VOL. 20 JANUARY 1959 No. 1

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 20 **Number 1**

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. Use of funds for printing this publication approved by the Director of the Bureau of the Budget (October 17, 1958).

Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., 20 cents a copy, or by subscription at the rate of 75 cents per year, domestic, or $1.00, foreign. Postage stamps will not be accepted in payment.

Forest Service, Washington, D. C.

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON: 1959

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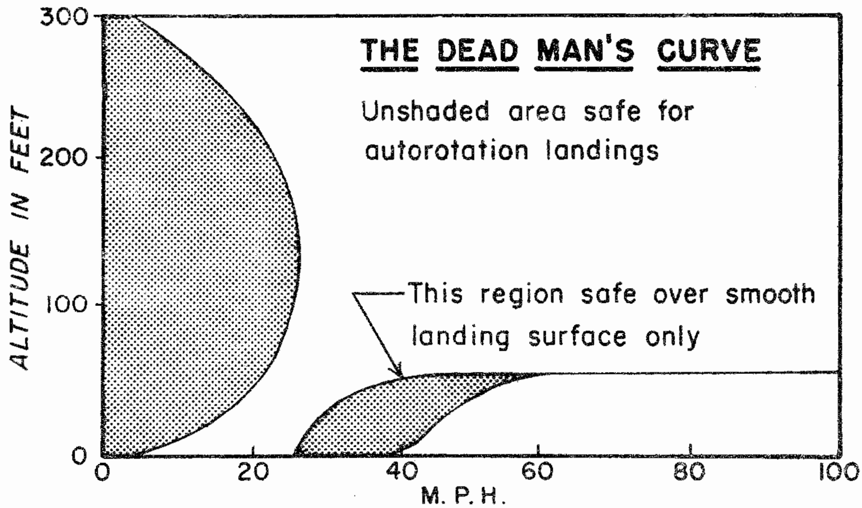
THE HELICOPTER AND THE DEAD MAN'S CURVE

JAMES L. MURPHY
Research Forester, California Forest and Range Experiment Station[1]

"Straight up! That's how a helicopter takes off. Just get him a hole in that timber big enough to clear his rotor blades—that's all he needs."

Man—you are so wrong. If you're asking your pilot to fly in and out of that kind of helispot, you'd better read on. Why? Because you're asking him to flirt with the DEAD MAN'S CURVE.



From Bell Helicopter Flight Manual for Bell Model 47 G2

Let's suppose that a helicopter is operating at low elevations and *does* have the power to lift straight out of a hole in the timber. What happens if the engine should fail? "Well," you say, "that's why a helicopter's so safe. The pilot just autorotates to the ground—that is, those overhead rotor blades act like a wing and he just glides on in."

Now, wait a minute. Let's see what a helicopter manufacturer has to say about it. Take a look at the graph.

What does the graph say? Here are the most important points:

1. The helicopter must lift vertically at least 300 feet before the pilot can safely autorotate. If his engine fails before reaching 300 feet, the ship will drop like a rock.

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[1]Maintained at Berkeley, Calif., by the Forest Service, U. S. Department of Agriculture, in cooperation with the University of California.

2. If the helicopter is flying at an altitude of *less* than 200 feet and the engine fails, the ship must have a forward speed of *at least* 28 miles per hour to autorotate safely to the ground—or again it drops like a rock.

So when the pilot asks you to get him a helispot with a drop-off into the prevailing wind, or a hole in the timber at least 300 feet square, do it. It's the only way to keep our helicopters out of the DEAD MAN'S CURVE.

☆ ☆ ☆

Mobile Bridge For Crossing Canals

The problem of crossing canals with heavy equipment, particularly tractors and fireline plows, is general in eastern North Carolina. In many areas, standing timber for the construction of emergency bridges is not available, and it is often necessary to walk the equipment long distances to cross canals. The ever increasing number of canals has made the dependence upon permanent access bridges impracticable. The need for a mobile bridge for this purpose has been recognized for several years.

The North Carolina woodlands personnel of the West Virginia Pulp & Paper Company have developed a mobile, heavy duty, steel bridge, capable of spanning the largest canals in the area and of supporting the heaviest tractor and plow equipment currently in use. This bridge is towed as a trailer behind a conventional 2-ton truck. Large, balloon-tired dual wheels support the bridge on the highway and serve to position it in the canal. When the bridge arrives at the canal bank, it is detached from the truck and a crawler tractor is coupled to a hitch mounted on the rear of the bridge. The tractor positions the bridge, and by lowering the wheels into the canal, seats it on the two opposing banks. Hinged ramps are provided at the front of the bridge to prevent cave-in of the bank. The bridge is removed by simply pulling it back to the roadbed. The entire process takes less than 20 minutes.

A special hitch, also developed by one of the company supervisors, allows use of the tractor winch, rather than direct drawbar attachment, to position the bridge. This adds flexibility to the operation and saves considerable time.

This bridge was developed from bridge spans designed by the United States Army Engineers. Smaller bridges of the same general design would have more widespread application in other parts of the Coastal Plain. Assistance through the Operational Development Project would be available to any agency interested in developing a smaller or lighter mobile bridge of this type.—*Division of Forestry, North Carolina Department of Conservation and Development.*

SLIPON TANKER-FLAMETHROWER

A. B. EVERTS
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There are many management jobs where an economical, *really hot* flamethrower can be used to good advantage. Liquid gas, either propane or butane, produces a hot flame, but it does not have the body to consume wet or heavy fuels. Once the torch is removed the fire goes out. The addition of diesel oil provides the body necessary to sustain heat. Excess oil can be applied in such a way as to make otherwise difficult fuels ignite and continue to burn after the torch is removed.

