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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.

UNITED STATES DEPARTMENT OF AGRICULTURE 1862 1962

Growth Through Agricultural Progress

Volume 22 Number 3

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

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Forest Service, Washington, D. C.

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TACTICAL USE OF FIRE RETARDANTS FROM THE AIR

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The roar of powerful aircraft engines and the cascading of a thousand gallons of fire retardant marked another tactical application of fire retardants by aerial methods. This was part of the air tanker program of the Intermountain Region, U. S. Forest Service. Following successful field tests in California, the first air tanker unit in the Intermountain area was established in 1957 on the Boise National Forest. Since then the program has expanded to include 7 of 18 national forests in the region. Nearly 400,000 gallons of fire retardants were used in 1960.

The end of the expansion is not in sight. Proper use of retardants is the end point of successful programming. Although much has been learned, it is imperative that we continue to record, analyze, and report on this important fire suppression tool.

ACCEPTED TACTICS

Tactics in fire suppression can be defined as fire control action based on what needs to be done, where, how, and when. The definition of tactics for the aerial use of retardants is no different; all the factors that influence fire behavior, fire control, and safety must be weighed carefully. Tactical use now accepted generally in the Intermountain area is as follows:

Small fires.—Air tankers are perhaps most valuable for initial attack, knocking down and corralling small, dangerous fires. Although a few fires may be extinguished by this method, ground action is almost always required to complete the job. The key to successful initial action on small fires is fast attack. Decisions on air tanker use are based on fire behavior, expected effectiveness of the drop, resource values, elapsed time for ground crews and the air tankers, and comparative costs with and without the use of air tankers.

Air tankers also can be used effectively for followup on small troublesome fires that threaten to escape control of ground crews.

Large fires.—Tactical use of air tankers on large fires embodies the same principles used in ground attack. In general, however, air tanker attack should be limited to situations where the chance for successful action is high and benefits will more than offset costs. Sound, experienced judgment is needed during the entire operation.

The most effective result expected of air tanker action on large fires generally is the stopping or delay of fire spread. A hotspot attack, spot-fire attack, or temporary control line may be involved.

Attack on the head of the fire normally should be considered first. However, unless the head of the fire is small, fuels are light, or sufficient air tankers are available to achieve the objective, flanking attack usually will be more effective. Often these decisions must be made when the air tanker is already over the fire, in many cases by the initial attack pilot. Preferably, they are made by the air attack boss under the direction of the line boss.

Frontal attack can be effective on a ridgetop or along a change in fuel type where there is a better than normal chance to stop fire spread. Frontal attack may also be sound where delaying tactics can prevent fire from running into areas where it will be more difficult and costly to control.

Flanking attack on badly spotted areas or on small fingers to keep fires from fast-spreading, heavy fuel areas or steep topography will likely do more to lessen the total perimeter than attack on the main head of the fire.

Besides its value for initial attack, the use of retardant for hotspotting has proved most successful. Flareups can be knocked down effectively to keep fire within planned limits. This applies to spot fires outside the line as well as to crown or ground fire runs within the planned or constructed line. Spot fires can often be prevented by timely action on brand-throwing snags and flareups.

Air tankers are also used on large fires to lay continuous preplanned control lines of retardant, either alone or coordinated with ground forces. Retardant firelines are placed in locations similar to those constructed by hand or machine, and with the same attack objectives: (a) direct attack by laying the line on the fire edge; (b) parallel attack by laying the line a short distance from the fire edge, primarily in coordination with ground crews to shorten lines on irregular fire edges; and (c) indirect attack by laying lines fairly distant from the head or flanks from which ground crews can backfire or burn out. Because of safety factors, direct-attack retardant lines generally are laid as extensions of lines constructed by the ground crew rather than concurrently with the ground crew.

When air tankers and ground crews are conducting a coordinated direct attack on the same sector, the air tanker is best used as an advance hotspotting unit to knock down and cool the fire. This enables ground crews to work safely on the fire edge. Air tankers are also useful as control support during the burning-out phases of parallel and indirect attack. Complete coordination is necessary, however, to be sure retardants are dropped only on dangerous hotspots and not on the planned burning.

