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FIRE CONTROL NOTES

A quarterly periodical devoted to forest fire control

CONTENTS

COVER—A typical lookout of 1912. Communication with headquarters or with other lookouts was by telephone or heliograph—if the sun was shining. For more current detection methods, see report on page 8.

(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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BUILDUP INDEX ANALYSIS—AID TO FIRE CONTROL?

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ESSA Weather Bureau Office for Forestry

Man has long used numerical scales to solve his problems. Fire Control personnel are acutely aware that a simple solution permitting a quick appraisal of the fire-danger situation across a forested area by such a scale is nonexistent and is not even on the horizon. However, the National Fire Danger Rating System (NFDRS), introduced in 1963, presents a reasonable approximation of the cumulative effects of weather across a forested area.

This system has one common denominator, the "Buildup Index" (BUI), for relating and comparing situations across otherwise reasonably homogeneous forested areas. The Buildup Index has been defined as "a number expressing the cumulative effects of daily drying factors and precipitation in fuels with a 10-day timelag constant." It is an expression of the moisture conditions of the heavier fuels—those that require 10 drying days to lose approximately two-thirds of their moisture above equilibrium. As the moisture content decreases, the BUI increases—indicating an increase in the severity of burning conditions. Therefore, the BUI is essentially a numerical value indicating the moisture content of the heavier fuels of a timbered region as influenced by weather.

An examination of the spread-phase tables of the NFDRS confirms this belief that the BUI depends totally on weather. The variables—dry-bulb temperature and atmospheric moisture (the latter is expressed as wet-bulb temperature, relative humidity, or dewpoint)—are the primary determining parameters. The importance of antecedent precipitation has been acknowledged in the original definition, and the exact influence can be seen by referring to the Buildup Index Recovery Table of the Spread Phase Tables of the NFDRS. By doing so, it is easy to see that the BUI can be determined by using observations from urban or nonforested areas as easily as from prime timberland locations if the bookkeeping of drying factors are recorded daily.

Prior to the development of the National Fire Danger Rating System, many danger rating systems were in use. The Lake States and Central States systems were sensitive to the number of days since rain. Fire-weather forecasters plotted precipitation charts daily and ascribed the proper number of days since rain for each reporting station. Analysis of the days-since-rain chart pinpointed areas of concern. In short, lack of rainfall was the forecaster's main criterion for labeling "hot" areas or potential trouble spots. After some experience forecasting for the NFDRS, analysis of BUI values seemed logical to the forecaster for the same reason.

Regional analysis of BUI values can be accomplished once a base map is established to facilitate plotting of the data. The observational input for determining BUI can include regular weather reporting stations as well as observations from the fire-weather station. Routine daily observations from forested locations are taken at the basic observation time, generally at 1 p.m. in the Southeastern States. These observations are an important supplement to the routine Weather Bureau observation input to the fire-weather forecaster. The number of reporting points available to the forecaster varies from State to State. However, in all States the number should be sufficient to assess the situation and to describe the range of BUI values in enough detail to permit decisions on operations, both by the forecaster and a fire control headquarters.

At the ESSA-Weather Bureau Office for Forestry at the Georgia Forestry Center near Macon, Ga., daily samples are gathered routinely from 13 points throughout the State. However, the maximum BUI, if greater than the BUI, at the regular reporting station within each forested district, is added to the routine report. These values are normally sufficient for

[1] The authors are U.S. Weather Bureau, ESSA, employees stationed at the Georgia Forestry Center, Macon, Ga., and are cooperators in the U.S. Forest Service Forest Fire Meteorology Project. Mr. Hagerty also serves as Coordinator, Weather Bureau Southern Region Forestry Meteorology Programs.

a representative BUI analysis, but 17 hourly weather reporting stations in and adjacent to the State can be used to complete the analysis if desired.

In response to requests by concerned groups, BUI analysis was initiated by the Macon Fire-Weather Office in 1966. It was necessary to obtain the cooperation of the ESSA-Weather Bureau fire-weather forecasters serving the Southern and Southeastern States and the forestry interests of individual states. Essentially, the Macon office became the clearinghouse and analysis center for data samples collected weekly from the individual fire-weather offices. One such analysis (fig. 1) permits further insight into the procedure and results.

The analysis is a static picture of the BUI situation on a given date. However, by superimposing the expected precipitation over the analysis, both as to amount expected and time of occurrence, an estimate of the easement, intensification, or little change in the fire danger rating can be projected. The ESSA-Weather Bureau 5-day outlook charts are quite useful for this type of interpretation.

Analysis of the plotted BUI values is helpful to fire control in assessing the burning potential and permits easy presentation of the situation

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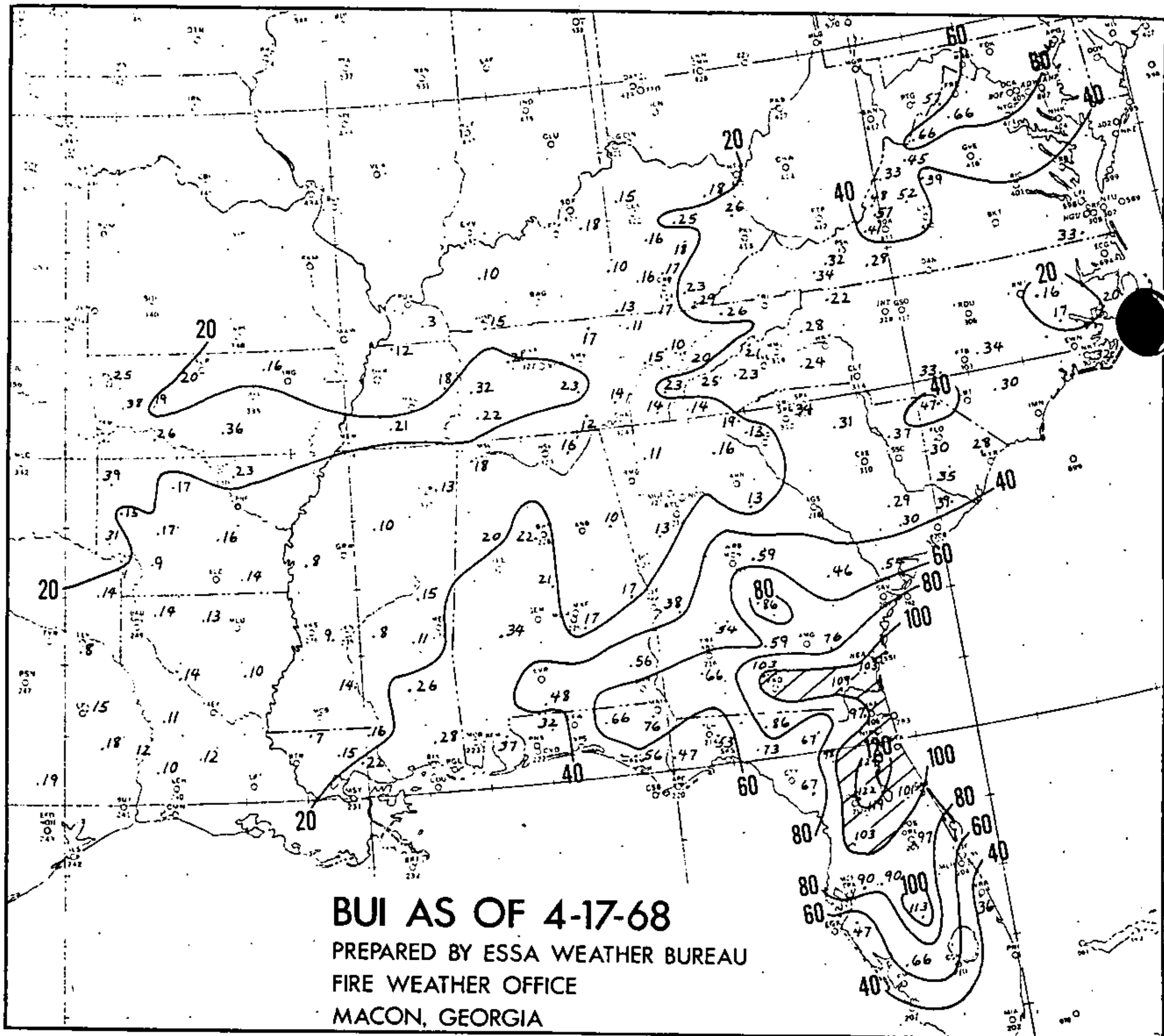