Flamethrowers using diesel oil and butane or propane have been described in Fire Control Notes in the past. The flame produced by the torch described in this article is much the same as those previously reported. What is new is the method of producing it.

FIGURE 1.—Slipon tanker-flamethrower. Gage pressure on the vaporizing cylinder registered 40 pounds at about 30° F.

Previously reported flamethrowers were of two types. (1) One used a battery of small butane tanks hooked together by copper tubes. The diesel oil was contained in a pressure tank which was pressurized by an air compressor. (2) The other flamethrower used propane pressure to expel the diesel oil. It required the transfer of propane from commercial containers to the propane tank on the flamethrower unit. There are hazards in connection with this transfer process.

Butane has a higher heat value than propane. One gallon of liquid butane will give off 103,500 B.T.U.'s at 60° F. The figure for propane is 91,690 B.T.U.'s. Gage pressure in pounds for the two gases is as follows:

	Propane	*Butane*
60° F.	92	12
100° F.	172	38

From the above, it is obvious that butane is essentially a warm-weather gas. It can be used in flamethrowers for backfiring or burning out in normal summer weather. However, for flamethrowers designed for use in freezing or below freezing weather, such as the winter burning of slash, propane is required.

The parts of the new unit are as follows (fig. 1):

(*A*) A 110-gallon steel tank which has been hot-dipped galvanized.

(*B*) Standard 91-pound commercial propane tank.

FIGURE 2.—The torch can be regulated as needed to obtain sufficient heat to ignite the piles.

FIGURE 3.—Stripping a juniper tree with the flamethrower. This photograph was taken in April. Humidity about 80 percent.

(*C*) Vaporizing cylinder made of 6-inch steel pipe, one-fourth inch thick. This cylinder serves two purposes:

(1) It permits carrying the propane tank on its side. Normally these tanks are used in an upright position, with liquid in the bottom and gas in the top of the tank. As the gas is withdrawn, the liquid is converted to gas. When the tank is placed on its side, liquid is withdrawn, at least until the tank is half empty, making it necessary to convert the liquid back to gas. This is done by means of the vaporizing cylinder C. The liquid is withdrawn from tank B and enters the bottom of the vaporizing cylinder. The gas is withdrawn from the top of the cylinder.

(2) The freezing of liquid gases is in an inverse relation to the surface area of the liquid. Since both the commercial cylinder and the vaporizing cylinder lie on their sides, the surface area of the liquid is increased. No freezing occurred.

(*D*) Tool box.

The pump used to pump the diesel oil is the little ECO, 8-10 g.p.m. Top diesel oil requirement at full torch blast is about 2 g.p.m.; however, if the unit is to be used as a tank truck, a pump of at least 8-10 g.p.m. capacity is required. Neoprene rotors tend to swell when used to pump diesel oil. Flamethrower pumps should use the carbon rotors. All hose and hook-up lines are oil resistant.

When the flamethrower is converted to a tank truck, the carrier rack for the propane tank and vaporizing cylinder is removed and the water hose replaces the dual oil and gas hose.

The torch is 6 feet long with twin-control valves so that the propane and diesel oil can be regulated as desired. In use, a 6- to 8-inch gas flame is carried as a pilot light. The head of the torch is inserted into the piled slash, and the oil is turned on. In slash which is difficult to ignite, the torch can be turned on full blast (fig. 2).

On piled roadside slash, one barrel of diesel oil and one-half tank of propane appear to be sufficient for a day's operation when the piles are somewhat difficult to start; for example, piles covered with 6 inches of snow.

In addition to using the unit for slash disposal, the flamethrower has been used for stripping juniper trees encroaching on the range (fig. 3) and for winter burning sage and rabbitbrush. The area was then seeded with crested wheatgrass.

Further experimentation is planned this winter. The torch will be tried out as a means of thinning "dog-haired" ponderosa pine. It is believed that the flame is selective enough to strip the trees of needles. This will not only dispose of the hazard, but may prove to be cheaper than cutting the stems.

Further sagebrush burning is also planned. This will be done with the aid of a mist sprayer that can create wind velocities up to a hundred miles an hour.

TOTALIZING WIND COUNTER FOR CONTACTING-TYPE ANEMOMETERS

Division of Forest Fire Research, Intermountain Forest and Range Experiment Station

About 95 percent of the wind observations taken at fire-weather stations are recorded manually. The 1/60 mile contacting-type anemometers are used with a buzzer or a flashing light and a watch to count the number of contacts (fig. 1). Generally, this is done for a 2-minute interval three times a day, the results are averaged, and the afternoon wind is calculated. The other 5 percent of the wind observations are taken on Weather Bureau dial-type anemometers which mechanically sum the passage of wind during the afternoon period. This equipment is expensive, however, and could not be used at all fire-weather stations.