Air tankers can be effective in strengthening control lines, particularly in sectors with hastily constructed shoestring lines. They can also be effective in the fireproofing of larger areas outside the lines where the potential of spotting is great.

Retardant line-laying around improvements, pretreatment of improvements, and suppression of blazes already started are acceptable uses of the air tanker if benefits justify the costs. Similar tactics can be used to protect personnel and equipment.

BASIC REQUIREMENTS

Initial planning.—Use of air tankers is a costly operation, including the establishment of the program and actual employment of personnel. Consequently, various decisions must be made before tankers are obtained. Will tankers produce more effective control than other methods? Are suitable operation bases available? Can qualified pilots and ground personnel, satisfactory aircraft, and adequate communication be obtained?

Basic plans and needs.—Operation bases should be strategically located for maximum mobility and minimum flight time. The primary base should be as near the center of expected activity as possible. Mixing and loading facilities must be adequate to handle normal planned use and also adequate for expansion to meet maximum sustained operation. Supplemental portable equipment may provide the overload facilities needed at the primary base as well as the temporary facilities needed at secondary bases. Water supply, tank storage, electricity, communication, and aircraft servicing facilities are all essentials at the primary base.

Concurrent with selection of base facilities is determination of the retardant(s). Effectiveness as measured by density of material, tested dispersal patterns, penetration, and lasting retarding action should be considered. Cost comparisons should be made, including basic materials, transportation, storage, mixing equipment, and mixing crews. Possibilities for adequate backup supply support during sustained operations should be explored.

Firm arrangements for adequate numbers of suitable aircraft should be made. Number, type, and capability should be determined, based upon distance involved, speed, maneuverability, capacity, drop characteristics, landing field requirements, and rental rates. Satisfactory tanks and gates are essential. Suitable lead planes and other control aircraft should be included and helicopter tankers considered.

Reliable radio communications are an absolute necessity for safe and effective operations. Air-to-ground communications with the base, dispatching headquarters, and ground attack forces are as essential as air-to-air needs.

Manpower requirements must be met fully and all segments well organized. Skilled and experienced pilots must be obtained along with adequately trained men to handle base operations. The lead plane pilot and at least one tanker pilot should be qualified as an initial attack pilot. Pilots' qualifications and training should be verified through preseason checks. Provision must be made for relief pilots and ground crews during sustained operations. All manpower assigned should be welded into a smooth functioning team that can be integrated into a fire suppression organization of any size. The air attack organization for large fires must be developed so that control is maintained over each part of the entire air operations at all times. Fully trained and qualified individuals should be available to fill air officer and air attack boss positions.

Training in air tanker operations is a "must job" that should extend to all levels in the fire organization. Base personnel must have training in all phases of base operations and in large-fire organization. As a minimum, pilots should receive training in fire organization, fire behavior, tactics, drop techniques, and safety. They should be given written guides and rules for safe and effective operations and should receive in-flight drop training. Fire overhead who may utilize air tankers should be trained in aerial tactics, organization, and traffic control, with in-flight or mockup training provided for those who will fill specific positions in the air operation organization. All other fire personnel must receive training in the safety aspects of aerial operations.

A system of recordkeeping and reporting is vital to the air tanker operation not only for financial control but also for evaluation of results. Procedures should be well established prior to the start of seasonal operations.

A safety plan should be prepared for each base and adequate aerial safety rules and instructions incorporated in other plans and training programs.

Operating plans.—The success or failure of any tactical mission depends to a large degree upon the adequacy of mobilization and dispatching, as may the efficiency, effectiveness, and safety of the entire air tanker operation. Preseason planning and preparedness plus a highly competent dispatcher are required.

Preparedness for the dispatcher must include well-conceived action guides that remove much of the guesswork. As a minimum, an air operations map should be prepared which will show aerial tanker use areas and flight hazard areas. It should be based upon flight time, travel time for ground crews, resource values, fuel types, and topography. From this map, dispatching guides can be developed for various fire danger classes. Type and strength of initial attack and the followup required should be included in the action guides as well as provision for aircraft and ground crew standby and automatic dispatch.

