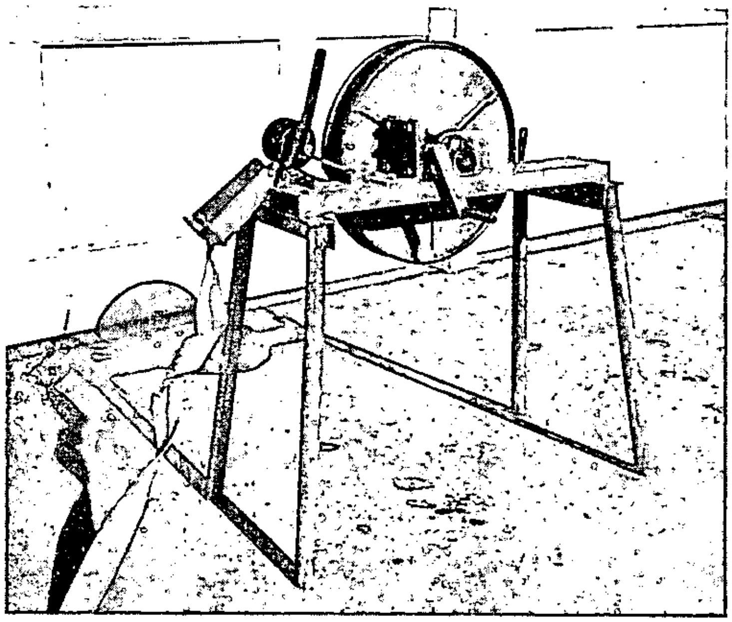

FIGURE 1.—Hose rolling machine showing gear reduction drive, hand crank, trough, and pressure rollers.

The removable disk is secured by latches while machine is in operation. Slots at the end of the drum allow hose to be tied before removal (fig. 2).

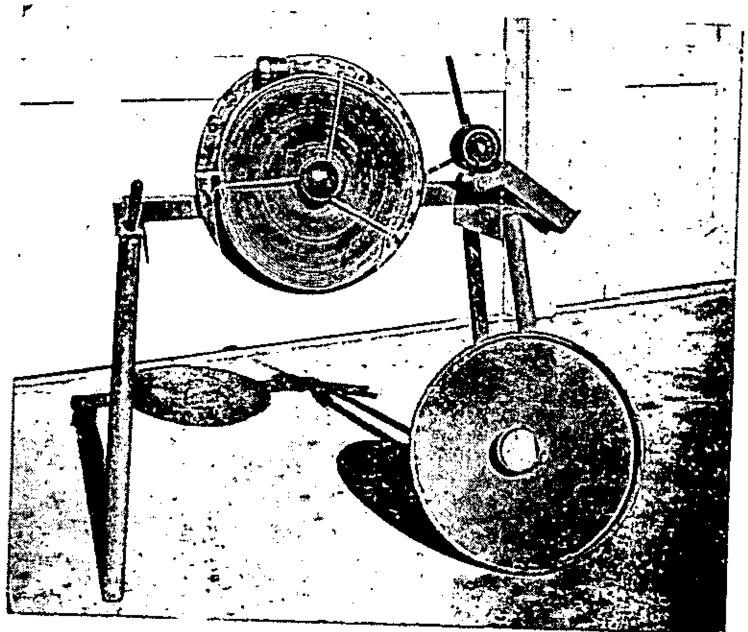

FIGURE 2.—Machine with disk removed and tied roll on drum.

The machine can be operated by one man, although it may be desirable for a second man to assist in laying out the hose. A 100-foot length of 1½-inch hose can be rolled, tied, and removed from the drum in 2 minutes. Compared to handrolling, the machine greatly expedites rolling hose returned from the fireline and makes it more quickly available for reissue on subsequent fires.

Planned modifications will make the machine more portable for shipping or cargoing purposes. Cost of the machine in its present form is approximately $160.

DEVELOPMENT OF AN ORGANIZED SUPPRESSION CREW PROGRAM

Sequoia National Forest

For many years it was possible to pick up agricultural workers in Porterville, Calif., for fire suppression work. These men were either citizens or legal aliens who lived permanently in Porterville. Since agricultural work is heaviest in the late fall and early spring, they were available on reasonably short notice for fire suppression work during the summer months. Prior to 1958 the maximum number mobilized at one time was about 75 men. In 1958 this number was increased some. The bad fire year in 1959 caused us to take a more active interest in this source of manpower.