Figure 1.—An analysis of buildup index values received from timberland locations in 13 Southern and Southeastern States. Note the [illegible]mum values in southern Georgia and northern Florida.

REDUCING THE INCIDENCE OF CHILDREN AND MATCHES FIRES[1]

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California Division of Forestry

Children and matches are a serious risk in the Division's primary responsibility areas. Children utilizing various sources of ignition, mostly matches, are responsible for over 20 percent of the man-caused forest fires in California each year. These fires are commonly referred to by the fire services as "C & M" fires. There has been no significant decline in these types of fires during the past 20 years despite the aggressive Fire Prevention Information and Education Program that has been directed toward them.

Recent studies have revealed that "C & M" fires become a problem at an age younger than that at which fire prevention efforts have been directed toward in the past. (table 1).

TABLE 1.—*"Children Fire" starts, by five age groups*[2]

Age	*Percent of Fire Starts*
Under 5	12
5 to 7	34
8 to 10	28
11 to 13	16
14 and over	10

[2] Folkman, William S., "Children With Matches" Fires in the Angeles National Forest Area: USDA Forest Serv. Res. Note PSW-109, Berkeley, Calif., 1966, p. 2.

Good Information Alone Cannot Change Attitudes

Since the conception of Smokey Bear over 20 years ago, we have been very successful in getting the message about the dangers of fire to the public, but the information received does not do a fire prevention job by itself. The well-known "Only you can prevent forest fires" and many other such phrases have gotten the information to nearly every person in the land; however, it has evidently failed to convert the attitude of many people concerning their individual responsibilities to reduce the incidence of wildland fires.

This "hard-to-influence" attitude phenomenon is not peculiar to fire prevention. It is evident in other campaigns, such as those for the prevention of accidents and diseases.

[1] Adapted from California Fire Prevention Notes, October 1968.

Butte Ranger Unit personnel are attempting to break through this attitude barrier by educating the very young child about fire, the cause of fire, and how unwanted fire can be prevented.

By educating the child at the earliest age possible, and by proper followup, the fire prevention information hopefully will be retained as he or she passes through each successive age group. Also, the child may, in his innocence, very effectively act as a second conscience to many of these potential fire starters who are older than he is by parroting fire prevention messages to them. Consequently, with this procedure you are getting the information to many age groups through the young child, and you are also creating within him an everlasting, favorable fire prevention attitude. Thus, it has hoped that good fire prevention practices will become deep-rooted habits.

Establishing a Fire-Prevention Program

After accepting the foregoing as a solution to the children and matches forest fire problem, the Butte Ranger Unit Fire Prevention Officer in charge of the Information and Education program contacted Dr. James F. Lindsey, principal of the Aymer J. Hamilton Laboratory School at Chico State College, Chico, Calif. One of the basic functions of this Lab School is experimentation and innovation in teaching and teacher education.

After hearing an explanation of the Division's problems and the proposed solution, Dr. Lindsey became energetically enthusiastic about assisting in the planning and development of the methods which would serve as a vehicle for attaining the desired solution.

Teaching The Teachers

The first step was in teacher education. In this case, it was teaching the lay-teacher Fire Prevention Officer how to use some of the most up-to-date teaching techniques. This was the first encounter that that Lab School had ever had in teaching lay people professional techniques of early childhood instruction. The 6 hours of classroom instruction proved rewarding for Dr. Lindsey and his staff because the Fire Prevention Officers learned the techniques with surprising rapidity.

The backbone of the instruction consisted of a familiarization with team teaching. In team teaching, children are separated into very small groups of between 5 and 10, and each group is taught a subject according to their speed of learning.

Dr. Lindsey and his staff covered many "do's and don'ts," and some of the more important methods and techniques of presentation that the Lab personnel introduced to the Fire Prevention Officers follow:

1. Save your "attention-getters" until last. Arrange your presentation so that each successive portion is more interesting, more exciting, or more motivating than that which preceded it. Do not, for example, begin with the most interesting part of the presentation—such as Smokey Bear, a fire truck, or a flashy demonstration. For a group of youngsters, your badge, nameplate, and uniform provide enough contrast with the everyday humdrum of a young child's life to be an initial attention-grabber. It would be best if the group of youngsters could not even guess what was going to happen next; if they could, some of them could be distracted.

2. When dealing with very young children, never try to hold their attention any longer than 10 minutes with any gimmick or phase of your presentation.

3. The most important item for holding a group of youngster's attention for longer than 2 or 3 minutes is to keep your group small. Encourage the group to teach themselves by individual, active participation. It is amazing how little help, other than praise for correctly channeled thinking, that the group needed to learn all of the right answers.

