FIRE CONTROL NOTES

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FIRE CONTROL NOTES

A quarterly periodical devoted to forest fire control

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COVER.—A B-26 air tanker attacks a small fire. Air tankers are an effective and efficient element of the fire control force when used on a planned, selective basis. See related story on page 6.

(NOTE—Use of trade names is for information purposes and does not imply endorsement by the U.S. Department of Agriculture.)

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COMBINATION HELITANKER-AIR TANKER ATTACK ON THE PINE CREEK FIRE

AFM Library

TROY KURTH, *Forest Research Technician*
Pacific Southwest Forest and Range Experiment Station[1]

A combined helitanker-air tanker attack can safely and effectively help control a forest fire if communication is constantly maintained between all aircraft and the ground and if operational procedures are followed. Excellent helicopter control can be maintained if all drop missions are directed by an Air Tanker Boss in a lead plane. These two points were demonstrated during the Pine Creek Fire of Aug. 9-11, 1967, on the Cleveland National Forest, Calif. The primary mission of the air tankers was to reduce fire intensity. Helitankers were assigned to specific targets that threatened to spot across or burn around retardant drops, to make the first attack on spot fires, and to support handline construction crews. An Air Tanker Boss in a T-34 lead plane directed all retardant drops.

AUGUST 9

The fire started in a remote section of the Pine Creek drainage during the hot, dry afternoon of Aug. 9, 1967. Flashing through the extremely dry brush and grass, it soon spread beyond the area where the initial-attack helijumpers could contain it. By dusk the fire had scorched more than 150 acres. And during the night it continued to burn actively. However, handcrews, fighting the rugged terrain as much as the fire, succeeded in confining the fire to the upper two-thirds of the west slope (fig. 1). Also, tractor operators managed to construct a 4-wheel-drive trail to the edge of the fire in the early morning hours.

AUGUST 10

At dawn, the Fire Boss faced a dangerous fire. More than one-half of the fire had only a scratch line around it. Using the three light helicopters at his disposal, the Fire Boss quickly ferried fresh crews into the critical sectors. Three ground tankers were able to reach the edge of the fire, and the helicopters rapidly laid 3,000 feet of hose to extend tanker operations on the fire.

At 0930 a flareup, beyond the reach of tankers, quickly exceeded the capacity of ground crews equipped with handtools. The three helicopters, now converted to helitankers, were able to delay the firespread. As the intensity of the fire increased, two fixed-wing air tankers were dispatched. They succeeded in reducing the rate of spread enough to enable ground crews, supported by helitankers, to control the flareup.

However, by 1030 the situation had become critical. The rapidly rising temperatures and rapidly falling humidities on the east exposure made the flashy brush and grass highly receptive to spot fires and flareups. The Fire Boss realized that low-volume helitanker drops would not be able to contain the flareups and spot fires.

With an Air Tanker Boss in a T-34 lead plane, additional air tankers were ordered.

Air-Attack Organization

The Fire Boss decided to set up an air-attack organization. He knew the hazards created by unorganized fixed-wing and helicopter operations over a fire area. The Air Attack Boss position was established. Then the Air Attack Boss established a pattern. The pattern utilized two frequencies:

1. Air net between all aircraft and the Air Attack Boss.
2. Forest net among the Air Attack Boss, fireline personnel, and the Helicopter Manager.

The Air Attack Boss and the Air Tanker Boss decided to combine all retardant aircraft, deploying helitankers in the same manner as air tankers. They established the following operational procedures:

1. All inbound air tankers would report to the Air Tanker Boss. When he was 3 minutes from the fire, the Air Tanker Boss would inform the Air Attack Boss.
2. Air tankers would maintain a minimum altitude of 1,500 feet over the fire until the Air Tanker Boss led them in on a target assigned by the Air Attack Boss.
3. The normal altitude at which helitankers would fly over the fire to the assigned target areas was 500 feet.
4. An air tanker would not be led in for a drop without the Air Tanker Boss clearing the drop with the Air Attack Boss.
5. The Helicopter Manager would not clear any helitanker for takeoff without first checking with the Air Attack Boss.
6. All operations would immediately cease if, for any raason, both the Air Attack Boss and the Air Tanker Boss did not know the exact position of any aircraft.

[1] Headquarters for the station is at Berkeley, Calif. The author is located at Riverside, Calif.

Information from the fireline personnel was transmitted to the Fire Boss and the Air Attack Boss on the forest net. The Air Attack Boss and the Air Tanker Boss determined the correct type of aircraft for deployment on every target.

Air-Attack Operation

In operation, all helitankers were refilling at the fire base heliport while an air tanker was being led in for a drop by the Air Tanker Boss. The helitankers were cleared for takeoff as soon as