The action plan should provide for guide modification by the dispatcher as needs dictate and include a list of operational limitations that may be encountered by the various aircraft. Since this modification will be based upon availability of ground crews, fire behavior, rate of speed, wind and other weather and flight conditions, provision should be included for the collection of this information. Pilot briefing should be incorporated in the action plan so that all pilots are completely apprised of the mission to be accomplished, responsibility for drop decision, traffic control over the fire, and flight hazards. Maintenance of control at central headquarters over all aerial operations should be spelled out.

CONCLUSION

The use of fire retardants from the air has proved to be a fire control tool of great potential. Not all use has been effective nor have all operations been efficient and safe. Yet, considerable savings have been made through the use of this tool and serious accidents held at a low level. A continued expansion of the program, however, will depend upon more effective, efficient, and safe operations. A better understanding and use of acceptable tactics preceded by more careful planning and direction is needed.

NIGHT ATTACKS WITH TRACTOR-PLOWS IN THE SOUTH

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Forest Supervisor, Florida National Forests

The odds are in our favor when we make night attacks with tractor-plow teams on fires in the southern Coastal Plain. Although such attacks have some handicaps, there is a big advantage in reduced rate of spread during the night hours. The differences in fire behavior reported here, and in the burning conditions that caused them, were observed at a night attack training session on the Ocala National Forest January 31, 1961.

Two training fires were held on a 10-chain fire training strip in a 6-year rough of wire grass and palmetto under mature longleaf pine.[1] One fire was at 3:00 p.m. The other was at 10:00 p.m. and adjacent to the first one. Fuel moisture and wind velocity measurements were made at the fire danger station about 6 miles from the training strip. These were taken hourly from 8:00 a.m. January 31 to 8:00 a.m. February 1. On January 29, two days before the training fires, 1.83 inches of rain fell at the fire danger station.

During each fire, the rate of forward spread was measured by placing steel-can markers at the flame front at 1-minute intervals. Head fires were used both times. The attacks on the two fires were by a tractor-plow team led by a district ranger, and they were observed by fire men of greater experience who later participated in discussions. The differences in fire behavior and weather conditions were as follows:

	Day fire (3:00 p.m.)	*Night fire* (10:00 p.m.)
Fuel moisture, percent	6	16
Wind velocity, m.p.h.	4	0
Burning index (8-100-0)	5	0
Average RFS, chains per hour	33	3
Average flame height, feet	25-30	5-10
Backfire distance, chains[1]	5	1½
Parallel backfire distance, chains	1	½
Meeting distance, head fire and backfire from plow line, chains	1½	½

[1]On the day fire, the ranger's 1-minute observation of rate of forward spread was 50 chains per hour. Observers agreed that the backfire distance taken was about right.

The fuel moisture readings are shown in figure 1, wind velocities in figure 2, and burning index in figure 3. Although it is not customary to keep weather records throughout the night, the fire dispatcher and others who are familiar with weather conditions in the locality said that, except for the rise in wind velocity around 7 o'clock, the pattern was typical of the winter fire season.

[1]The use of fire training strips was described by the writer in Fire Control Notes 20(3): 69-76, illus. 1959.