4. Avoid all distracting situations. Never allow the students to anticipate what gimmick is going to be used next. For example, do not allow the children to see the projector, some unusual display case, the firetruck, other fire-fighting equipment, or a glimpse of Smokey Bear before these things are made part of the presentation. If you fail to do this, there is a good chance that many youngster's minds and imaginations will be diverted way ahead of you to the more exciting item, and your message will not even be heard, much less understood.

The First Operational Test

On February 9, 1968, five Fire Prevention Officers (four group discussion leaders and an observing leader) walked into a kindergarten class in the small community of Palermo, Calif., for the first operational attempt at using modern teaching procedure to teach fire prevention to the very young.

The class was divided into small groups by the teacher. Each group sat in a semicircle around a Fire Prevention Officer, who was sitting, as were the students, in a miniature chair for knee-to-knee, eye-to-eye contact, commonly referred to by interrogators as the essential periphery of awareness (fig. 1). Only five basic points were stressed during the conference leader-type discussion that ensued.

1. Do not play with matches.
2. If you find matches at home, give them to a parent.
3. If you are on your way to school and find matches, give them to the busdriver or school teacher.
4. If you see a younger child with matches, take them away and give them to an adult.
5. If you see a wildland fire, have an adult call the fire department right away.

Figure 1.—Optimum effectiveness is achieved through small groups, with the group leader at the childrens' eye level.

The four discussion leaders stressed these points for about 8 to 10 minutes. The Fire Prevention Officer leader furnished only information for thought and guidance. In every case, correctly channeled thinking was obtained from each respective group through their own, individual active participation.

When the observing leader was aware that the discussion leaders' uniform, badge, nameplate, patch, and questions were beginning to exceed the interest span of the youngsters, he advised all of the groups that a motion picture film was about to be shown. On this cue, the group leaders distributed Smokey Bear pins and praised their individual group members for their accomplishments (fig. 2).

The motion-picture film was a color fire-prevention film which lasted for about 10 minutes.

When the film was over, the observing leader, someone who was new to the individual groups, spent about 5 minutes asking the entire group what they learned during the session. The favorable, enthusiastic response was terrific. Then, as a grand finale, Smokey himself came to repeat the inquiry as to what the group had learned and to express his appreciation for what they had learned.

Only Time Will Tell

The first operational phase of the progressive teaching of fire prevention to youngsters has been completed at 11 kindergarten classes in the Oroville area. Butte Ranger District personnel are now planning to give similarly taught monthly followup programs. The use of regular fire control personnel to fulfill team assignments will be encouraged in the followup programs.

Figure 2.—Group leaders concluded the discussion by praising each child and pinning on a Smokey Bear pin.

The results of this training will probably not be very evident until this type of instruction has been practiced for several years.

However, it is the author's belief that a milestone has been reached in our attempts to reduce the incidence of fires caused by children and matches.

Buildup Index—*Continued from page 4*

across forested areas so that all factors can be weighed in determining needed action. Also, briefing of concerned but technically unfamiliar officials is possible.

Fire control chiefs can brief high-level State officials on the situation across a given State and can highlight the more critical areas so these officials can consider closing woods, imposing burning bans, or increasing TV or radio spot announcements on fire prevention in "hot" areas.

However, other officials must know the situation across a combination of States. Researchers documenting wildfires have expressed a need in this area in order to establish degrees of readiness for equipment and manpower. Coordinators of Forest Fire Compacts can use the analysis as an aid in assessing the relative situation among member States. If the BUI can be considered as a partial expression of the potential for large fires, then the analysis can be an important tool in making decisions associated with coordinating manpower and equipment actions resulting from affiliations and obligations of Compacts. Also, in this respect, regional fire control officials who must make interstate decisions should find the analysis a definite aid in fire control preparedness.

The future is bright in this area of BUI analysis. It has been suggested recently that

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AN OPERATIONAL TEST OF AN INFRARED FIRE DETECTION SYSTEM

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An infrared (IR) fire detection system, developed by Project Fire Scan personnel at the Northern Forest Fire Laboratory, was operationally tested during the 1967 fire season. The system, installed in a Convair T-29B aircraft (fig. 1), included three items not found in other IR systems:

1. A rapid film processor
2. A target discrimination module (TDM) which automatically marks hot targets on the film, and
3. A Doppler radar navigation system which provides accurate, instant information on an aircraft's position.

This operational test was designed (1) to determine how well an IR system could detect latent forest fires under natural conditions, and (2) to investigate problems associated with identifying targets on the IR imagery, locating their position on a map, and quickly dispatching the information to the fire control organization.

For this test, a study area covering 41 National Forests in Forest Service Regions 1, 2, 4, and 6 was established. Personnel of each Forest helped verify the IR-detected targets and provided information about fires detected by conventional methods to help determine whether the IR system had missed any fires.

Forests were ranked by their lightning-fire frequency to help in the selection of each mission area. The Weather Bureau's radar at Missoula, Mont., and the radar net centered at Salt Lake City, Utah, provided information on thunderstorm activity in the study area. Using this information, missions were scheduled over the areas affected that had the highest probability of lightning fire occurrence.

Figure 1.—Convair T-29B aircraft used for fire detection missions.

All missions were flown at night about 15,000 feet above the terrain. After each mission was completed, the imagery was interpreted; the legal locations of possible fires and campfires were dispatched to the Forests at about 0700 hours. During July and August, 21 missions, averaging 2.4 million acres, were flown. Unfortunately, we could not fly for about 3½ weeks (July 27 to August 21) because of an aircraft engine failure; half of the planned missions were eliminated.

Imagery recorded from flights included 1,434 TDM marks. The number interpreted as hot targets was 601 (fig. 2). The remaining 833 were interpreted as false alarms. Shortly after the test flights began, we found a design error in the TDM that caused it to mark it in addition to hot targets. Since completion the study, the TDM system has been redesigned to reduce, if not eliminate, the problem.

Of the 601 hot targets, 213 (35 percent) were interpreted as wildfires (fig. 3). Some were later confirmed as other types of hot targets (fig. 2). Most of the remaining 388 (65 percent) hot targets were incorrectly identified because of incomplete ground intelligence. Accuracy of identification should be nearly 100 percent if the location of camping areas, hot springs, or scheduled slash burnings is available to the interpreter.

Fifty-five reported fire targets could not be found or identified on the ground. These unconfirmed reports caused suppression units to lose valuable time in unsuccessful search. Twenty-one of these 55 fires probably burned out naturally. Unfortunately, no remains could

[1] Research Forester, Bitterroot National Forest, Darby, Mont. This article is based on work performed when the author was Study Leader in charge of the Project Fire Scan infrared lightning fire patrol evaluation. He was then stationed at the Northern Forest Fire Laboratory, Missoula, Mont.

found later to verify this hypothesis; however, lookouts reported flareups at locations of two of the unconfirmed targets. The remaining 34 unconfirmed targets could have been small fires that went out naturally or false alarms caused by the TDM and incorrectly identified by the interpreter. Future testing with the redesigned TDM should indicate the magnitude of the unconfirmed report problem.