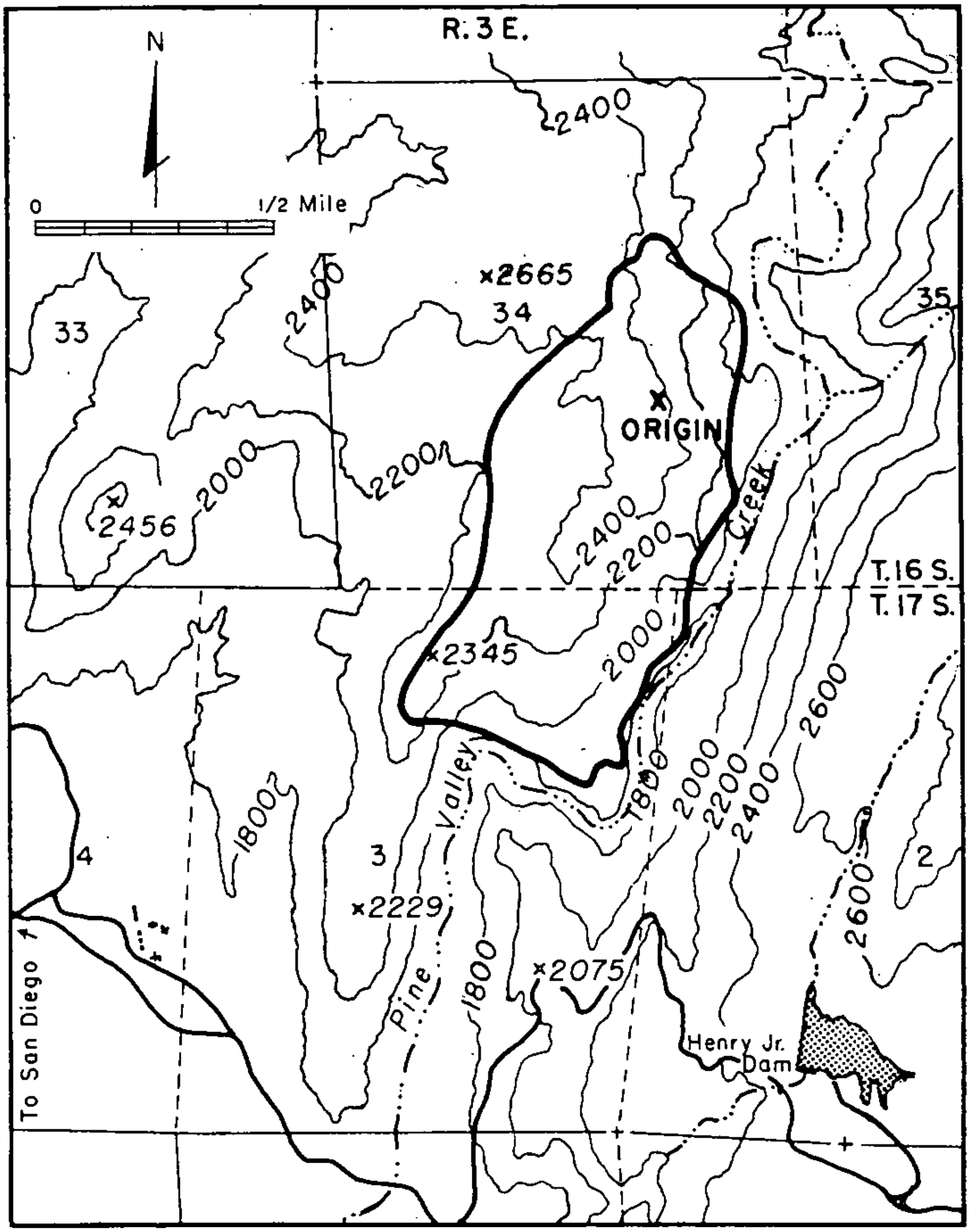

Figure 1.—Firefighters were confronted by rough terrain and were hampered by limited access in the Pine Creek Fire. The fire occurred on Aug. 9-11, 1967, on the Cleveland National Forest, Calif.

the air tanker completed its run. The Air Attack Boss, in turn, ordered the helitankers to the drop area, where the Air Tanker Boss directed them to specific targets. The helitankers were to knock down pockets of flame and spot fires that threatened to burn around or through the fixed-wing drops. This tactical maneuver almost eliminated the need for more than one air tanker drop at any point.

On several occasions, two air tankers would be led in, one behind the other, on a simultaneous run. One would drop immediately after the other so the most fire would be knocked down in the least time. The helitankers would follow up the air tanker drops to strengthen the lighter ends of the drop patterns and to assure an overlapping of the retardant line.

When air tankers were not over the fire, the helitankers assumed control. The Air Tanker Boss flew at an elevation that permitted him to view the entire situation. He would direct the helitankers to targets within their individual or combined capacity. This plan assured the Air Attack Boss that priority targets were being attacked.

During the brief lulls in air activity, the Air Attack Boss and the Air Tanker Boss would establish target priorities and would decide on the combinations of integrated attacks to be used when the loaded air tankers reported back to them. Several times during the day, helitankers were ordered to fast-breaking spot fires and flareups at the same time as ground forces were being notified of their existence.

Summary

By 1630 the three helitankers had dropped more than 18,000 gallons of retardant, had ferried 280 men to and from the fireline, and had delivered 7,900 pounds of urgently needed supplies to the ground crews. Four pilots were assigned to this operation, as the helicopters were in almost continuous use from 0600 to 1630. The average round trip required about 5 minutes; however, some of the flights to and from the north end of the fire were completed in less than 1 minute. Personnel transport was done as efficiently as possible and, under most conditions, two men were carried in and two men were carried out during one round trip.

The one B-17 and five TBM air tankers dropped 37,700 gallons of retardant on the fire. The last TBM tanker drop, at 1635, extinguished the last visible flames on the fire. By sundown, the fire was contained within an adequate fireline at 310 acres. The fire was announced as under control at 0900, Aug. 11, 1967.

TRAINING PAYS OFF

JOHN E. BOREN, *Investigator*
Kisatchie National Forest

One year in jail—that was a recent sentence imposed by a Louisiana State judge on a man who intentionally set three fires on the Kisatchie National Forest. This judgment resulted from vigilance on the part of a Forest Service employee.

For the past 2 years the Kisatchie National Forest has been stressing the need for Forest Service personnel to be observant. At law enforcement training sessions, the Forest Investigator has urged foresters not just to look, but to "see", what evidence may or may not be present at the scenes of fires or other possible criminal violations occurring on the National Forest.

Early one dry morning, a Catahoula Ranger District fire prevention technician answered the office phone. A voice said, "There's a ground fire at the Stuart Recreation Area." The technician notified a fire suppression crew, then left in his pickup. Arriving at the area, he saw a man trying to stamp out a fire. Then two more fires—very small. He also noticed there was no one else around. A moment's discussion revealed the helpful man who called about the fire had then come back to help put it out. (The nearest house was over a mile away. Two of the fires were only as big as a hat when the technician arrived.)

This man muttered a name and that he was from Olla, a small town 50 or 60 miles away. He then got in an old model, light-colored car and drove away. The technician did not see the license number, but did observe a name written on the driver's door.

This information was relayed to the Kisatchie Investigator, who launched an immediate investigation. Local inquiry revealed no likely suspects who could have set the fires. But a check with other local law enforcement officers disclosed that several families with last names similar to that of the "helpful" man lived in the vicinity. The Deputy Sheriff at Olla advised that he knew of two men by that name, and that one of them *did* own an old model car with his name writ-

(Continued on page 16)

AIR TANKER USE: A 5-YEAR APPRAISAL

Division of Fire Control
Washington, D.C.

More than 45 million gallons of water and fire-retarding chemical solutions has been dropped on forest fires by the Forest Service since its air tanker program was started about 12 years ago. A comparison of the National Forest protection area burned during this period with that of the previous 10 years shows a reduction of more than 20 percent. Certainly intensified prevention efforts and many improvements in equipment and techniques have contributed to this reduction. But it generally has been felt that air tankers have played an important role in effecting it.

The Study

In order to better measure their value, in 1962 the Forest Service initiated an administrative study to appraise the effectiveness of air tanker drops on going fires. During the 5-year period from 1963 through 1967, a sample consisting of 922 individual drops was evaluated.[1] Data studied for each drop included information on the fire (size, fuels, topography, spread characteristics, etc.), weather, tactical objective of the drop, and how much it helped ground forces bring about control. If rated less than a "definite help," the reason for the drop's ineffectiveness was also noted.

The fires and individual drops represented in this study were selected by chance rather than by a systematic sampling method. Evaluation was done by selected fire control personnel, and at times they were needed for fire suppression duties at the sacrifice of making the evaluations. However, the data gathered reflects a variety of fire and drop conditions, and is, therefore, felt to be representative.