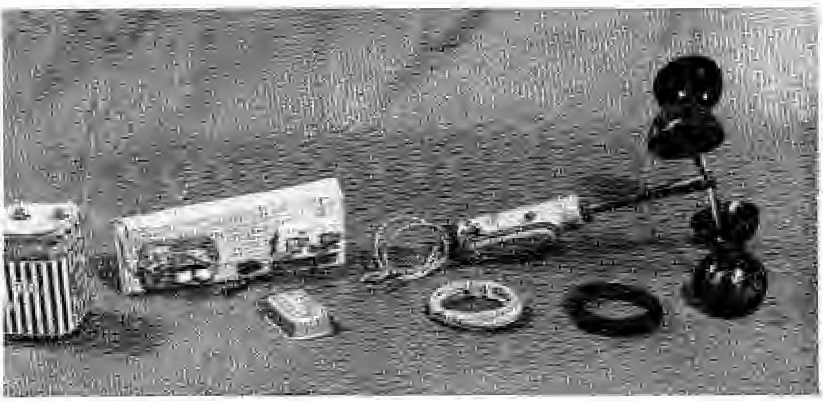

FIGURE 1.—Buzzer-type anemometer.

An equipment development project to modernize the wind measuring system at fire-weather stations was established. Incorporated in its objective was the desire to make the new system as automatic as possible, thus reducing the risk of human error. Also, the old buzzer or flashing light method is awkward to use and time consuming, which increases the chance of getting pseudo wind observations.

To meet all the objectives, an electrical system seemed the most practical. Mechanical methods must be used at the exact location of the anemometer, while an electrical circuit can be a remote operation.

Development History

The market did not have available suitable electric wind counters that were economical and could be used with the 1/60 mile contacting-type anemometers at fire-weather stations. The counting circuit needed to include certain features to be acceptable for lookout operations. The unit had to be operated by a dry cell, and it had to incorporate a means of saving current discharge when the anemometer was becalmed and the contact closed. Furthermore, the counter had to respond to wind speeds of at least 60 m. p. h., and it could not record the chatter found in all pressure-contact anemometers. The unit needed to be durable enough to withstand the climatic conditions at lookouts and fire-weather stations. Lastly, the components of the counter had to be readily available on the open market and inexpensive enough to make the replacement of the buzzer systems feasible.

Advice from electronic labs and private research firms was sought, but none of the suggestions proved acceptable. A cooperator proposed a counter that seemed usable. The circuit diagram and related information was passed on to the Forest Service Radio Laboratory at Beltsville, Md. They investigated the circuit and found it satisfactory, and they found several local manufacturers who could produce the counter for approximately $15. With this confirmation and the price low enough, the next step was to get the counters field tested.

During the summer of 1956, the California Forest and Range Experiment Station conducted a wind survey. The circuit diagram was sent to them, and they had 12 units constructed. The counters worked satisfactorily as long as an input voltage of 4.5 to 6 volts was maintained. Later the station built several units and placed them at fire-weather stations.

Several prototypes were built and tested for chatter reaction and endurance (fig. 2). The housing was a simple aluminum box 5 inches long, 3 inches wide, and 2⅝ inches deep. One unit was used by Montana State University's Wildlife Division on an elk survey, and the counter worked perfectly all winter, even at tem-

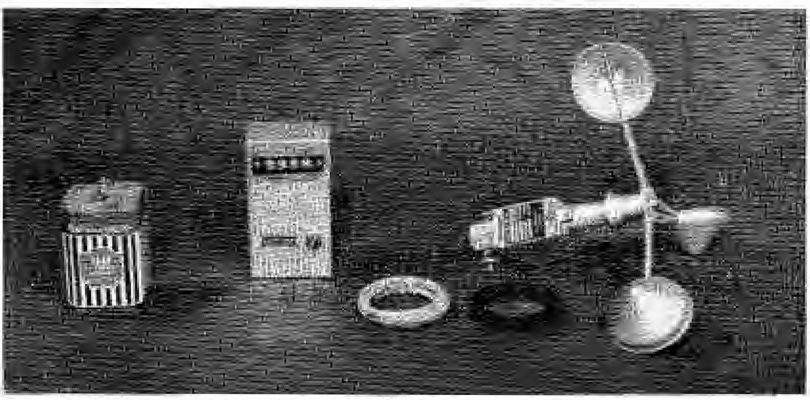

FIGURE 2.—Early model wind counter.

peratures as low as —38° F. During the summer, the prototypes functioned properly at maximum temperatures of about 95° F. Two counters were tested at the Priest River Experimental Forest against a single register recorder using the same anemometer. They were found to check perfectly. Laboratory tests proved the electrical circuit eliminated the danger of chatter or multiple counts. A variable resistor was used to compensate for line loss; however, later findings proved a booster battery worked better when the operating voltage dropped below 4½ volts.

During the summer of 1957, 12 units were built and tested. There were no failures. Twenty-two more were built and included in the instrumentation of the portable fire-weather station (fig. 3).