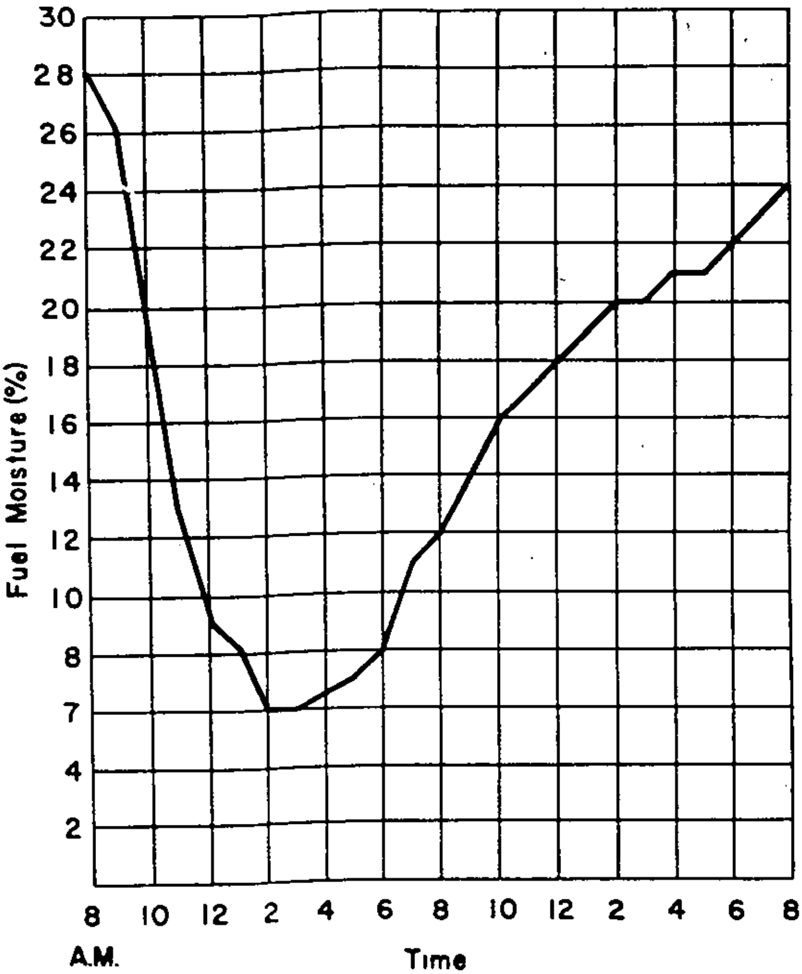

FIGURE 1.—Fuel moisture for 24-hour period.

It is evident that conditions most favorable to an attack occur between 8:00 p.m. and 8:00 a.m. Wind velocity is low and fuel moisture is rising. The combination results in milder fire behavior. This is the principal advantage in night attacks. It should be remembered that the night attacks discussed herein are initial attacks made with tractor-plow teams on fires that started at night or late in the afternoon.

The day after the training fires, about 30 fire control men, some with many years of experience, discussed the problem of night attacks with tractor-plows. It was agreed that night attacks are to be used as fully as possible in spite of some of the handicaps and problems involved. It was evident that the problems are created principally by darkness and by fatigue and sleepiness that

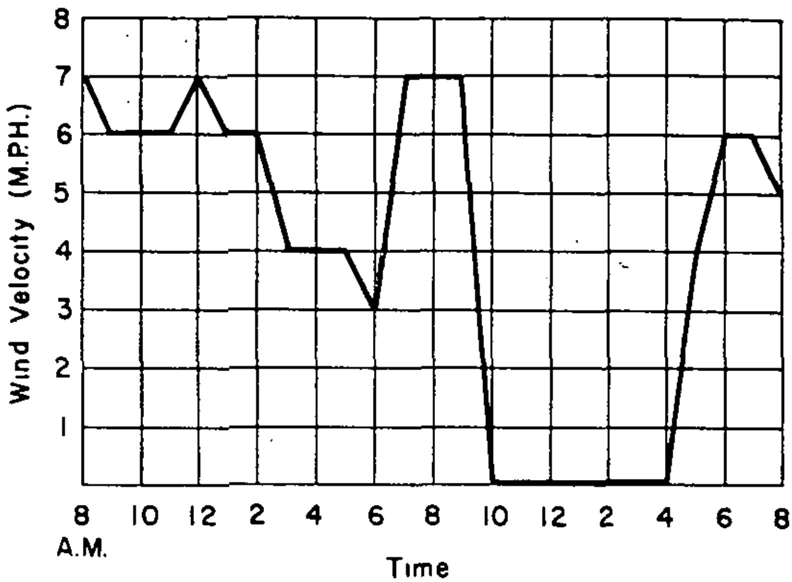

FIGURE 2.—Wind velocity for 24-hour period.

accompany night work, especially if men have worked or traveled during the preceding day.

Darkness prevents air scouting; observers can see fires but cannot locate landmarks. Darkness also hinders ground scouting and even the use of aerial photos; it is very difficult to locate bays and swamps in flat country at night by either method. Deciding what is ahead of the fire and what is ahead of the plow is more difficult at night. It is also more difficult to ascertain the width of the head of the fire if it is beyond immediate vision.