Results

Overall, the benefits of the air tanker drops sampled were impressive. Seventy-nine percent were reported to have been of "probable" or "definite" help to ground forces in controlling fires (table 1). Seventy-one percent were "on target," and 15 percent were reported as "partial misses." The remainder (14 percent) were "complete misses," caused mainly by such factors as height or speed of the aircraft, poor visibility, difficult target, and mechanical failures. Misses due to mechanical problems noticeably declined over the 5-year period, reflecting the continuing improvements made in tank gates and related equipment.

TABLE 1.—*Air Tanker Drops Evaluated and Their Reported Effectiveness*

Evaluation of Effectiveness	Number of Drops	Percent of Total
Definite help	576	62
Probable help	155	17
Doubtful help	73	8
No help	118	13
Total	922	100

Complete misses accounted for two-thirds of those drops evaluated as being of doubtful help or no help. Another 12 percent of the drops rated ineffective was judged by evaluators to have been unnecessary, i.e., even though the drops hit the target, ground forces could probably have readily controlled the fires without them. The remainder of the "ineffective" drops was so rated because the fire subsequently *burned through, spotted across,* or *flanked* the retardant line.

Evaluation

Results of this study indicate that air tanker drops have the greatest chance of being a definite help in control of smaller fires (fig. 1). Better than two out of three drops on Class B and C fires (0.26-99.9 acres in size) were rated as being a "definite help." On fires 100 acres and larger, only two of five were so rated. The relatively low-rated effectiveness of drops on Class A fires (0.25 acre or less) may be explained by the fact that their small size makes them a difficult target. Being small, they are also likely at times to have been controllable by ground forces alone, and thus the air drop was rated ineffective because it was unnecessary.

Of the drops evaluated, the highest percentage rated as a definite help were those made on the head of the fire (table 2). Where character of the fire is a concern, air tanker use is generally of least value on fires with a slow rate-of-spread (fig. 2). More than one-third of the drops studied were made on "smoldering" and "creeping" fires, with only 46 percent rated of definite assistance, undoubtedly because they were often unnecessary for control.

[1] Drops by helitankers made up only 3 percent of the sample studied; therefore, results reported are generally most applicable to fixed-wing tankers.

TABLE 2.—*Retardant Drops by Target Area*

Fire Target	Total Drops, percent	Definite Help Drops, percent
Head	51	73
Flank	24	50
Rear	3	38
Spot fire	22	52

While these data might imply that retardants are most effective when used on the *head* of *fast-moving* fires, some caution is wise. Both logic and experience indicate that such drops will be futile in situations where the fire will burn or spot across, or flank the retardant line before adequate followup action can be taken.

In general, there was no marked variation in reported effectiveness of the drops by type of fuel in which the fire burned. The percentage of air tanker drops reported to be of definite help ranged from 56 to 66 for grass, brush, litter, and overstory fuels. In slash fuels, 76 percent were so evaluated.

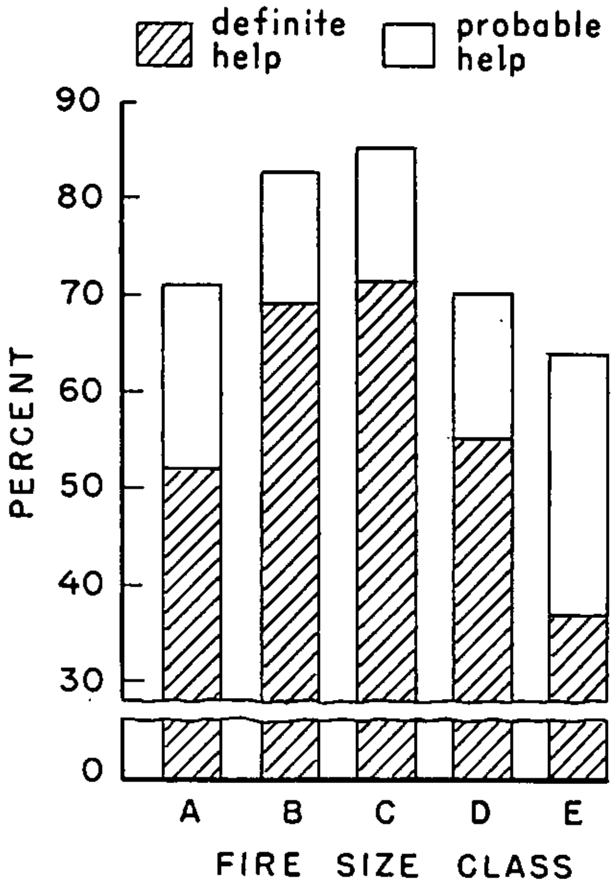

Figure 1.—Percent of drops rated of definite or probable help, by fire size class.

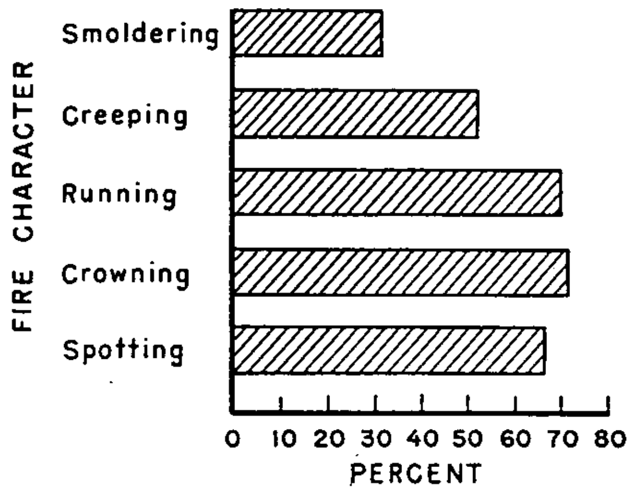

Figure 2.—Percent of drops rated a definite help, by character of fire at time of drop.

Slope gradient of up to 70 percent does not appear to be significant to the effectiveness of air tanker drops. The sample did not include enough drops on steeper slopes to be meaningful, but there is an indication that the chance of such a drop being effective decreases, particularly on those slopes with greater than 80 percent gradient.

No correlation was noted between percentage of drops rated a "definite help" and windspeed up to 14 m.p.h. Above that rate, effectiveness decreased with increasing windspeed. While the sample included relatively few drops made with windspeeds greater than 25 m.p.h., only about one-third of those evaluated were believed to have materially assisted ground forces.

Reports indicated the highest percentage of "definite-help" drops occurred when the tactical objective of the drop was line building in direct attack (table 3).

TABLE 3.—*Retardant Drops by Tactical Objective*

Tactical Objective	Total Drops, percent	Definite Help Drops, percent
Line building, direct attack	23	79
Line building, indirect attack	4	69
Delaying	29	62
Cooling to hold line	21	58
Cooling spot fire	15	51
Reinforcing weak line	8	37

Use of air tankers generally was less effective during periods of high fire danger. With burning indexes of 0-50, 63 percent of the drops were reported to be of definite help; above that index level the average decreased to 54 percent.