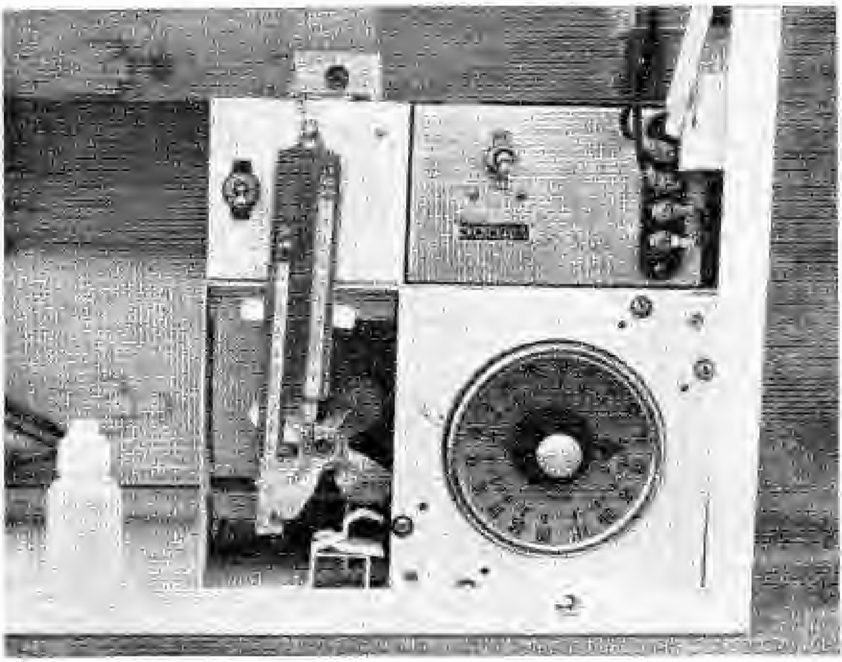

FIGURE 3.—Totalizing wind counter in upper right of portable fire-weather station.

Method of Observation

The totalizing wind counter does meet all the objectives stated earlier. The unit makes use of a simple electrical circuit which is dependable and inexpensive (estimated total cost about $15). Use of an automatic counter eliminates some of the human error involved in observations. These steps are followed when the wind counter is read:

1. Record the count and the time.
2. Turn the toggle switch to the *ON* position.

3. Let the counter run the desired length of time. The longer it runs, the more accurate will be the calculated afternoon wind.
4. Turn the toggle switch to the *OFF* position.
5. Record the count and the time.
6. Calculate the wind speed by dividing the elapsed count by the elapsed time in minutes. This will give the average wind velocity in miles per hour.

The total wind time used by the buzzer system is only 6 minutes. The totalizing wind counter can be run for several hours while the observer does his other field duties. A simple form would make the recording of wind velocity an easy matter with little chance of error.

Recommendation

We recommend that the totalizing wind counter be used at fire-weather stations instead of the buzzer or flashing light system.

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Intercommunications Equipment—An Aid in Fire Control

One solution to interstation communications problems is a modern, inexpensive two-way "intercomm" outfit. These systems of two or more units cost from about $12 on up and are simple to install and operate.

Where radio and telephone communications are frequently tied up with fire traffic, the intercomm units make ideal local substitutes. Units between offices, dispatchers, and work areas permit fire control personnel to be readily informed while going about their duties, thus freeing them to some extent to do other work during the critical fire periods. At other times, the units may be used for administrative purposes, increasing the efficiency of the organization the year round.—FRANKLIN O. CARROLL, *District Ranger, Apache National Forest.*

UNDERGROUND SOURCES OF WATER FOR FIRE SUPPRESSION

D. D. DEVET, *Assistant Supervisor,* and L. T. FENDLEY, *Assistant Engineer, South Carolina National Forests*

The Francis Marion National Forest, located on the Coastal Plain of South Carolina, has many bays and swamps. During drought periods, fires in the peatlike fuels of the forest require large volumes of water to control, mopup, and extinguish them. In the past, large sums had been spent hauling water to these fires. Yet, an abundant supply of water lies underneath the ground in the immediate vicinity of any fire.

To study the possibility of utilizing the underground water for fire suppression, the geology of the forest and local wells were studied and mapped. Tests were conducted by the Forest Service and by a commercial well-drilling outfit under contract.

FIGURE 1.—A 4-inch casing ready to be lowered by hydraulic method. The derrick is positioned and the well casing and washing nozzle are in place ready to start pumping operation.

The Forest Service used its own hydraulic equipment and employed methods similar to those developed in the Lake States for establishing shallow wells (less than 30 feet deep). Six test holes, from 12 to 26 feet deep, were made on the Francis Marion National Forest.

A trained crew can set up the hydraulic rig in 12 to 15 minutes (fig. 1). When the pump is started, the casing is rotated by two men with large pipe wrenches. This reduces soil friction on the outside of the casing and allows the casing to help cut its way into the ground. A fourth man, not shown in figure 1, raises and lowers the cutting bit and washing nozzle inside the casing while the casing is being lowered.

While the well casing is in the ground, the screen and suction pipe are lowered inside the casing until the tip of the screen reaches the bottom of the well. The casing is then pulled leaving the screen and suction pipe in the well (fig. 2). If water-bearing stratum has been penetrated, water will flow into the screen and rise in the suction pipe. The elevation to which the water will rise is governed by the hydrostatic head on the gravitational water in the water-bearing stratum, and the yield of the well is governed by the perviousness and depth of the water-bearing stratum.

Successful penetration of the deep layer of heavy clay underlying the sands required considerable time and large quantities of water. The equipment could not reach the hard, porous, and permeable marls and limestones—the water-bearing stratum. The yield of any single well was less than 10 gallons per minute and consisted primarily of surface seepage.

FIGURE 2.—Suction pipe and well screen placed in well ready for pumping.