Of the 388 hotspots identified as miscellaneous targets, two were later confirmed as fires. Both were beside a road and were identified by the interpreter as campfires.

During the patrol season, 134 fires, in various stages of control, were scanned (fig. 4). When control action starts, the amount of radiant heat available for detection decreases until the fire is extinguished; therefore, only unmanned fires were considered in the analysis to determine success of IR detection.

Forty of the 134 fires (30 percent) detected were unmanned when they were scanned. The TDM detected and marked 23 of these 40 fires (58 percent). Five others (12 percent) were recorded on the film, but the TDM did not alarm on them. Redesign of the TDM increased its sensitivity, and we hope these marginal targets will activate it.

Although success of IR detection was lower than anticipated, it compared favorably with conventional detection. At the time the 40 fires were scanned, only 14 (35 percent) had been detected by conventional methods versus 23 (58 percent) for IR. IR detected 14 fires before conventional methods. Several of these fires could have become serious, but early detection by IR prevented such occurrences.

Accurate location of fires is necessary so that suppression units may find them quickly. The interpreter located detected targets to one-

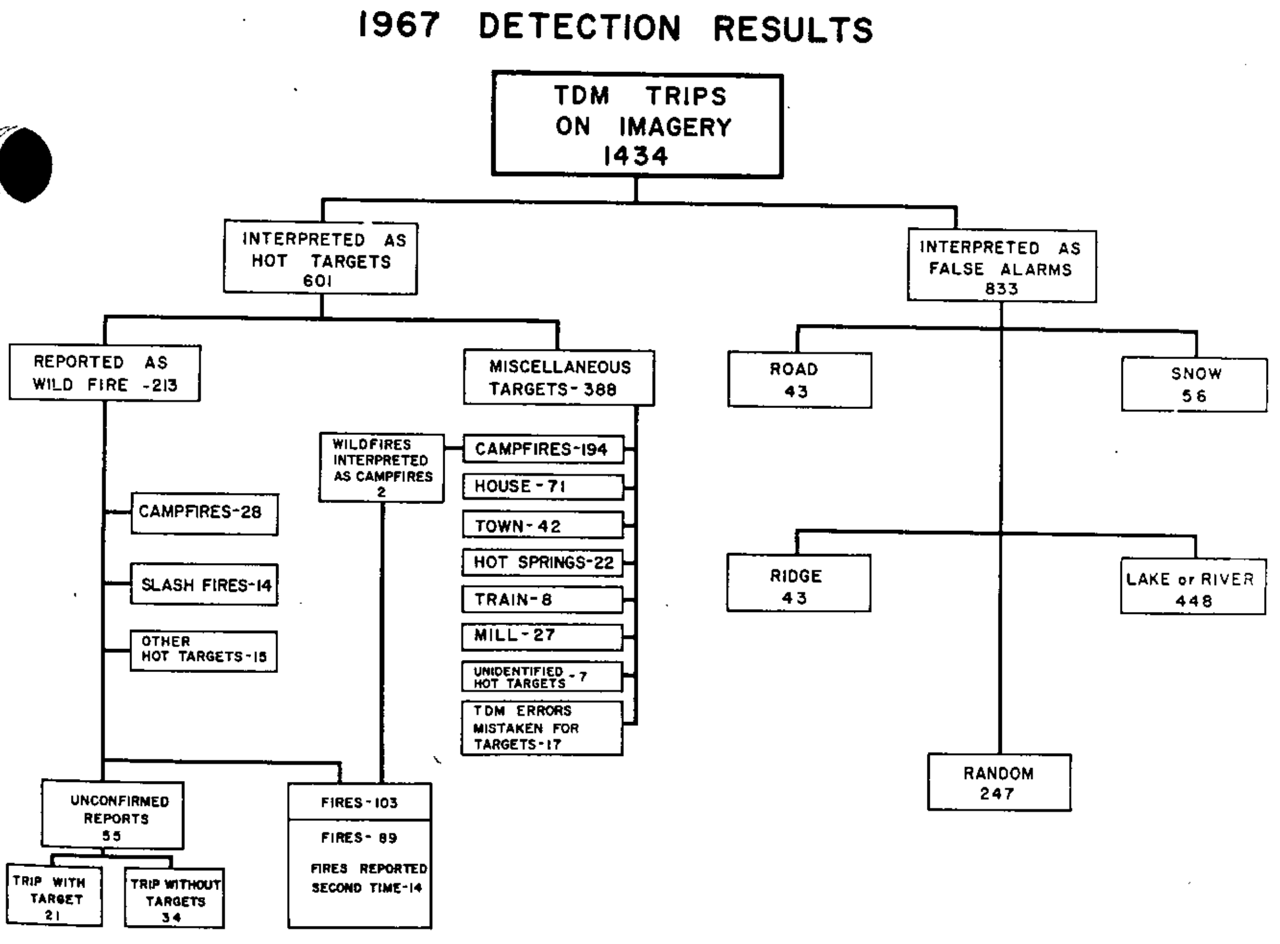

Figure 2.—Summary of imagery from operational test flights in 1967.

sixteenth of a section (a 40-acre block) with the aid of ½-inch-to-the-mile Forest Service maps. To check the accuracy of the interpreter's location of a fire, we compared it with the location shown on the Individual Fire Report compiled by Forest personnel. This check showed that 73 percent of the fires were located within one-fourth mile of the location shown on the official Individual Fire Report; 90 percent were located within one-half mile.

The tests in 1967 demonstrated that this prototype system could detect small wildland fires and that the information could be made available to the fire control group when it was most valuable. An improved system now being developed will increase detection success, reduce the false alarm rate, and provide better IR image detail for more precise fire location.