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CHAPARRAL CONVERSION PROVIDES MULTIPLE BENEFITS ON THE TONTO NATIONAL FOREST[1]

J. J. Baldwin, *Forester*
Tonto National Forest

Chaparral vegetative types on the Tonto National Forest are at 3,000 to 5,000 feet in elevation. At this elevation range, annual precipitation is 15 to 25 inches. Here temperatures during the summer are more than 100° F. during the day and relative humidity is often less than 10 percent. In heavy stands the volumes of this chaparral fuel range from 30 to 50 tons per acre.

The grazing capacity of chaparral is low for both wildlife and livestock because of the impenetrable cover and little herbaceous growth. It is difficult to manage cattle in the dense brush. Local livestock operators often must rely on cattle traps around the few watering areas to capture their animals for branding or marketing.

Watersheds in dense chaparral produce little water because of both high plant transpiration and high evaporation loss when rainfall is intercepted by dense vegetative cover. Soil erosion and offsite soil movement are common under the brush cover.

Wildfires in this chaparral type are frequent, and they often burn with explosive intensity. The cost of suppressing these fires may easily exceed $30 per acre. As a result, a prescribed burning program has been underway since 1961.

Burning plans included coordination of all land uses. The objective of this project was to burn the dense chaparral and to convert the area to open Savannah-type grassland, retaining islands of chaparral for wildlife cover. Riparian vegetative types were also to be protected because of their value for wildlife and for use by recreationists.

Figure 1.—Typical cover conditions in Brushy Basin prior to prescribed burning treatment.

Experimental burns were conducted in 1961 and 1962. In accordance with Forest Service fuel hazard reduction policy, it was decided to use fire as a management tool in large chaparral areas.

The Brushy Basin Project

About 5,000 acres in Brushy Basin, 50 miles northeast of Phoenix, Ariz., in the Tonto National Forest, were selected for the first major prescribed fire treatment of chaparral in the Southwestern Region (Arizona and New Mexico) (fig. 1).

Plans were made to control-burn small segments; all burning of the Brushy Basin area was to be completed in 3 years. A study of fire weather was initiated prior to burning to establish criteria for safe burning. Late September and all of October were chosen because the most favorable burning weather occurred then. Individual periods lasted from 1 to 8 days. In later years, application of new, special safety precautions extended this period of safe burning.

Early in 1963, fuel breaks, designed to be permanent, were selected and constructed in the most strategic locations. Where possible, these fuelbreaks were built with bulldozers to widths varying from 75 to more than 200 feet. When topography prevented the use of bulldozers, lines were built by hand and widened just prior to the major burn by burning out on the side toward the area of the controlled burn.

Experiments were also started to determine if the application of plant desiccant chemicals (2-4-D and 2-4-5-T mixed) would materially aid burning. These experiments are continuing.

All new employees of the Tonto National Forest were introduced to prescribed burning as a training measure during their first year on the Forest. Because of this training we believe these men are now permanently better prepared to cope with fire situations. Burning crews were assembled when weather conditions met established criteria. Except for key people, these crews were not experienced in fire control or fire behavior.

Initial burning was completed in 1965, and a grass cover was established by 1967. It is now apparent even to the average viewer that conversion of chaparral to grass is practical.

[1] Adapted from a paper presented at the Tall Timbers Fire Ecol. Conf., Tallahassee, Fla., March 1968.

The public has been kept well informed since the early stages of the program; this effort was made to gain and then increase understanding and acceptance of the burning project.

Firing Methods

Burning procedures changed as improved commercial ignition devices became available. The drip type and pressurized diesel torches were replaced by grenades and electrically detonated preplaced "squibs." Our main tools now include napalm grenades, grenade launchers, Very pistols, fusees, handheld butane torches, large butane weed burners, and electrically detonated grenades. Electrically fired devices are becoming more popular because they provide greater flexibility in ignition and increase safety for the firemen.

To obtain proper consumption of chaparral fuels, a crown fire is required. Thus, burning conditions must be high if the desired results are to be gained. Wildlife islands and streamside vegetation are saved by skillful burning ahead of the main burn. This is usually done during the afternoon and night before the main burn by firing away from and through these desirable areas.

Firing for the main burn is begun from the tops of ridges using a backing fire. This widens the control line. Firing then progresses downhill along the sides of the areas to be burned. Once the margins have burned to a sufficient width, strip head-firing is started. The entire bottom of the slope is ignited for an uphill sweep. All steps must be in sequence and properly timed. Crews must be in constant communication.

A favorable 5-day weather forecast is desirable prior to any burns which will last for more than 1 day. During all burns, weather must be observed continuously and reported, and forecasts must be interpreted so the fireman may be kept fully informed on the possible effects of weather. Decisions to proceed or to halt the burn depend on these forecasts..

Revegetation Successful

When the burn is completed, the area is ready for seeding to grass (fig. 2). Seeding has been successful both immediately following the burn in the fall and in the next July just prior to summer rains, but the latter time appears to be better. Regardless of seeding dates, germination does not occur until after August rains. Livestock grazing must be deferred during grass establishment, and the area must be properly managed following establishment of the grass.

Figure 2.—A view of the Brushy Basin area immediately after prescribed burning.

Within 18 months after the burn is completed, the burned area must be sprayed with herbicides to prevent resprouting of the brush. Spraying is repeated annually for at least 3 years to obtain a successful sprout-kill and to maintain the open Savannah-like type. All but 3 of some 20 species of brush involved are prolific sprouters. Three other species readily produce new plants from the seed left on the ground after burning (fig. 3).

Multiple-Use Benefits

Studies on the Brushy Basin and adjacent areas indicate that water production increases about 1.5 inches per acre. Good-quality water is now permanently flowing in the area. During years of heavier precipitation, water yields increase from 1.5 inches per acre per year to as much as 6 inches per acre per year.

After observing the results of burning and subsequent treatment from 1961 through 1963, the Salt River Valley Water Users Association is now contributing financial support to chaparral con-

Figure 3.—Established grass cover on treated area. Application of herbicides will check the brush regrowth.

version projects using prescribed fire as the initial treatment. The association believes the benefits will be sufficient to meet the cost.

Prior to treatment, annual grazing use in Brushy Basin was approximately 20 head of wild cattle. Beginning in 1967, 200 head of cattle was placed on the area under a rotation system of range management. Based on observations, it is clear that more cattle could be grazed if the forage being produced is to be fully used. It is too early to determine exactly how much grazing capacity will have been increased.

White-tailed and mule deer also use the area. The burn-and-spray treatment has improved the deer habitat, but further study will be needed to fully evaluate how much the total wildlife habitat has improved. Increases in the quail population after treatment have been noted; also, this spring's songbird population increased notably.