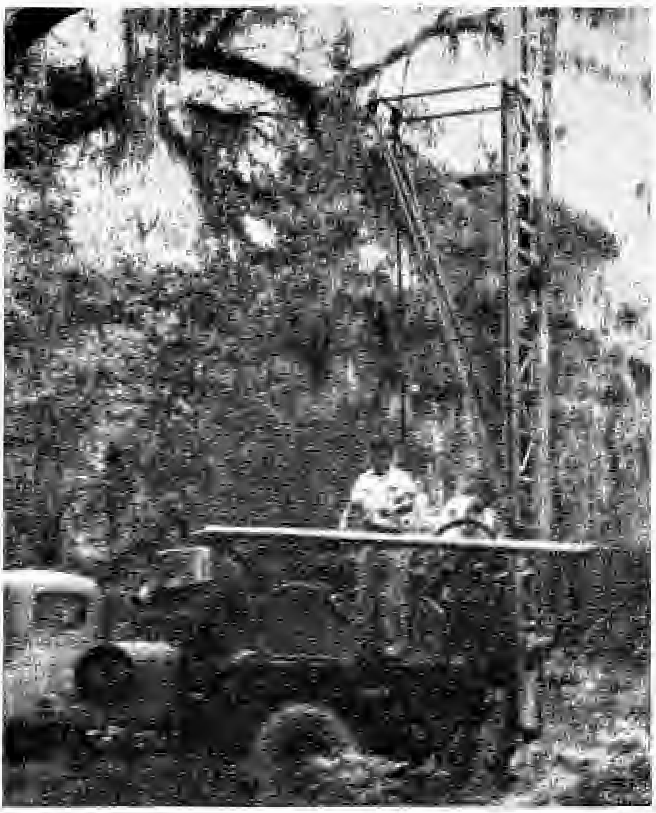

FIGURE 3.—Commercial drilling equipment in place.

A log of all wells drilled revealed that no formation above the hard rock would yield a sufficient flow of water for fire-control purposes. The average elevation of hard-rock formations on the Francis Marion (except for the extreme northwest corner) is about 40 feet below ground level. The average depth of water for fire-suppression use, 30 g.p.m. or more, is less than 10 feet in the hard rock.

A good well-drilling machine can drill through sand and clay formations and install 4-inch casing at a rate of approximately 35 feet per hour. The same machine can drill through hard rock at the rate of about 3 feet per hour. Once the stratum is reached, the hydrostatic pressure is sufficient to raise the water to a level within operating range of the suction pump. (The pump used for this experiment was a rotary type, positive displacement, rubber-gear pump, capacity—50 g.p.m. at free flow; approximately 30 g.p.m. at 200 p.s.i.).

The well-drilling equipment of the contract outfit gave better results in the tests. A mobile drilling machine was driven from Columbia, S. C., to the Francis Marion National Forest (a distance of 130 miles) in 2 hours and 50 minutes. It was set up ready for drilling, with cable tool, in 13 minutes (fig. 3). Excluding time spent for testing flow and soil stratum samples, this rig drilled a 4-inch well 39 feet deep in 2 hours. At this depth, a yield of 55 g.p.m. was measured without causing any draw-down in water level. One hour and 48 minutes were required to drill from a depth of 39 feet to a depth of 44.5 feet through hard rock. At this depth, a yield of 82.5 g.p.m. was measured without causing any draw-down in water level.

In addition to its effectiveness, commercial equipment could be moved from Columbia, S. C., to practically any well site on the Francis Marion National Forest within 3 hours, and set up and ready for operation approximately 15 minutes after reaching the well site. The average cost of the two wells drilled with contracted equipment was $240.

The results of the tests showed that the use of fast-drilling contract outfits for establishing wells needed for fire control has definite possibilities on the Francis Marion National Forest.

This preliminary work is part of a long-range plan to control all fires through an in-place system of wells and devices to suppress fires by water alone.

CANTEEN TEMPERATURES VARY WITH COVERING MATERIALS AND EXPOSURE

Arcadia Equipment Development Center, U. S. Forest Service

Opinion varies on the effectiveness of the present canteen covering. The attention a fireman gives his water container probably influences its temperature more than the type of either the covering or the insulation. When a canteen is checked out of fire camp in the morning and is carried with a dry cover exposed to the sun all day, the present type of cover and insulation, as such, serves little purpose. In fact looking at the problem from a cost standpoint alone, around 45 cents could be saved on each canteen by eliminating the covering. To improve Forest Service specifications for canteens, we have studied the effect of various covers on water temperature.

The 1-gallon canteen commonly used by the U. S. Forest Service is insulated by an inner blanket and a khaki duck covering. The general description of the current specification [1] requires "insulation to the extent practical so that... water will remain reasonably cool." The regulation cover also offers some advantages as a pad; however, this was not considered as a part of the study.

Three basic methods were used in studies to alter canteen temperatures: (1) insulation; (2) evaporation; and (3) reflection. Various combinations of the above means were also employed and observed.

Tests were conducted with 19 standard canteens, some having altered covers and insulation (table 1). Each canteen was classed into one of four groups: Sun (exposed to direct rays of sun broadside), and canteen either wet or dry; and shade (maintained in full shade entire test period), with canteen either wet or dry.

All canteens were rinsed and filled with water at 60°.[2] A 50-gallon can provided a source of water for the "wet" canteen groups, which were wet hourly. This water was allowed to warm by exposure to air temperature from 59° at the start to 89° by 1330. By 1630 hours the air temperature had lowered to 87°. The water temperature of each canteen was observed at 1-hour intervals beginning at 1030 and concluding at 1630 Pacific Standard Time, July 24, 1956. Air temperatures and relative humidity were also recorded (table 1). Wind direction was variable and ranged from 1 to 5 m. p. h.

For this test it was also agreed that an actual temperature was needed to serve as a breaking point between "cool" and "tepid" water. It was conceded that this value would vary widely with personal opinion but could serve for comparative purposes. After considerable discussion and actual sampling, 76° was selected as a reasonable figure for the purposes of this study.