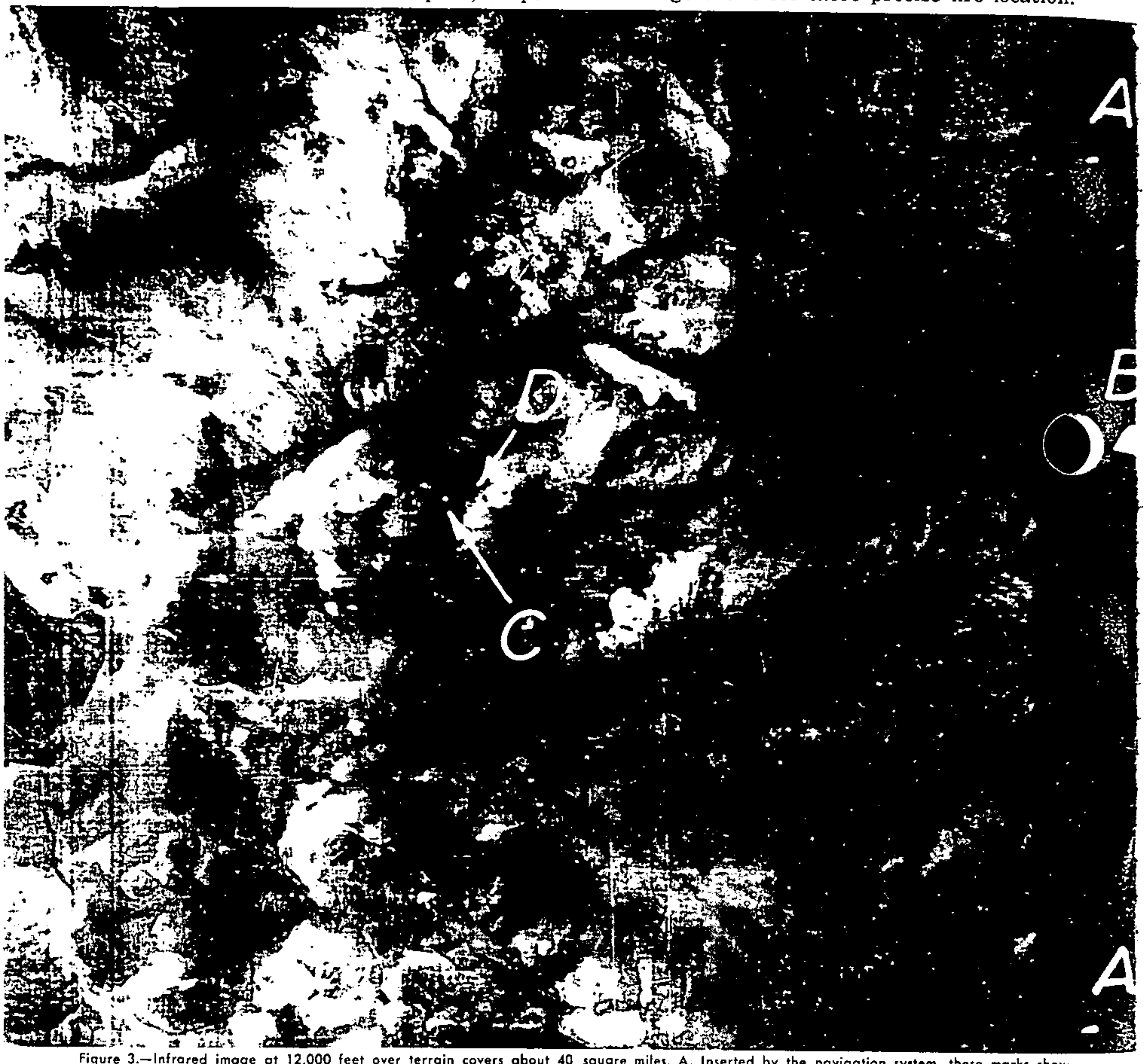

Figure 3.—Infrared image at 12,000 feet over terrain covers about 40 square miles. A, Inserted by the navigation system, these marks show 5-mile intervals along the track; B and C, automatically inserted by the TDM to indicate the presence of a fire target; and D, latent forest

DETECTION SUCCESS

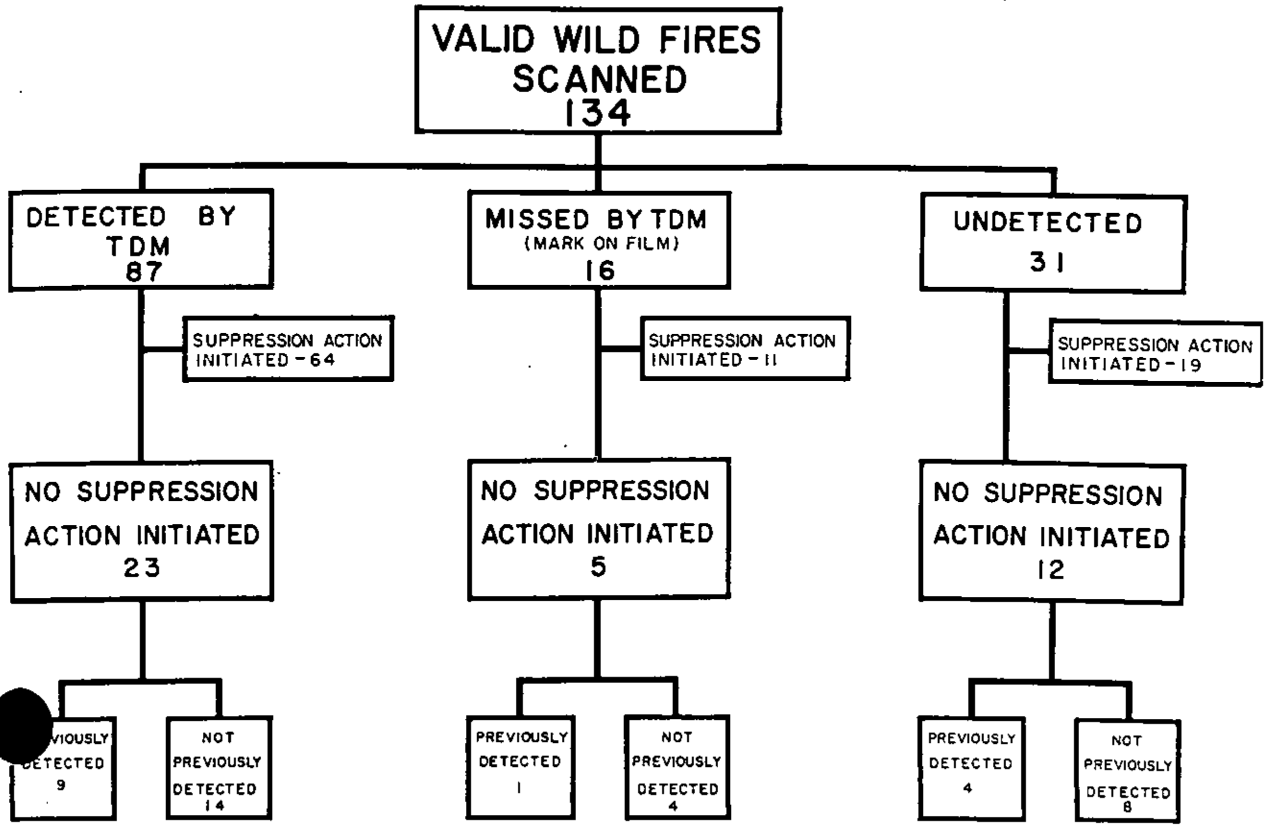

Figure 4.—1967 detection success.