Darkness also brings increased danger of accidents with trucks, especially if there is smoke, and with tractors. In fact, experienced tractor-plow operators were unanimous and firm in saying that having a lead man was too dangerous; they could not watch for his safety and they did not need him to avoid holes or stumps. It was also recognized that there are greater possibilities of injury from falls and handtools, and that eye injuries from twigs are more likely at night.

The following suggestions were made as to means of relieving the handicap of darkness. Scouting can be done well enough if local men are used as guides rather than on other jobs. Dispatchers can help read aerial photos and direct crews if lookouts can give accurate fire locations and crew locations can be pinpointed. Less hazardous working conditions at night can be brought about by good foremanship; good crew organization and discipline are essential. The foreman should remind men of safe practices to avoid night hazards. Good lights, preferably head lights, are desirable but not every man need have a light. Tractor-plows are equipped with lights, front and back. Even though tractor operators do not want a lead man, they wish to have another man

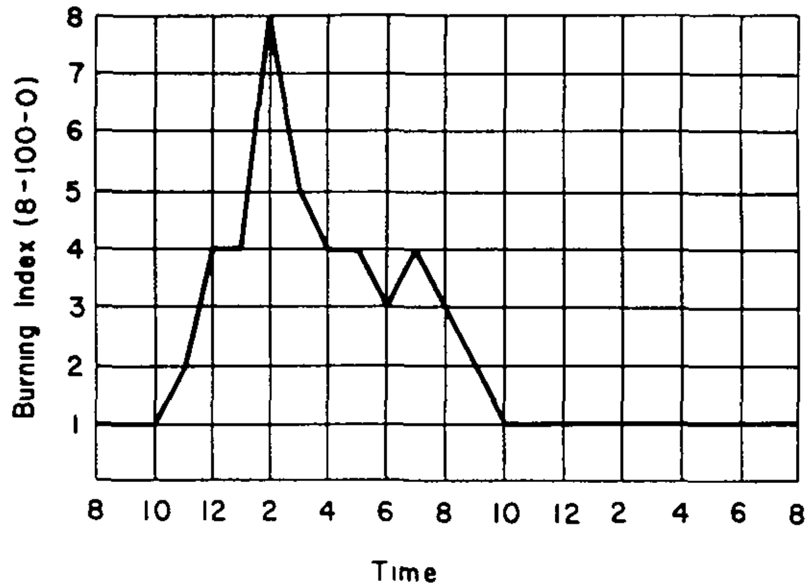

FIGURE 3.—Burning index for 24-hour period.

handy, preferably one who can operate in an emergency and who can assist if the tractor lodges on a stump. Line firing and holding are faster at night, but tractor-plows can still keep ahead of crews while operating at lower speeds. Slower truck driving, especially if there is smoke, was emphasized as an important safety measure.

To help overcome the handicap of fatigue and sleepiness associated with night work, it was agreed that 12 hours of tractor-plow operation should be the limit. The most practical suggestion was to arrange two split shifts of 6 hours each during the night. This would enable each operator to get some rest. The crew members could also be shifted, but doing so was considered not especially important because of the easier work at night. The men should be fed, of course, during the night. The tractors are tireless but, as one man said, "they do get hot, dry, and thirsty." With the declining burning index in the early evening, it was considered desirable to service the tractor-plows before dark. Operators said they could do so faster and better, particularly where visual checking is involved. In general, if a night shift is needed, the need should be realized before 5 o'clock so that arrangements can be made with the districts from which reenforcements or replacements are to be obtained.

The conclusion was that even though tractor-plow teams might have difficulties with severe fires all afternoon, they could look forward with confidence and relief to the 12 hours from 8 p.m. to 8 a.m. during which they could easily close lines, fire them, and mopup.

IRRIGATION PIPE ON FOREST FIRES

Steve Such, Supervisor,
Forest Fire Experiment Station, Michigan Department of Conservation

Effective forest fire suppression requires a large variety of materials, equipment, and techniques. Among the many useful and practical types of equipment making an appearance on the fire scene is aluminum irrigation pipe.