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[1]Amendment No. 2 to U. S. D. A.—Forest Service—Specification No. 83, amended 3/18/58, on the one-gallon canteen: "The sides . . . shall be covered with a blanket material which has a minimum weight of 16 ounces . . . and recovered with an 8 ounce double filled khaki canvas . . . The material may be secured by a . . . steel retaining band, or by completely covering the body and sewing."

[2]All temperatures expressed in this article are in Fahrenheit.

TABLE 1.—*Temperature of water in individual canteens,*[1] *by exposure, type of covering and evaporative cooling, and time of day, July 24, 1956*

SUN

Hour (Pacific Standard Time)	Air temperature[2]	Relative humidity[2]	Standard canvas and blanket		Bare, dry	Foil and blanket, dry	Foil, perforated, wet	Foil and flock, wet
			Wet	Dry				
	°F.	*Percent*	*°F.*	*°F.*	*°F.*	*°F.*	*°F.*	*°F.*
1030	82	46	60	60	60	60	60	60
1100	82	46	64	61	62	62	62	62
1130	85	43	69	66	68	64	66	64
1200	86	41	72	70	74	68	70	68
1230	87	38	74	75	80	72	74	70
1300	88	38	76	81	82	77	76	72
1330	89	38	78	83	85	79	78	74
1400	88	38	79	87	89	82	81	77
1430	89	38	80	90	91	85	82	78
1500	89	38	81	94	93	87	84	80
1530	88	38	81	96	96	88	84	80
1600	89	38	81	96	96	90	84	81
1630	87	41	81	98	97	90	84	81
Difference from standard canteen at 1630					—1	—8	+3	0

SHADE

Hour (Pacific Standard Time)	Standard canvas and blanket		Bare, dry	Foil and blanket, dry	Canvas only, dry	Plastic sides, dry	Flock only, wet
	Wet	Dry					
	°F.	°F.	°F.	°F.	°F.	°F.	°F.
1030	60	60	60	60	60	60	60
1100	64	63	64	62	64	63	64
1130	65	64	67	64	65	66	66
1200	67	67	69	67	69	68	68
1230	69	70	71	69	72	71	70
1300	71	71	74	71	74	74	71
1330	71	74	75	72	76	75	72
1400	73	76	77	73	78	78	73
1430	73	77	78	74	79	79	73
1500	74	80	79	75	81	80	74
1530	74	80	81	77	82	82	74
1600	74	81	82	78	84	84	74
1630	74	82	82	78	84	84	74
Difference from standard canteen at 1630			0	—4	+2	+2	0

[1]"Tepid" canteen temperatures are those higher than 76° F.

[2]Standard weather observation, applies to both sun and shade exposures.

Canvas and blanket (a standard canteen, blanket lined and covered with canvas, meeting specification No. 83, 3/18/58).—The canteen that was wet hourly and maintained in the shade reached a maximum temperature of 74° at 1500 hours; it never exceeded 76°. The canteen kept dry and in the shade reached the "tepid" state by 1430 hours. The canteen kept dry and in the sun reached the "tepid" category between 1230 and 1300 hours and continued to rise to 98° by the time of the last observation, while the wet canteen in the sun reached a maximum of 81°.

If we then consider the effect on these four canteens as more or less typical and standard, all subsequent tests can be related to it as canteen coverings are removed or altered for the study. These differences are included in table 1.

Bare.—Both the canvas cover and the blanket liner were removed from standard canteens and the bare metal of the containers was exposed to sun or shade.

Foil and blanket.—The canvas cover was removed from these two canteens and replaced with aluminum foil held in place by the customary spun metal rim (fig. 1). No change was made in the blanket underneath. The results were more favorable than those of any other covering.

Foil perforated.—The canvas cover on this canteen was replaced by perforated aluminum foil held over the blanket insulation by a metal rim (fig. 1), and the canteen kept wet.

Foil and flock.—The canvas and blanket on this canteen were replaced by aluminum foil over a flock covering, and the canteen kept wet.

Canvas only.—The blanket insulation was removed in this test and only the standard canvas cover was retained over the metal. The container was kept dry.

Plastic.—The regular side covering was removed and replaced by green plastic sheet material cut to fit out of $\frac{1}{16}$-inch stock. These new sides were held in place by the spun metal band, and the canteen kept dry.

Flock only.—A green flock coating was substituted for the usual blanket and canvas cover, and the canteen kept wet.

Other tests were also run but these were not included in table 1. The canvas was removed from 3 canteens and they were ex-

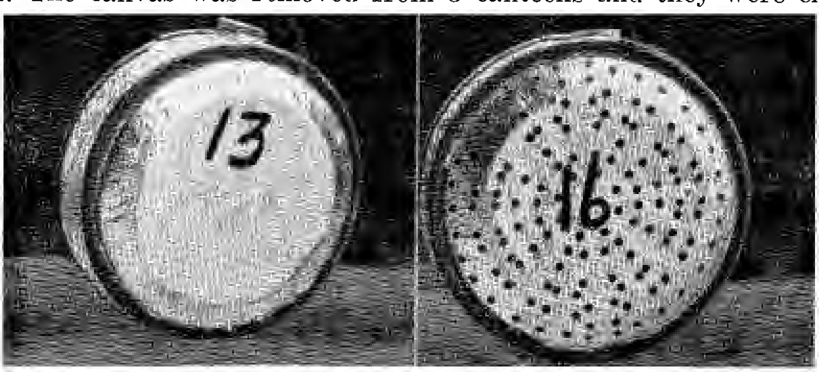

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FIGURE 1.—*Left,* Foil and blanket cover. *Right,* Perforated foil cover.

posed with the blanket insulation only. Their temperatures ran from 1 to 3 degrees higher than those of the standard canteens. One experimental[3] fiberglas canteen which did not meet the construction specifications was also included as part of this study. It not only shattered on the first drop but reached the "tepid" category an hour before the standard dry canteen under shade and was 3 degrees warmer at 1630.