DUMP TRUCKS AS A PORTABLE WATER SOURCE FOR HELICOPTER PICKUP

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Helicopters with buckets suspended from their cargo hooks are being used effectively in wildfire suppression.

One requirement for efficient use is a nearby source of water of sufficient quantity and depth, and in a location where a suspended bucket can be dipped. There are many areas in the forest where there is enough water in the small streams, but the water is not deep enough. For two reasons, it seemed advantageous to try to find a way of obtaining a useable supply of water or retardant in such areas. First, the minimization of delivery time would provide [illegible]e water on the fire; second, the total fire bill would be substantially less.

One way to provide such a spot is to set up a large plastic or canvas sump or tank and keep it filled using a pump. While these sumps or tanks have been used successfully, they are not commonly available, and are usually stored somewhere other than where they would be needed in an emergency. Also, they can be bulky and difficult to handle.

A more readily available substitute was needed. A check indicated that there were quite a number of large dump trucks available in most of the logging areas in western Washington.

In July 1968, tests were conducted in the Kelso District of the Department of Natural Resources, using these dump trucks as a portable source of water for pickup by helicopter.

The tests were conducted under simulated fire conditions in timber in the Whitten Creek drainage of the South Toutle River in Cowlitz County in southwestern Washington. A turbocharged Kaman H-43 helicopter and a 10-yard dump truck with the bed lined with polyethylene were used for the tests (fig. 1). The helicopter has a maximum allowable gross weight of 7,750 pounds (exterior load) (U.S. Air Force manual.) The weight of the aircraft including fuel and pilot is 4,900 pounds, leaving a load carrying capacity of 2,850 pounds. A washtub-type monsoon bucket 29 inches deep and with a 250-gallon capacity was used. The bucket is slung on wire ropes approximately 8 feet below the aircraft.

Suggested rules for setting up a dump-truck or retardant supply for helicopter pickup follow: Preparation—Use a dump truck with a capacity of at least 10 yards (approximately 2,000 gallons). Line the box with a large sheet of polyethylene, and tie down all loose edges to keep them from whipping with the downdraft from the rotors. Place the dump-truck in a cleared area, if possible, on a rise. Point the rear of the truck into the wind and downhill if possible. Be sure there is adequate clearance for the rotors and enough runway for the helicopter to build up flying speed. A cleared area (with a minimum radius of 100 feet) for landing the helicopter should be available nearby for refueling and maintenance. Wet down the area around the water pickup source to minimize flying debris and dust.

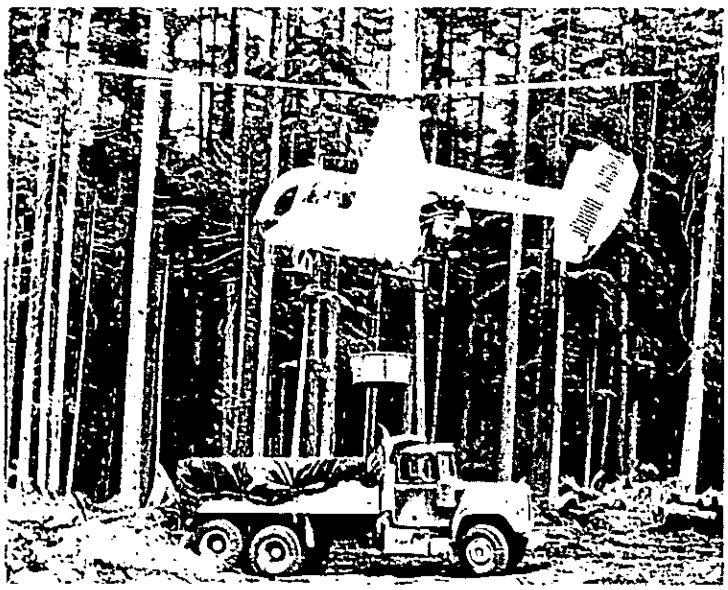

Figure 1.—A helicopter prepares to fill its bucket from a dump truck. Conversion of the truckbed to an emergency water tank is quickly done with a large plastic sheet.

Fill the truck with a volume pump. Gelgard or other short-term retardant or a detergent can be added, if desired, with the use of a field chemical mixer as the truck is being filled (approximately 12 pounds of Gelgard for each 1,000 gallons of water. A dye or coloring agent should be added to help the pilot see where he made previous drops. The truck can be kept filled while the helicopter is in flight. If a spare tire is mounted on the cabguard of the truck, it should be removed.

Ground Control.—A trained signalman should be on the scene to assist the pilot in loading the bucket from the truck. All signalmen should know the standard hand signals used at heliports and similar facilities. The signalman should wear a hardhat with a chinstrap because of the strong wind caused by the downdraft of the rotors. He should also wear goggles while working near the helicopter. All unnecessary personnel should be kept away from the area.

Some industry officials who witnessed the tests were so impressed that they volunteered to have each of their dump-truck beds lined with a folded piece of polyethylene. And dump-trucks were used quite successfully in fighting a slash fire on private land in October 1968.

LIQUID RETARDANT CONCENTRATES—A REPORT ON OPERATIONAL USE

DUANE W. MYLER, *Regional Air Officer, Region 8*

The Southern Region has used liquid phosphate concentrates for mixing retardant for aerial application for 6 years. In 1962, a trial operation was initiated to test the feasibility of air tanker use in the Southeast. Because it was a trial program with an uncertain future, a large expenditure for the mixing equipment, storage tanks, and other facilities required for the dry powder retardants then in common use was not justified. Therefore, attention was directed toward a liquid ammonium phosphate fertilizer manufactured by the Tennessee Valley Authority. The liquid would permit the retardant solution to be easily mixed in the air tanker as needed, and elaborate and costly equipment and facilities would not be required (fig. 1). Analysis of the liquid phosphate by the Macon, Ga., Fire Laboratory indicated it was as effective a retardant as the dry salt DAP or MAP being used elsewhere.[1] The 1962 spring fire season was brief and the fire load was light; therefore, results of the air tanker trial were inconclusive. Therefore, it was decided to continue the project to gain more experience.