These men, until 1959, had been recruited in mass with no thought toward a working organization, training, or crew stabilization. With the Southwest Indian crew organization as a guide and about 200 available local agricultural workers, mostly of Spanish-American extraction, we set out to improve the efficiency of these crews.

Many of these people do not speak English, or speak it poorly. This has lead to the development of "leaders," or "contractors," in their ranks. These leaders speak English and act as go-betweens, or intermediate agents between the ranchers and the laborers. Study of these people in action led us to two natural organizers.

We sat down with these men and discussed the problem of organization and training. We agreed to pay one man crew boss wages (the crew leader) for each 25 to 28 men, and one man squad boss wages for each 5 to 7 men. Each man in a crew was to receive a complete physical examination and 8 hours of training either on a fire or in planned training sessions. When a crew reached this status, a blue cooperator card was issued each crew member. The so-called organizers, who are really the key to the organization, are paid sector boss wages. They are responsible for qualifying crew leaders and squad bosses, discipline in the crews, welfare, organization, etc.

The crew leaders must all speak English. These men are not qualified Forest Service fire crew bosses, but it is intended that each crew leader will work with the crew boss and relay his directions to the men through the squad bosses. It is also the leader's responsibility to maintain the crew as a unit in fire camp and to direct its activity in the absence of the Forest Service crew boss. Many of these men could be qualified as fire crew bosses. We prefer to have them called *crew leaders* to distinguish them from fire crew bosses. The squad bosses are qualified Forest Service squad bosses for these crews.

Originally this program was developed as a source of followup manpower for fires on the Sequoia Forest. It was organized to the point where we could have 200 men on their way in 2 to 3 hours. In 1959 word got around and crews were requested for off-forest fires. Each time this occurred, interest was created in the surrounding area and additional crews were organized. At the present time we have 22 qualified crews of 26 men each. During the 1961 fire season, these crews were dispatched to 8 National Forests and 3 other protection agencies in California. They were employed on 20 major fires and numerous smaller fires. Man-employments were 6,986 with a total of 29,000 man-days worked.

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Map Azimuth Circles For Base Heliports

During periods of very high or extreme fire conditions on the Six Rivers National Forest helicopters are often contracted for fire standby on the ranger districts. Two to four specially trained men are provided by the district for use as a helitack crew. The helicopter, loaded with tools and equipment and ready for dispatching, stands by at a base heliport near the district headquarters.

Quite often the helicopter pilot is unfamiliar with the terrain in which he is to operate. If a fire call comes in, it may be necessary to brief the pilot with maps and directions before he can be dispatched. Sometimes the fire is located far from the base heliport in difficult, unfamiliar terrain. Valuable time may be lost in searching for the fire.

On the Mad River District we have speeded up helitack dispatching by using an azimuth circle placed on the dispatcher's map directly over our base heliport, exactly as is done for lookouts on the map. This azimuth circle should be offset east or west depending on the magnetic declination of the area involved. This is necessary, of course, because the helicopter is flown by magnetic bearing.

A retractable string reel allows the dispatcher to reel out the string directly over the bearing that the pilot should fly to the fire. The dispatcher may then merely give the pilot a flight bearing and distance from the base heliport to the fire or another helispot on the district. This simple use of the azimuth circle can, in many areas, simplify and speed up the helitack dispatching system.—JOHN D. DELL, *Fire Control Officer, Mad River District, Six Rivers National Forest.*

"FIRE WATER" IN THE SOUTH AND A FIRE "HEAD BREAKER"

R. J. RIEBOLD
Forest Supervisor, Florida National Forests

Eighty some days of fall drought, drying swamps and bays, and the winter-spring fire season coming on are enough to start a southern fire control man thinking about "fire water," not fire water in the usual colloquial sense but water that plays a part in fire control.

Fires in the dry swamps are something to think about. The dry swamps are not plowable. The tractor-plows upon which all southern fire control men depend are useless once a fire gets off the pine land into the dry swamps. The obsolete 4-wheel-drive tankers most fire control organizations still have are almost as useless. Sometimes they can get to the edge of a swamp and sometimes their hundred feet of hose will reach the deep burning fire but usually with only a hundred gallons of water. Fire crews sometimes putter for days on dry swamp fires and sometimes a dry swamp fire breaks out days later and makes a new run across the pine land. Yet in the Coastal Plain there is an ocean of water within 30 feet of almost any fire. To get it, all you need is a hole in the ground and a pump.