Conclusions

Chaparral conversion on the Tonto has proven to be an economic success. With increased water production and beef production, and reduced fire suppression costs, $3 is being realized for each $1 spent. This analysis does not place an economic value on increased wildlife use, or on use by recreationists for camping, picnicking, and general outdoor enjoyment. Another intangible benefit is the training we are able to give all personnel who have worked on the Tonto since the conversion program became a reality.

FIRE PROTECTION ON THE OUACHITA

LOUIS L. DAVIS, *Fire Staff Officer*,
and ROBERT C. ROBERDS, *Forest Dispatcher*
Ouachita National Forest

The Ouachita National Forest, established by Presidential Proclamation in 1907 as part of the Arkansas National Forest, has a gross area of 2.5 million acres with 1.5 million acres of National Forest land. It is located in the Ouachita Mountains of Arkansas and Oklahoma, a system of long, narrow ridges, lying to the east and west (fig. 1). The area is subject to periodic prolonged drought, occurring at 8- to 10-year intervals.

The area's original fire control organization, composed of guards and patrolmen scattered thinly over the Forest at strategic mountaintops, patrolled assigned areas daily throughout the fire seasons. Communication was by word of mouth and travel by horseback or on foot. Tall trees served as lookout towers. Fires were attacked as found. The main suppression tool was often a pine top.

Figure 1.—A typical view of the Ouachita Mountains.

By 1925, the situation had greatly improved. A telephone net spread over the Forest. Roads and trails were being developed, lookout towers and guard dwellings were built, and motor vehicles were in use. There was a large rural population, with communities in every valley. Trained warden crews were the backbone of the fire control organization in these valley communities. Each warden was on the Forest telephone net, had a tool and ration cache, and transportation.

During the depression years of the 1930's, the rural people began migrating from the area. Row crop farming did not provide necessary subsistence, and there was little or no market for timber. The warden system began to break up. The impact was not extensively felt at the time since the Civilian Conservation Corps took over the fire suppression job.

World War II stripped the Forest of needed manpower with military service demands, industrial labor requirements, and the closing of the CCC. After World War II, improved equipment, such as radio communications networks and the mountain fire plow, absorbed some of the responsibility. Intensive timber stand improvement under the Knutson-Vandenberg Act helped to beef up the area's manpower resources. The Ranger District then served as the fire control unit. Initial attack was made by regular Forest Service personnel with backup by volunteers recruited from local towns and communities. But in bad years, the manpower situation was critical.

A New System

By 1960, it was apparent that a reorganization was necessary if the Forest was to continue to meet its responsibility. Accepting the facts that large numbers of firefighters would not be available on short notice and that the Forest had small crews of skilled firemen on each District, the problem was how to make the most of available resources.

After much research and study, the following steps were taken:

—Supplemental air detection was activated in early 1963; most of the towers were abandoned, releasing the lookouts for ground service. This system consists of two contract aircraft with pilot and obesrver flying planned routes (fig. 2).

—The Master Plan was revised, dividing the Forest into two fire control units of six Ranger Districts each. The dispatching organization consists of a forest dispatcher and two zone dispatchers. The action plan authorizes zone and forest dispatchers to dispatch the nearest crew and equipment to the fire regardless of district boundaries, without the time lost in having to request such help from the Ranger involved. It also provides specifically for shifts in responsibility from zone to forest dispatcher, or reverse, as conditions change.

—An air tanker base was established at Fort Smith, Ark., within 30 minutes flying time of most of the Forest. Multiengine tankers, carrying from 1,200 to 2,400 gallons of retardant, are used.

—The Weather Bureau began daily fire weather forecasting at Fort Smith in early 1964. The forecaster is in direct radio communication and usually gives revisions as soon as changes become apparent. He also provides spot forecasts for going fires and for prescribed burning.

—The communication plan was revised to provide for a separate frequency for each zone instead of a single frequency handling heavy traffic. This system, with all new V.H.F. equipment, gives ground-to-ground direct contact, zonewide, through repeaters. The dispatchers have both frequencies.

These changes required much training and practice. Weaknesses that appeared were ironed out by plan revision and more training.

The 1967-68 fire season showed the new organization was functioning as planned.

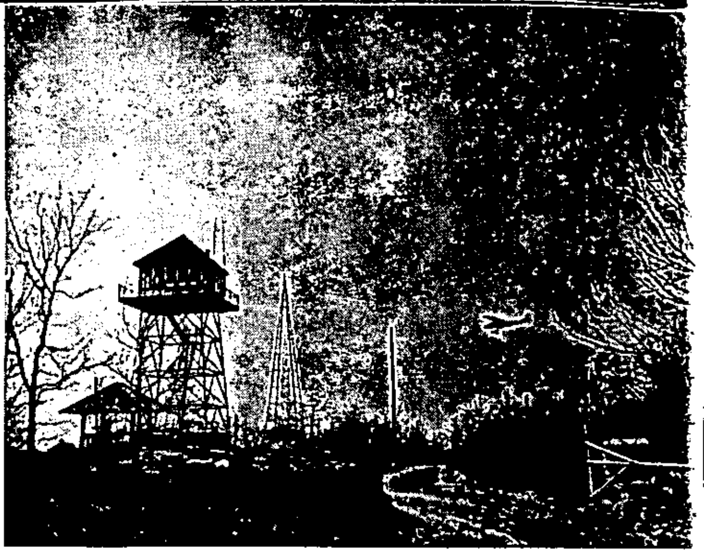


Figure 2.—The Fire Detection Team, Ouachita National Forest.

Air-Ground Detection

The air-ground detection system meets detection time standards, eliminates false alarms, and provides prompt scouting of going fires. A side benefit is the aircraft's preventive effect.

Dispatchers know the location of every crew and piece of equipment in their respective zones each day. Dispatching is prompt and attack fast and aggressive. During a multiple fire situation in 1966, one blowup fire was hit by top firefighters and equipment from five Ranger Districts. It was controlled at 900 acres in 12 hours—10 hours before the next burning period.

In 1963, the air tankers, directed by ground forces with no experience in their use, performed extremely well. At least five fires were prevented from becoming project fires, saving hundreds of thousands of dollars in suppression costs and damages. The tankers have become even more effective as people become more experienced in their capabilities and limitations.

Rangers express a sense of security, knowing that skilled help is available that an aircraft is only minutes away, and that the air tankers are warmed up and ready to go. Direct radio contact with their people and other Rangers has eliminated the need to relay messages.

Method changes are difficult and sometimes painful, but the Ouachita will continue to change as needs indicate. With the intensive mechanization of agriculture and the timber industry, firefighting manpower will continue to be scarce. Thus, adjustments must be made to take advantage of new developments in fire control.