Conclusions

1. Drinking water can be kept at an acceptable temperature in the present standard canteen by the use of shade and evaporative cooling. Water temperatures actually increased for 4 hours to 74° and then leveled off.

2. If both shade and evaporative cooling are impossible, dry storage in the shade is more effective than wet storage in the sun since the water reaches the warm state an hour or so later. After 6 hours one dry exposed canteen approached 100° on a day with moderately high temperatures.

3. The value of evaporative cooling is greatly reduced in humid weather.

4. Bare canteens lacking any covering, influenced water temperatures in a manner similar to standard canteens when left dry and in the sun. The water in bare canteens, however, warmed faster and exceeded 76° generally in about 2 hours.

5. Canteens with dark, heat-absorbing covers reached the highest recordings and one canteen ran as high as 102° (data not included in table 1).

6. Aluminum foil, with its highly reflective characteristics, was used in various ways as a covering material. A "foil over flock" canteen maintained "wet" and in full sunlight had little advantage over the present canteen. A "perforated foil" container ran warmer and contrariwise "foil over dry blanket" ran 4 to 8 degrees cooler. "Canvas only," "plastic," and "flock only" appeared to hold little advantage.

7. Slight to significant advantages were gained by varying the type of insulation and/or cover materials. Some of these changes are minor, by themselves, but it may be possible to combine several modifications into worthwhile results. For example, hand-sewn covers appeared to encourage thorough "wetting" and better evaporation than those with metal bands or rims. Rubber cement, which is sometimes used in fabrication, tends to waterproof the material and reduce evaporation. Even the use the container has been put to seems to influence the porosity of the cover and changes the results slightly.

8. Tests indicate that the care and use of a canteen on a fireline or project influences the water temperature more than any particular kind of cover as may be required by specification.

[3]Temperature is only one part of the canteen specification study under way. Burlap is being used as covers on certain commercial brands. The present metal galvanizing process may cause gastric disorders and its use with acid liquids, fruit juices, or coffee is impractical. Aluminum, stainless steel, plastic, and polyethylene have all been proposed. The use of a synthetic would probably lick the leaky cap "bugaboo."

BATTERY-OPERATED FAN PSYCHROMETER

Division of Forest Fire Research,
Intermountain Forest and Range Experiment Station

One of the three most important weather measurements taken at forest fire-weather stations is relative humidity. This information is obtained from a psychrometer, which consists of a wet- and a dry-bulb thermometer. Moving air past the moistened wicking of the wet-bulb thermometer causes evaporation; this in turn lowers the temperature reading of the thermometer. The difference between the wet-bulb and dry-bulb temperatures indicates the relative humidity, which is read from a table.

Most fire-weather stations measure humidity with either a hand-crank psychrometer or a sling psychrometer. Both types are manually operated. The hand-crank unit creates wind by using a hand-driven fan. The sling psychrometer uses a whirling motion to create the effect of wind. Both devices are satisfactory when used correctly, but they are susceptible to human error and may result in erroneous relative-humidity readings.

Hand-crank fans were designed more than 20 years ago. Since then, each renewal order has required special tooling by a contractor, for none of the components is available on the open market. Many tubes in the two sizes of sling psychrometers are broken by inexperienced field personnel, resulting in unnecessary cost and lost humidity information.

To modernize humidity-measuring instruments became a necessary task. A unit had to be set up, using easily obtainable components, that would (a) give long service at low cost, (b) supply consistent and reliable data by reducing the chance of human error, and (c) increase the ease of handling for the observer. A study of commercially produced psychrometers had shown that they were either too elaborate, too costly, or impracticable for servicewide use. It was then decided that working with the instruments available at the fire-weather stations would be the simplest and least expensive procedure.

The problem was to find a suitable substitute for the hand-crank fan. When using manual psychrometers, inexperienced field personnel often did not create enough wind for a long enough period to depress the wet-bulb temperature to its proper point. In order to have the maximum depression of the wet-bulb thermometer, a minimum air displacement of 12 feet per second must flow past the moist wicking. Any amount of wind less than that is likely not to lower the wet-bulb temperature to its correct value. This, of course, would give an erroneous relative humidity. To avoid this error, an electrical fan aspirator was needed.

In the spring of 1955, several types of small electric motors were bought and tested along with different makes of fan blades. The combination blade and motor, in addition to its ability to displace a minimum of 12 feet per second air movement past the wicking of the wet-bulb thermometer, had to be powered by a 6-volt dry cell, have a low current drain, and have long life under severe field conditions.

During the first tests, electric timers were used to run the motors for 2-minute periods; however, timers were later abandoned as impractical for field purposes. Some motors were rejected because they used more than 1.5 amperes; the dry cell drained too fast. Others were eliminated because they did not operate efficiently in a voltage range of 4 to 6 volts; this stipulation was necessary to ensure proper air flow even when the battery was old and weak.

Further testing proved that the motor bushings had to be metal or nylon; they wore quickly otherwise. Motors with cardboard or fiber bushings were rejected. Several motors functioned well but were not completely encased, thus making them susceptible to weathering. Others had spring-metal brushes, which appeared less desirable than carbon or silver-graphite brush tips.