Irrigation pipe first came into fire control use in Michigan in the early 50's and has become increasingly more popular. The many advantages of irrigation pipe over hose, and some of its applications, are well covered by L. A. Dorman.[1] In his article Mr. Dorman summarizes the distinct advantages of irrigation pipe as follows:

1. Faster to lay and to pick up.
2. Less labor to handle.
3. Cleaner and easier to handle.
4. Less maintenance, especially in cleaning, drying, and storing.
5. Usable over greater distances because of low frictional losses.
6. No deterioration in storage.
7. Greater lifetime than hose.
8. General all-round usefulness.

Since this article appeared, irrigation pipe has been used successfully on many fires in Michigan. Field personnel attest to its excellence with enthusiasm. Used mainly on fires requiring large volumes of water, irrigation pipe has been found ideal for muck and ground fires.

Transportation of this pipe is facilitated by the use of a special four-wheel tandem-axle trailer, designed to accommodate either 16-foot or 20-foot lengths of pipe (fig. 1). Any given trailer may carry one of the following quantities with the necessary fittings:

1. 100 lengths, each 3 inches by 20 feet.
2. 195 lengths, each 2 inches by 20 feet.
3. 50 lengths, each 3 inches by 20 feet, and 88 lengths, each 2 inches by 20 feet.

Aluminum pipe is especially light in weight and unusually strong. Pipe 2 inches in diameter, 20 feet long, weighs 9 pounds. Pipe 3 inches in diameter, 20 feet long, weighs 12 pounds. The 2-inch pipe has a bursting pressure of 300 p.s.i., and the 3-inch pipe a bursting pressure of 250 p.s.i. Sections are connected by steel ball couplings which are permanently affixed to the pipe.

[1]L. A. Dorman. Use of irrigation pipe in forest fire suppression. Fire Control Notes 15(3): 9-13, illus. 1954.

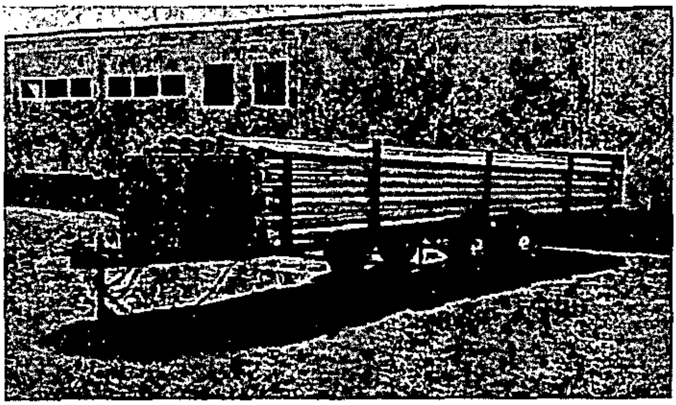

FIGURE 1.—A four-wheel tandem-axle trailer with a full load of aluminum irrigation pipe ready for dispatch to fire. Pipe can be handled fast and efficiently.

Coupling is accomplished by a push, and uncoupling by an easy twisting pull. A flexible steel coil spring makes both a positive lock and seal with the slightest water pressure.

Although in appearance, aluminum pipe looks rigid, it is surprisingly flexible at the joints, permitting up to 22 degree displacement for placement on rough terrain. This feature alone allows this pipe to be used on practically any forest fire, including those in dense growth of trees and on rough ground found in Michigan.

A 12-foot length of 2½-inch discharge hose is coupled between the pump and pipe to act as a damper. Each irrigation pipe trailer permits the use of up to eight or ten discharge lines, although in practice two or three are the most that are used.

The pump used in conjunction with irrigation pipe is generally of the centrifugal type, and is trailer mounted. Most of the units in Michigan are capable of displacing 500 g.p.m. at 120 p.s.i. They are powered by a 115 hp. industrial engine. The centrifugal pump costs approximately $2,600 and total cost of the trailer, pipe, and fittings, is approximately $2,100.

The many satisfactory experiences with irrigation pipe make certain that its use in Michigan will remain one of the standard methods of pumping water on forest fires. The amount used will surely increase. Further information may be obtained from the Michigan Forest Fire Experiment Station, Roscommon, Mich.