MARKING TEMPORARY HELISPOTS AND DROP SPOTS ON PROJECT FIRES

REID JACKSON, *Fire Staff Officer*
Boise National Forest

Many project fires involve extensive use of both helicopter and paracargo aircraft. It is not unusual for six or eight helicopters to be working on a single major fire at any one time. Also, it is not unusual to have four or five spike fire camps, serviced primarily by helicopter or/and paracargo, for one fire.

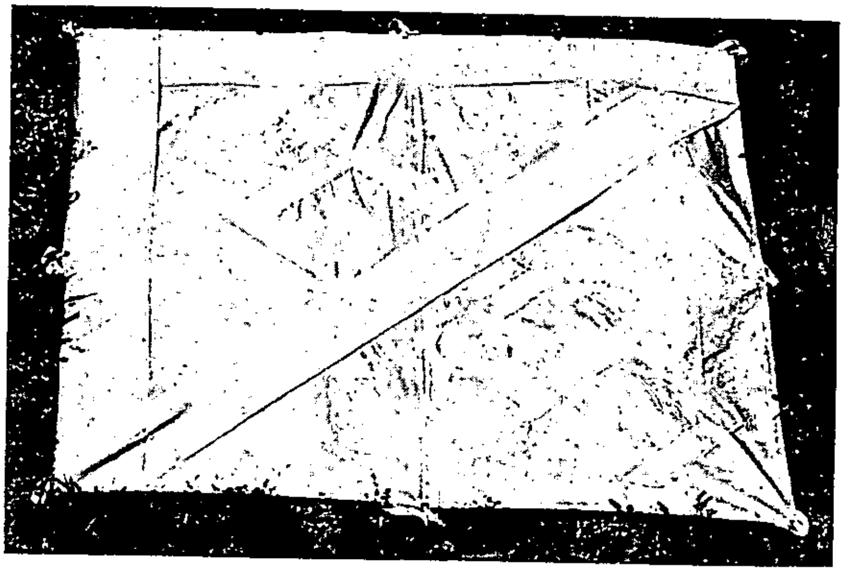
Current Deficiencies

To help minimize flight time and to improve the efficiency of helicopter and paracargo operations on project fires, an effective system of marking the numerous helispots and paracargo drop spots is needed. The present marking method varies from little or no marking (only written or verbal description to pilots) to marking with colored streamers. The streamers are frequently blown out of shape and are difficult to locate and identify. Helicopter pilots use limited, expensive flying time locating helispots used to deliver men and supplies. Paracargo pilots, besides using expensive flying time locating drop spots, occasionally are unable to identify the drop spot and have mistakenly dropped cargo in the wrong area. When such mistakes are made, fire managers cannot provide vital supplies for their firefighters at the proper time and place.

Improved Marking System

A marking system that has minimized the flight time and prevented mistaken drops is now being used on the Boise and Payette National Forests. The markers are constructed of Herculite, a plastic-impregnated nylon cloth obtainable in various weights and colors. Large, high-visibility standard marker symbols are sewn onto a sheet of this material. The colors of the material and markers contrast. The Boise uses red on yellow for helispot markers and red on white for drop spot markers. The markers are square and measure 100 inches on each side; therefore, it is easy to spot them and to correctly identify them by number (fig. 1).

The markers are assembled in a kit. The kit consists of the marker, eight 12-inch metal tent pegs, nylon cord for tiedowns, and a small canvas carrying bag. The kits are manufactured by smokejumpers during the winter. The helispot markers and the canvas carrying bags for the Boise are numbered consecutively, from 1 to 16. Fewer drop spot markers are needed; the Boise keeps 8 in its cache, and these, too, are numbered consecutively, from 1 to 8.



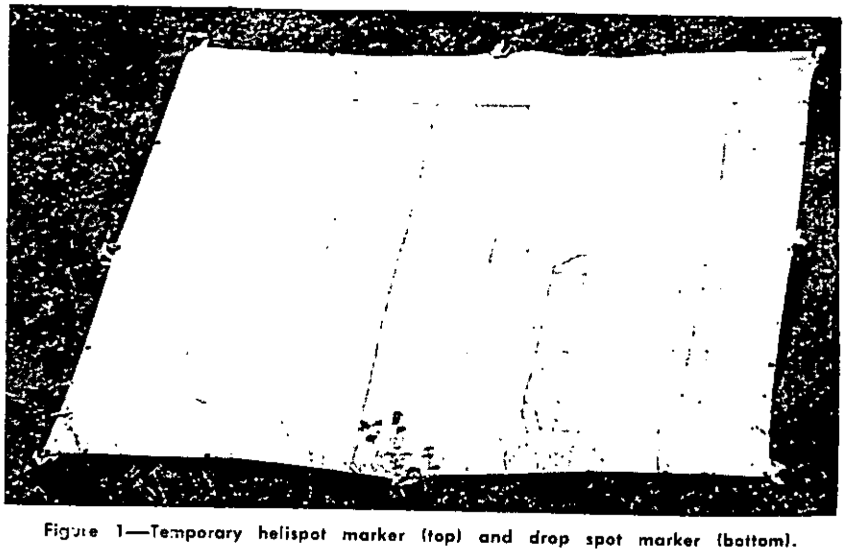


Figure 1—Temporary helispot marker (top) and drop spot marker (bottom).

Advantages of New System

By assigning a numbered marker to each helispot and drop spot, dispatch of pilots is simplified, control of two phases of air operations is improved, and flying costs are reduced (fig. 2). The savings could be several hundred dollars on a single project fire where numerous helicopters or/ and cargo aircraft are involved.

The Herculite is strong and washable; thus, the markers can be placed directly over the touchdown pads and help reduce the dust problem associated with many emergency helispots. Markers must be securely tied down, using tent pegs and nylon cord provided with the kits. This will eliminate the damage resulting from blade down-wash blowing the markers into the rotor blades. Tying the markers also insures that symbols and numbers will be visible at all times.

The initial investment in the markers is somewhat high—$34.50 each—due primarily to the high cost of the Herculite. However, the markers can be used repeatedly; thus, the price is a fairly minor consideration. The savings in reduced flight time would quickly offset the cost of the markers.

Figure 2.—Markers are easily located and identified from the air.

Additional Information

Formal specifications have not yet been developed for the markers, but units interested in obtaining kits can now order them from the Boise or Payette at the following addresses:

Forest Supervisor
Boise National Forest
413 Idaho Street
Boise, Idaho 83702

Forest Supervisor
Payette National Forest
Forest Service Building
McCall, Idaho 83638

Air Tanker Use—*Continued from page 7*

Conclusions

Although this study is based on some necessarily subjective judgments by individual evaluators, it shows that air tankers have provided substantial assistance to ground forces. But it also points up the necessity for using them on a selective, planned basis for the utmost efficiency since they are a relatively expensive fire suppression element.