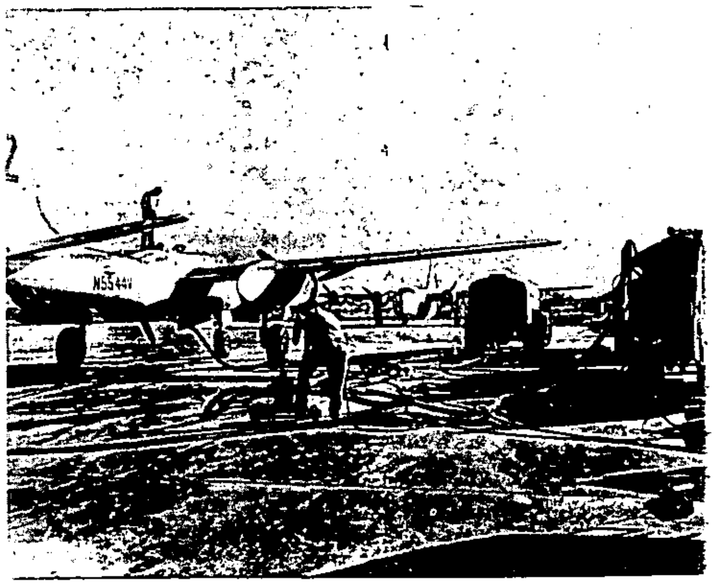

Figure 1.—The Knoxville, Tenn., air tanker base during the early days of air tanker use in the Southern Region. With liquid concentrate retardants, base facilities need consist of little more than a water source, concentrate storage tank hoses, and a pump to load the aircraft.

When the 1963 fire season started, the Region was better prepared for an air-tanker operation. More storage tanks (Air Force surplus refueling units) were acquired, and larger pumps for loading were available.

The 1963 spring fire season rapidly developed into the worst since 1942, and the air tanker trial project quickly became a full-scale attack operation. By March 31, four B-26 air tankers were flying on Region 8 fires. All available retardant was soon exhausted and wet water had to be temporarily substituted. More storage tanks were acquired from the General Services Administration on an emergency priority. Also, the Tennessee Valley Authority cooperated by expediting delivery of retardant. And a PB4Y2 arrived from the West to bolster the air-tanker attack force. Initial attack with the retardant on the smaller fires provided almost 100-percent effective containment until ground crews arrived. In a few cases, air tankers were actually credited with full control. Even on larger fires, the liquid concentrate was extremely effective. In a few cases, attempts were made to cut off the head of hot, fast-rolling, project fires. Little success was achieved under these conditions due to spotting and the inability to build enough line ahead of the fire in a brief enough time. However, it was obvious after the fire was controlled that the retardant was extremely effective—the drop areas were easily identified as unburned islands of fuel. This was well established on a number of fires in the southern Appalachians and in Arkansas.

In the fall fire season, extreme conditions occurred again. Arkansas was in the third year of prolonged drought, and an emergency air tanker base was quickly established at Fort Smith. By this time, tanker crews and the lead-plane pilot were becoming more proficient with the use of liquid concentrate and in overcoming its basic drawback—its invisibility from the air. This was not a problem on initial attack; it occurred only during indirect line-building on larger fires. Lead-plane pilots soon

[1] Johansen, R. W., and Crow, G. L., Liquid Phosphate Fire Retardant Concentrates, Fire Control Notes V. 26, No. 2, pp. 13-16.

found it was not too difficult to keep track of the drops by checking terrain features. Small gaps that did occur were not hard to plug.

Since tanker and lead-plane pilots were all experienced in Western firefighting and in the use of thickened retardants, some were pessimistic about the liquid concentrate unthickened fire retardant. However, by the end of the 1963 fall season, all were enthusiastic.

As a result of the successes attained during the 1963 fire season, the trial air-tanker project emerged as an operational program. Since that time, Region 8 has established permanent air tanker facilities at Knoxville and Tri-City, Tenn., Fort Smith, Ark., and Weyers Cave, Va. (fig. 2).

In 1968, as a result of very critical fire conditions which developed in Florida, an emergency tanker base was also established at Deland, Fla. The first load of retardant was flown from the base 1½ days after work started, utilizing emergency trailer equipment furnished by the State of Florida, and the base was fully operational in 2½ days. The establishment of this base received wide publicity in the local newspapers, and on television and radio. Consequently, fire occurrence declined drastically and far less use was made of the tankers during the rest of the season. (Debris burning is the major cause in this area.) A typical report of the limited use, however, came from St. Regis Paper Company people—"We could not have stopped the fire short of 2,0 acres without the tankers; as it was, we he it to 80 acres." Region 8 will continue a trial project in cooperation with the Florida State Forest Service.

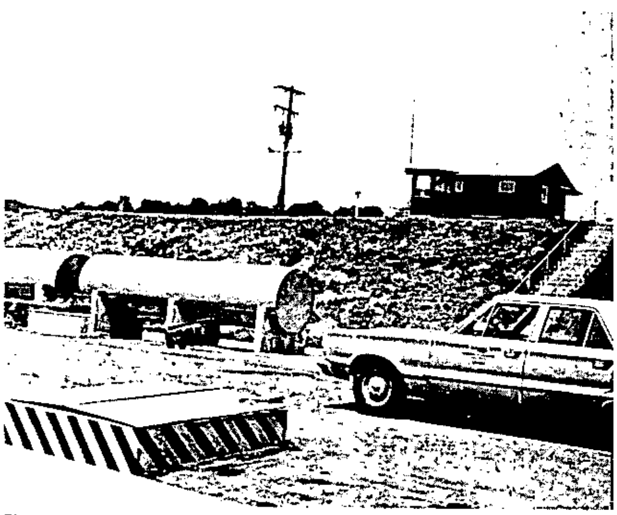

Figure 2.—A view of the permanent retardant base at Knoxville, Tenn., showing dispatch building and two of the three concentrate storage tanks.

Based on 6 years' experience utilizing the liquid concentrate fertilizer as a fire retardant, Region 8 has reached the following conclusions.

1. The retardant penetrates heavy canopies very effectively, not only coating the canopy itself but also the ground fuel.

2. Where thickened retardants tend to coat only the top layer of heavy matted fuels, such as grass, pine needles, etc., the unthickened solution tends to run around, down, and through the fuel, thereby restricting the tendency of the fire to creep under surface fuels.

3. The unthickened material flows around aerial fuels and has more of a tendency to coat all surfaces of the fuel, rather than just the one side.

4. Liquid concentrate is more flexible than dry-prepared retardants because the formulation can be varied at will with no detrimental effects. The water can be reduced in drops prepared for heavier fuels, thereby increas salt coating on fuels.