When fire suppression wells were developed in Michigan in the 1930's they were discussed with interest in the South but actually met with no favor. Probably fire control men then had all they could do to deal with the thousands of fires on the pine lands. The dry years in the 1950's revived interest in suppression wells. Tests were made in South Carolina which were reported in Fire Control Notes by Devet and Fendley.[1] According to them the commercial well drillers are the best possible help on suppression wells. They can put down wells rapidly and cheaply. All that is needed is a list of well drillers in the surrounding counties and agreements as to availability and price.

Probably most fire control units have a few thousand feet of never used forestry hose and one or more gear pumps. The gear pumps are not for suppression wells. Shallow well water almost always contains so much suspended grit as to wear out a gear pump in a short time. There are rubber blade impeller pumps that will handle gritty water, and these can be purchased. If forestry hose could be concentrated in area depots, it could be airlifted to places where it is needed in quantities sufficient to do the job. Pumps could also be stocked in depots along with all accessories. With pumps putting out 50 gallons per minute from one or more

[1]Devet, D. D., and Fendley, L. T. Underground sources of water for fire suppression. U.S. Forest Serv. Fire Control Notes 20(1):11-14, illus. 1959.

suppression wells, fires in dry swamps can simply be watered out. Nobody needs to use suppression wells on every fire; everybody could use them on dry swamp fires.

Drought can usher in severe surface fires even on pine lands. The usual practice of simply plowing around a fire is not quite adequate because of the frequent spotting over the plow line. Ever since World War II most fire control organizations have been without the crews of men needed to fire and hold lines in support of tractor-plows. Even when work crews are available they do not arrive at fires as soon as the plows do. This has led to practices designed to hold line without crews, such as double plowing, "loop plowing," and "doubling back" to catch breakovers. Even when there are 4-wheel-drive tank trucks they cannot follow the plows in many places. Consequently, fires are not as well fought as they could be.

The means for supporting the tractor-plow without a crew of men was developed about 1950 in the light tractor-tanker. Several kinds have been described in Fire Control Notes and probably all would work well. One was briefly described by the writer incidental to a discussion of fire tactics in 1959.[2] Even though some units have been used since 1950, for some reason tractor-tankers have not been widely adopted. One man with 100 gallons of water under 150 pounds pressure on a light tractor can give adequate line holding support to a tractor-plow wherever the plow goes.

Prolonged drought makes even ordinary surface fires burn harder and faster than usual, so much so that it is often dangerous for one or even two tractor-plow teams to cross in front of a fire. The head of a fire has a tendency to form a point which sometimes becomes a column of fire. Even parallel backfiring and perpendicular backfiring are difficult and dangerous ways of stopping such a head. This calls for direct attack with water if it could be done.

In the early 1930's when fire control began generally in the southern Coastal Plain, the Civilian Conservation Corps used many small tank trucks on direct attack, augmented by large crews with handtools. The wheeled tank trucks did well until the young pines grew too large for them to ride over. For that reason the tank trucks were practically obsolete by World War II. With the availability of 4-wheel-drive trucks after the war, many new tank trucks were obtained. Even with 4-wheel drive, there are many places tank trucks cannot get to and most of them carry not more than 200 gallons of water. Obviously the tank truck is not suited for direct attack on the head of a difficult fire.

It is well known that, if a break can be made in the center of the head of a fire, the remaining two parts of the head drop in intensity and can be handled. It is also well known that the area inside a Coastal Plain fire is relatively cool and safe. At a guess, the area of active burning (from ignition to completion

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[2]Riebold, R. J. Tractor-plow tactics. U.S. Forest Serv. Fire Control Notes 20 (3): 69-76. 1959.

of combustion) on the head of a fire is probably not over 2 chains wide. Therefore, if a tanker could approach the head of a fire from the rear, through the burned area, and extinguish a strip about 2 chains wide for a distance of about 5 chains it would probably break the head of the fire. Five chains probably allows enough for the forward spread of the fire during the few minutes of the attack.