Air tankers are, in general, most effective in the early stages of a fire. On larger fires, the chances of effectively aiding ground forces with retardant drops tend to decrease significantly unless very sound judgment is used in selecting appropriate targets. In all cases, the decision to use air tankers must be based on careful analysis of the particular situation. Fuels, weather, fire behavior, topography, followup action, and the difficulty the air tanker may have in hitting the target are all factors that must be considered in deciding *first,* whether the retardant drop is actually needed for control, and *second,* what the probability is that it will, in fact, accomplish the desired results. This is particularly important on larger fires, where the study data show the lowest percentage of retardant drops to have been effective.

REMOTE MEASUREMENT OF WET AND DRY BULB TEMPERATURES

ERWIN H. BREUER, *Research Technician*
Intermountain Forest and Range Experiment Station[1]

Measurements of wet and dry bulb temperatures that are obtained using mercury thermometers and a sling or fan can vary among individuals because of incorrect readings of the thermometers or because of failure to achieve minimum wet bulb temperatures. A system providing an accurate readout and an easy determination of wet and dry bulb temperature is desirable. Also, the ability to read the measured values 200 yards from the weather station can offer advantages.

The sensors best suited to these requirements are thermistors. They have high sensitivity to temperature changes, and their signal is relatively unaffected by the length of the signal line.

Thermistors are "thermal resistors," i.e., resistors with a high negative temperature coefficient of resistance. As the temperature increases, the resistance decreases; and as the temperature decreases, the resistance increases. Thermistors were chosen because their large resistance change (78 ohms per degree Centigrade) provides good accuracy and resolution compared to that of a platinum resistant bulb with the same basic resistance (only 7.2 ohms per degree Centigrade).

A useful circuit for measuring temperature with thermistors can be made by using a Wheatstone bridge. As the temperature changes, the resistance of the thermistor changes, and the flow of current through the meter can be calibrated in terms of temperature. The thermistor may be mounted a great distance from the meter, and ordinary copper wire may be used to complete the circuit. This capability met part of the test requirements of the weather station, which was the effect of long transmission lines on the signal level from various fire-weather instruments.

The Wheatstone bridge circuit (fig. 1) is described as follows: Switch 1 (SW 1) is the master power switch; it sends 6 volts across the bridge to the thermistors. The two 1.78K resistors are fixed to provide balance for the bridge. Meter sensitivity was selected to match the current change as the bridge unbalances. Switch 2 (SW 2) is a double-pole, double-throw switch with a 537-ohm resistor for a null balance and a 333-ohm resistor for span adjustment. The 2K dial variable resistor is within the range of resistance as the thermistor; i.e., 1,000 ohms. The 1K fixed resistor is in parallel to the thermistor; it is used to linearize the thermistor because the thermistor resistance change is not linear to temperature change. The two thermistors used in our design have a resistance of 1,000 ohms at 25° C. and a maximum operating temperature of 150° C.

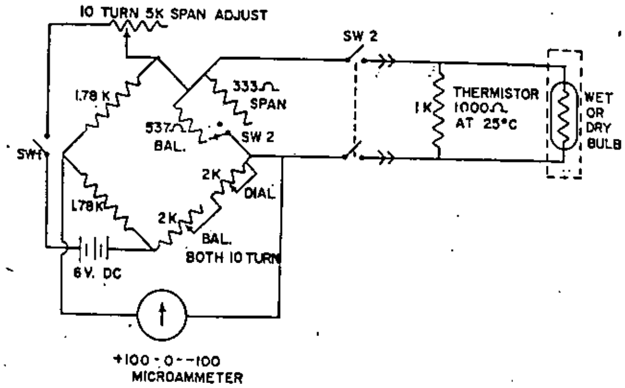


Figure 1.—Wheatstone bridge circuit. One is required for each of the thermistors.

One requirement is that the two 6-volt batteries in series be close to the fan motor to produce the speed and airflow required for the wet and dry bulb. These batteries are actuated by a relay (fig. 2) as is the battery for the solenoid valve. The switches to activate the relays are located on the console.

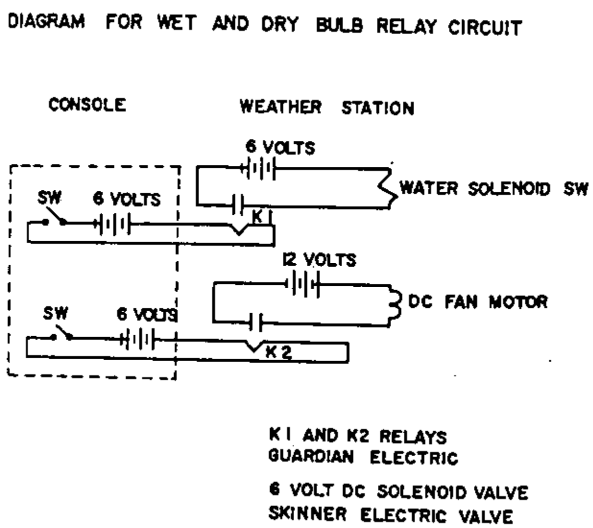


Figure 2.—Circuitry for fan and water relays.

[1] Headquarters for the Station is Ogden, Utah. The author is stationed at the Northern Forest Fire Laboratory, Missoula, Mont.

The two thermistors are mounted in place outside an air supply box (fig. 3). The water supply line of 1/8-inch tubing is placed directly over the wet bulb thermistor. Inside the air supply box are the fan, a 1-pint polyethylene bottle for water storage, and a 6-volt d.c. solenoid valve with the 1/8-inch water supply tubing narrowed at the outlet to give 3 drops per 10 seconds on the wet bulb. This amount of water will allow full wet bulb depression and maintain it long enough to allow the digital dial potentiometer to be set to the null point.

At most field stations, a remote readout will permit the weather station to be located at the most appropriate spot, even though this might be some distance from the observer. This permits the observer to take frequent readings without leaving his duty post—especially important during periods of high fire danger and heavy fire business.

The operating console is shown in figure 4. Procedures for reading the wet and dry bulb temperatures are:

1. Master panel switch to the *ON* position. (This is not shown in the illustration.)

2. Turn both wet and dry numbered dials to 70.0.

3. Turn both power switches *ON*.

4. On dry bulb, throw calibrate switch to *ON*.

5. Throw balance switch to balance, and null the meter, that is, to center zero.

6. Throw balance switch to span and adjust meter to 83 by turning span knob.

7. Recheck the null point on zero and also span at 83 on the meter.

8. Throw calibrate switch to *OFF*.

9. Null the meter on zero by turning digital dial. Result: the dry-bulb temperature reading is directly on dial.

Use same procedure for the wet bulb temperature, but with the following additions:

10. After calibration is complete, actuate the toggle switch labeled "water" to *ON* for at least 10 seconds; then turn to the *OFF* position.