5. Use of the concentrate eliminates costly mixing equipment and manpower requirements. The physical size of the air-tanker base facility is reduced by eliminating the need for large slurry mixing equipment and a warehouse for storing dry material, and by reduced storage-tank requirements.

6. Storage is not a problem in mild steel tanks. However, brass valves should not be used since any etching will cause the valve to leak. Region 8 has changed to stainless steel or cast iron valves on the retardant side of the system and has eliminated retardant leakage. A regular main-line watermeter has been used for 6 years with no apparent damage to the meter. By loading the 200 gallons of concentrate through the pump, and then following with 1,000 gallons of water, both pump and meter are thoroughly flushed after each loading. Consequently, a wide variety of centrifugal pumps (including aluminum impeller types) have been used successfully.

7. Overwinter storage of the concentrate has presented no problems since the salts

e concentrate act as an antifreeze. Some slushing may occur at extremely low temperature, but not enough to damage the equipment.

8. One of our major concerns at the start of the program was corrosion of the aircraft. Much work was done on inhibitors by the Tennessee Valley Authority, the Fire Laboratories, and industry. But none would protect all the various alloys of aluminum and other metals used in aircraft. Despite this limitation, corrosion problems have been minor. We do not load the plane until we receive a fire call. The aircraft does not sit loaded. At the end of a day's operation, the planes are thoroughly washed down inside and out, with special attention being given to the wheels.

The fertilizer industry now has liquid concentrate facilities spotted throughout the United States, thus eliminating the need for the Forest Service to keep large quantities. The one basic drawback (visibility of the drop from the air) has not proven to be the problem first anticipated. While some method of coloring would still be desirable, the advantages and savings in handling and mixing far outweigh the visibility disadvantage. Region 8 has used liquid concentrate fertilizer as a fire retardant in a wide variety of fuels and of climatic conditions, ranging from semiarid in part of Arkansas to semitropical in part of Florida. This fertilizer has been very effective in all areas.

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computer facilities could be used to compute national BUI values and that an analysis could then be released on the National facsimile weather circuit. Because the BUI is a cumulative expression and requires some bookkeeping, the memory capabilities of the computer seem ideally suited to this task. However, some problems in implementing this idea would have to be resolved. Although approximately 450 to 500 weather reports are taken hourly throughout the country and transmitted on weather teletype circuitry, the basic observation time peculiar to the National Fire Danger Rating System is not uniform throughout the country. Also, the time available for transmission of the computed data or/and analysis may be difficult to obtain on the already crowded schedules of the facsimile circuits. If these problems are solved, a daily aid to fire control during the critical periods will be possible through BUI analyses.

To carry this idea one step further, once the problems mentioned above have been surmounted, it would be a simple operation to add forecast values to the computer input. At present, forecasts of all the weather elements affecting the BUI are already easily obtainable. The computer output would then include not only the current BUI but a series of forecast values corresponding to the time periods covered by the forecasts.

While these BUI analyses and forecasts may not be available in the near future, they are far closer than just a dream. The ESSA-Weather Bureau's high-speed communications systems and the capabilities of its computers are such that only technical problems need be solved to achieve reality.

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A BATTERY CARTRIDGE FOR FLASHLIGHTS

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Flishlight batteries have been prepared and wrapped in various ways for field use. They have always been inserted the same way—one by one. When four batteries are required, they must be placed carefully in series, two with the positive contacts up on the same side, and two with the contacts down. Often the batteries must be inserted in total darkness, and it is difficult to get them correctly installed. Time is also lost in the field while inexperienced men are assisted in properly inserting batteries.

Four batteries fastened firmly together in proper series by *pressure sensitive tape* form a *cartridge* that can be placed in the flashlight without a mistake (insert either way) making proper contact immediately (fig. 1).

To implement this idea using the present stock of flashlight batteries, a simple device or "jig" for holding them firmly can be used to make up the cartridges (fig. 2).

The General Services Administration can supply 2-inch pressure sensitive tape (#8135-663-3738) at $1.90 per 60-yard roll.

The jig must be so constructed as to assure firm contact of the terminals by means of pressure from one end as the batteries are placed in the device for taping. If metal is used for this pressure plate or holder, an insulating material, such as tape, must cover the metal to prevent battery discharge during the tape-wrapping process.

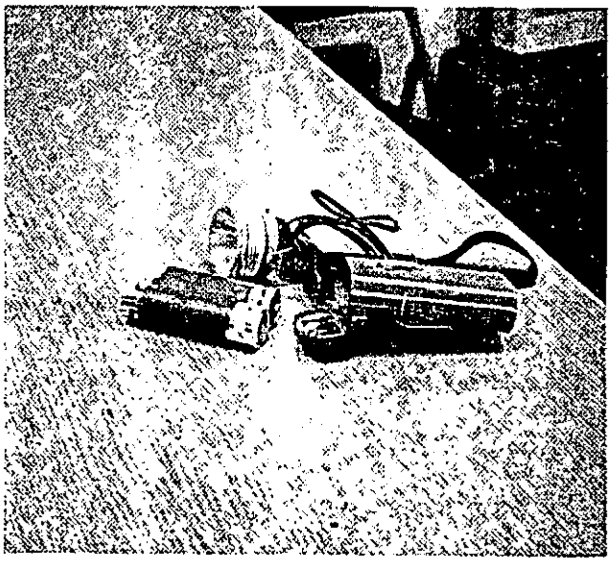

Figure 1.—Four-cell battery cartridge—no error in installation can be made.

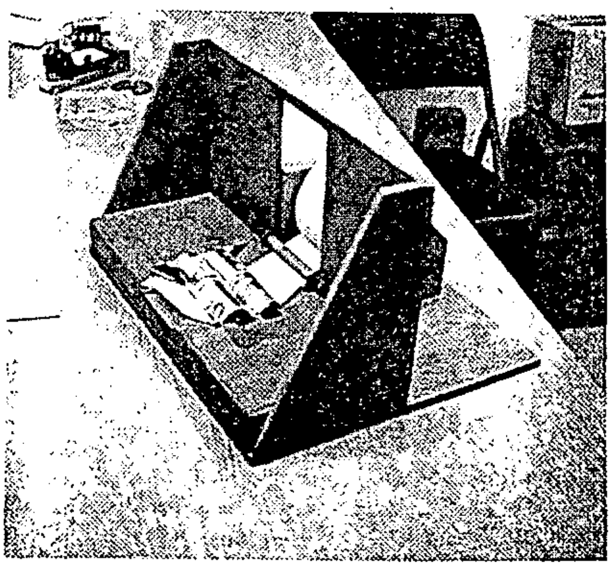

Figure 2.—Jig for quick battery cartridge construction.

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