Several types of fan blades were tested. A 4-bladed fan, clockwise rotating, plain finish, with an overall diameter of 3 inches, proved to be the most suitable. The hub of the fan blade did not fit the motor shaft; however, a special bushing corrected the situation. Other blades that fitted the motor shaft could be purchased, but the one chosen was the most economical.

By the winter of 1955, a motor and fan blade combination was decided upon as a result of the tests. Since the electric aspirator fan was to replace the hand-crank fan on standard psychrometers currently used, a "Fan Psychrometer Conversion Kit" was developed. This kit consisted of an installation template, an electric motor, a fan blade and bushing, an aluminum mounting, a toggle switch, screws, and appropriate wiring. After removing the hand-crank fan from the wood base, field personnel could mount the new unit with the aid of the installation template. A 6-volt dry cell was the power source. In the spring of 1956, the Forest Service warehouse in Spokane, Wash., made 25 conversion kits for Regions 1 and 4. These units were tested that summer; all worked satisfactorily.

A method was described for converting a sling psychrometer into a modified standard USFS fan psychrometer unit. In addition to the kit and psychrometer, only a wood baseboard, a piece of ½-inch strap iron, and a water bottle were needed. The installation template gave the proper relationship of the fan unit, the water bottle, and the psychrometer tubes. After preparing the wood base, the procedure was to mount the sling psychrometer on the metal strap, then screw the psychrometer unit and the fan unit to the wood base. Complete directions were included in the installation kits.

A second order of Fan Psychrometer Conversion Kits was made in the spring of 1957. More than 250 units were field tested that summer. During this time, sling psychrometers or hand-crank psychrometers were converted to battery-operated fan psychrometers; no completely new fan psychrometer units were purchased. The only failure occurred in the cracking of one plastic motor housing.

The battery-operated fan psychrometer has proved successful in field tests for two fire seasons. Laboratory tests showed that the fan blew more than the required amount of air displacement even when the operating voltage dropped to 4 volts. Endurance tests were made with the unit running continuously for 8 hours. Then the motor was tested by running it from an OFF position to maximum speed 1,500 times. The results of the endurance tests proved that the electric fan unit is sturdy and can have long life with proper care. A very small drop of oil on the bearings assures proper maintenance.

The battery-operated fan costs less than the hand-crank fan. All the components, except for the aluminum mounting, are available on the open market. An entire setup, including a modified sling psychrometer, can be assembled for approximately $10. The Fan Psychrometer Conversion Kit costs about $4.50. Successful field use points to the advisability of replacing all hand-crank fans with electric fans, and converting sling psychrometers to battery-operated fan psychrometers.

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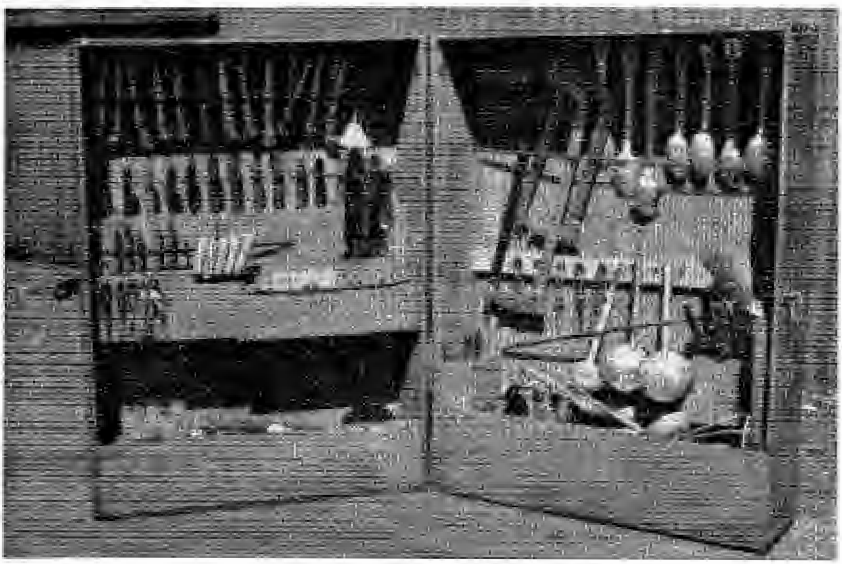
Box for Kitchen Tools Used in 300-Man Fire Camp

This box is made of ½-inch exterior plywood, and uses glue and #7 1¼-inch flatheaded screws on all joints. These joints are covered with metal edgings. The box is 31 inches long, 17 inches wide, and 43 inches high. Cut in the center and hinged in back, it provides two 8½-inch compartments (outside measurements). A 6-inch hasp in front and handles on each side make for easy loading. Hinges, handles, and hasp are put on with flatheaded stove bolts.



When opened on a table, each tool is in sight and easy to reach. Two bottom compartments hold such tools as potato masher, large can opener, and skimmer. Slotted compartments are for butcher knives, paring and vegetable knives, spatulas, ice picks, meat forks, and cleavers. Cup hooks on cleats at top and in center are used to hang pot lifters, soup ladles, cooking and serving spoons, peelers, meat saws, etc. There is room also for salt and pepper shakers and sugar dispensers.

Screen door springs stretched over hanging tools hold them in place while in transit. The exterior should be painted red; the interior given a natural finish and oiled.—David M. Edwards, *C & M Craftsman, San Bernardino National Forest.*

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.

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

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Smokey's Commandment
THOU SHALT NOT DESTROY THY FORESTS
Remember—
Only you can
PREVENT FOREST FIRES!