11. Actuate the fan switch, and null the meter to zero by rotating the digital dial, keeping the meter on zero until the meter will no longer drop below zero. Result: the wet bulb temperature reading. Keep checking the dry bulb zero and hold on zero while fan is running.

12. Throw all switches to the *OFF* position when readings are completed.

13. Refer to wet and dry bulb conversion chart for relative humidity and dewpoint in degrees Fahrenheit.

Conclusions

The thermistor system described herein was checked during a complete fire season and was as accurate as a standard psychrometer. Rapid response, ease of reading, and location of readout near a person's work area make this unit an aid to increased work efficiency. It also provides more complete, accurate records of two important fire-weather measurements. Other measurements that are needed to calculate fire-danger ratings, such as windspeed, could easily be incorporated to make a complete remote readout system.

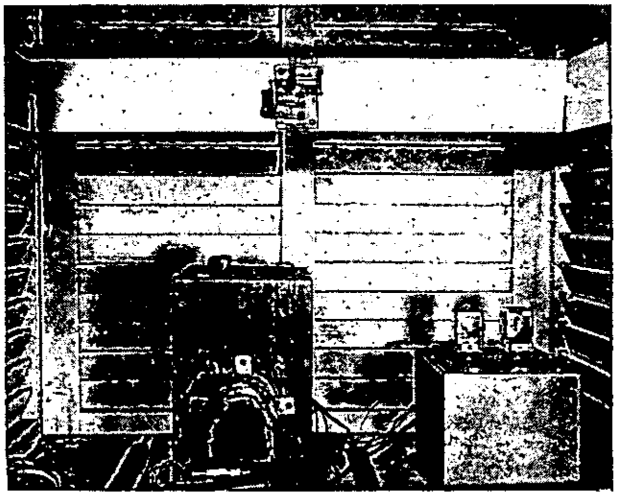


Figure 3.—Equipment is placed in the weather station shelter. The thermistors are mounted below the hood on the front of the air supply box.

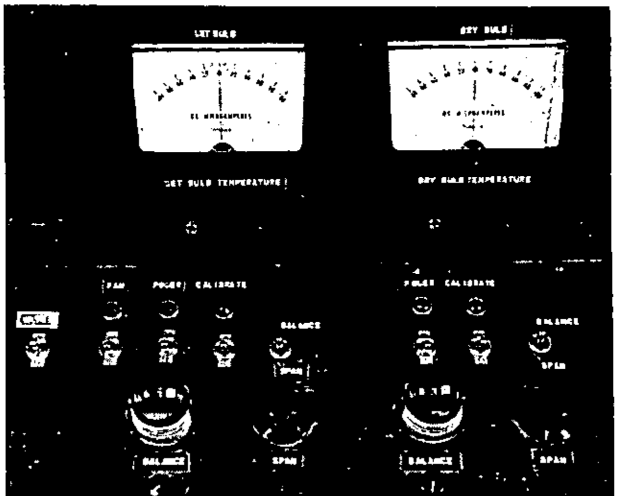


Figure 4.—View of the operating console. Temperatures are read on the two digital dials.

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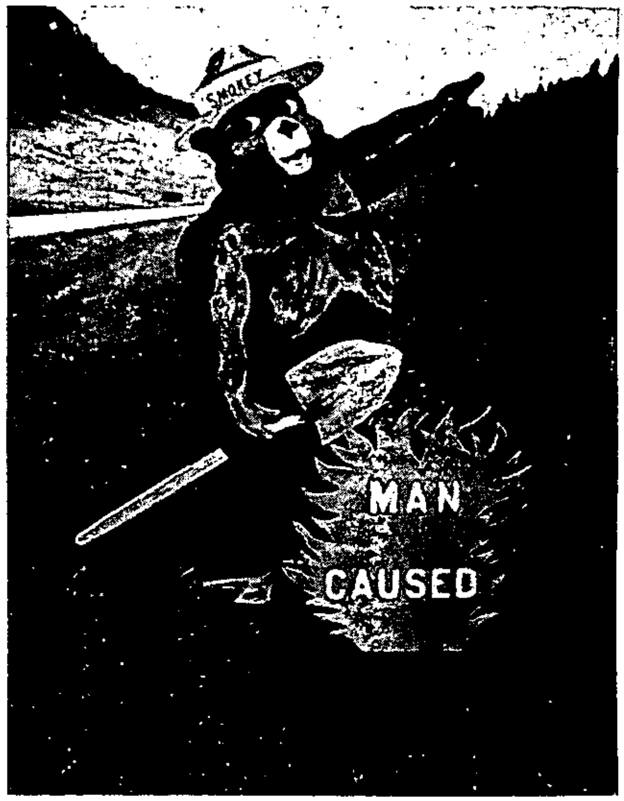
MAN-CAUSED FIRE SMOKEY SIGN

RUDY ANDERSON, *Fire Prevention Technician*
Black Hills National Forest

In the ceaseless battle to decrease the number of man-caused forest and range fires, personnel of the Black Hills National Forest combined some existing ideas to provide a new twist in prevention signs.

When a roadside fire occurs, a 6-foot plywood cutout of Smokey Bear is placed near the fire's origin, with Smokey pointing toward the burned area. At Smokey's feet, a plywood cutout of flames with a routed message saying "Man Caused" is mounted (fig. 1). Although the sign is simple, it is quite effective. It also receives many favorable comments from passing motorists.



Smokey and the flame was constructed from one 4- by 8-inch sheet of one-half-inch plywood. Smokey was painted on both sides in full color, and the flames were painted a fluorescent red with white letters. The letters were sprinkled with reflective beads for night viewing. A special support using 1 1/2- by 1 1/2- by 1/8-inch angle iron was constructed to speed mounting and disassembly of the sign.

The main value of the sign is its versatility. It can be put up and taken down in a few minutes. The message can be easily changed to meet changing needs. Or Smokey can be utilized in combination with permanent Forest signs.

Training Pays Off—
Continued from page 5

ten on the side. A check of local police files revealed that our "helpful" firefighter had a record of setting fires.

The suspect was subsequently located and interviewed. When presented with the evidence—small fires, no one else in the area, his name and description of his car, his past fire record—he confessed. He described how he set one fire in the recreation area, went to a phone and reported it, returned to the area, and set two more fires while waiting for the fire crews to arrive.

At 2 o'clock in the afternoon the day after the fire, a complaint was filed with the Grant Parish District Attorney. The subject of the complaint was arrested that night and tried 9 days later.

The Kisatchie Investigator's continual emphasis on "vigilance" at all trespass scenes motivated a technician to "see" what *was* and just as important in this case —what *was not* at the scene of this particular fire.

Because of this teamwork, the Forest Investigator was given good leads to follow, with the result that a woods arsonist was brought to justice.

Good training does pay off.