"Head breaker" is the name I would give to a proposed tracked assault tanker to be used for breaking the heads of Coastal Plain fires by direct attack from the rear. The "head breaker" would consist of a 1,000-gallon tank (120 cu. ft.), 8 nozzles, a suitable pump, and an operator's seat mounted on a crawler track and frame. A tracked logging sulky or the tracks and frame of a junked tractor could be used. The front, sides, and bottom would be armored for protection from trees, stumps, and brush. The front bumper should be strong enough to push down trees with the same ability as a D7 or equal tractor. The rear would be provided with a conventional hitch plus pushing bumpers.

To apply the water effectively, the tanker's 8 nozzles should be arranged in pairs. Each pair should consist of a jet and a spray or fog nozzle. One pair should aim forward; and a pair to each side at about 45 degrees. The fourth pair (both spray) should aim downward to protect the tanker itself as it moves forward. The discharge rate would be about 6-10 gallons per minute per nozzle, meaning that the pump should be capable of discharging up to 100 gallons per minute with pressure enough for a large reach for the jets, or fog if fog is found useful. The nozzles would be elevated to obtain maximum reach. The pump can be selected to obtain suitable operating pressures and power.

Any available heavy tractor would be used to pull the assault tanker from the unloading point into the fire and up to the head. At that point the tractor would turn itself and the tanker around and push the tanker into the head of the fire by backing up. With the pump running and all 8 nozzles discharging stream and spray the tanker would simply quench a hole in the head of the fire. If a breakthrough is made, the "head breaker" should widen it by attacking one side of the breakthrough until its water is expended. An advantage of this tanker is that it does not tie up a costly large tractor. Any working tractor, your own or a contractor's, can pull the tanker to the head of the fire and push it into the head during the attack.

Strategically, the "head breaker" would not be considered part of the initial attack force. It would be stationed as reserve at a fire equipment depot or work center. During the worst of the fire season it should be mounted on a lowboy, in readiness. When the boss of the initial attack force determined that the rate of forward spread at the head of the fire was too great for successful angle attack with tractor-plows or if the fire showed signs of high intensity behavior, he should request the assault tanker as part of the reinforcements and a D6 or D7 tractor to handle it. Moving the assault tanker and tractor would require two lowboys and truck tractors. Additional reinforcement should put at least 4 plow-tanker teams on the fire.

Tactically, the first two plow-tanker teams, if they are not able to make a two-plow attack on the head, should contain and extinguish both flanks up to the anchor points and keep up with the forward movement of the head, one on each side. The two plow-tanker teams arriving as reinforcements should accompany the "head breaker" into the head of the fire from the rear. If a breakthrough is achieved, the two plow teams inside the fire should exploit it by plowing through the break, turning right and left to form a double encirclement with the two plows at the anchor points, which should attack at the same time. Exploitation of a breakthrough must be rapid because the two parts of the head would burn together again in a short time.

With the wind at their backs and the head of the fire moving away from them, the men in the "head breaker" attack group are safer than those in front of a fire on an ordinary attack. There might be some heat but little possibility of exposure to flame. Certainly they would have an adequate escape route. With two men on "head breaker," two men on tractor-plows, and two men on tractor support tankers, there would be only two men, the backfire men, on the ground. They could and should travel to the scene in a 4-wheel-drive vehicle with the attack group boss. With the tractor and tanker equipped with brush guards, no other special safety provisions seem necessary. The use of protective clothing has been considered, but thought unnecessary.

To summarize, here is a proposal to develop a 1000-gallon tanker to break the head of a fire by direct attack from the rear. It is to be on tracks, to be hauled into position by any heavy tractor, to be pushed into the fire behind the discharge of 50 to 100 gallons of water per minute in jets and spray for an attack period of 10 to 20 minutes. The breakthrough should be exploited by plow-tanker teams. With the addition of a mounted swiveled nozzle and the addition of a length of hose in a rack, the tracked tanker could be employed in many other situations for attack and mopup.

In summary, suppression wells with centralized depots of pumps and hose are the tools for dry swamp fires. The light tractor-tanker is the natural teammate for the support of the tractor-plow. The tracked assault tanker is perhaps the next instrument for direct attack and for mopping up.

INFORMATION FOR CONTRIBUTORS

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

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

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

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

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

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


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