BOMBARDIERS FOR MARSH FIRE CONTROL

DON WILSON
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The Minnesota Division of Forestry put one specially equipped Bombardier crawler vehicle in service on swamp grass fires in the spring of 1960. An iron-mesh cab was installed to protect the driver and crew from brush, falling limbs, and timber. Two 150-gallon, low water tanks were installed directly over the tracks for better weight distribution. A pump powered by a 3 hp. air-cooled motor was mounted on the rear deck. It is capable of pumping 7 g.p.m. at 100 pounds pressure through 150 feet of 1-inch rubber hose on a live hose reel. Racks in the cab carry six backpack pumps, four No. 2 shovels, and four 3½-pound axes (fig. 1).

The Bombardier was used on 11 fires and controlled 840 chains of lowland fireline in 30 hours of operating time. Only on one fire was a refill of water tanks necessary. A water extender was used on all fires. Much of the 840 chains of fireline was controlled by actually driving on the fire and smothering it with the tracks, or by establishing a wet control line in front of the fire. The moisture in the peat was brought to the surface and thrown by the track

FIGURE 1.—The Canadian-manufactured Bombardier operates on endless rubber and rayon belts, and with lugs running over pneumatic tires that have less than 1 pound of ground pressure per square inch. The two 5½-foot long tracks, each 29 inches wide, carry the (11′8″ by 7′3″) vehicle powered by a 115 hp. 6-cylinder motor. Maximum road speed, 25 m.p.h.

action at the same time that the fuel was tramped down; this created a firebreak that was in most instances effective.

Fire throwovers were taken care of by firefighters on foot in the followup action or by turning back with the Bombardier to control the spots. When the fast rate of spread and the presence of smoke necessitated the use of water through the pumper, there was a definite advantage in operating on the burned side of the fireline. Operating in this position allowed the Bombardier and the crew to work much closer to the actual fire, and it proved much safer and more effective. Also, the driver was able to see any stumps, rocks, logs, or even pools of water which would indicate softer and unsafe ground.

The most effective crew was composed of a driver, a nozzle man, and two or three men with backpack pumps to do the mopup. It is essential that the driver be acquainted with the vehicle operation and that the nozzle man be experienced in order to extinguish a maximum amount of fire without wasting water.

The vehicle can be operated over the road to and from fires under its own power. However, faster and safer travel with no track wear was possible by transporting it on a tilt-bed trailer behind a 2-ton truck.

Each piece of equipment tried for fire control by our Division is viewed with the thought of possible usefulness in other phases of our work. The Bombardier has already proved valuable in forest management. During the winter of 1959-60 it was used extensively in the remeasurement of many of the 1,200 continuous forest inventory plots.

A special heated cab was installed. It was designed to carry four men plus snowshoes and gear. Trips up to 8 miles one way were made. The use of the Bombardier resulted in the saving of much time and was an important factor in the early completion of the project. In addition, the vehicle was used in the cruising of Christmas trees in spruce swamps. Many of these swamps are intermingled with large open lowland grass areas, and the use of the Bombardier greatly simplified movement of the crew from one stand to another.

The Division has successfully developed a swamp tree planter to be used in State-owned nonforest swamp areas. Experimentation to date has indicated the effectiveness of the Bombardier to pull the swamp planter, and it is expected that this vehicle will play an important part in the program.

Obtaining sphagnum moss for use in packing trees produced in Division nurseries is an annual project that has presented transportation problems because of the very wet swamps. By using a special type of dray on which to load the wet moss, and the Bombardier for pulling, a former problem became a routine job.

To date the one Bombardier owned by the Division has been used a total of 1,000 hours. Operating costs have totaled $247 and maintenance costs $1,100, which included one complete set of tracks. It is expected that a major motor overhaul will be necessary at about 2,000 hours and that maintenance costs after 3,000 hours will make retention of the vehicle prohibitive.

A smaller model of the Bombardier is also manufactured, and we plan to acquire one for trial. It is 2 feet 4 inches shorter, with 20-inch wide tracks but with the same motor power. It is capable of carrying two men for timber management work and probably half the amount of water and firefighting equipment. We believe that this unit will be nearly as effective for fire control work as the larger one, and it will cost much less. It should operate effectively on marsh fires with greater ease, and also provide faster transportation to fires since it can either be hauled on a truck bed or on a smaller trailer drawn by a pickup truck.

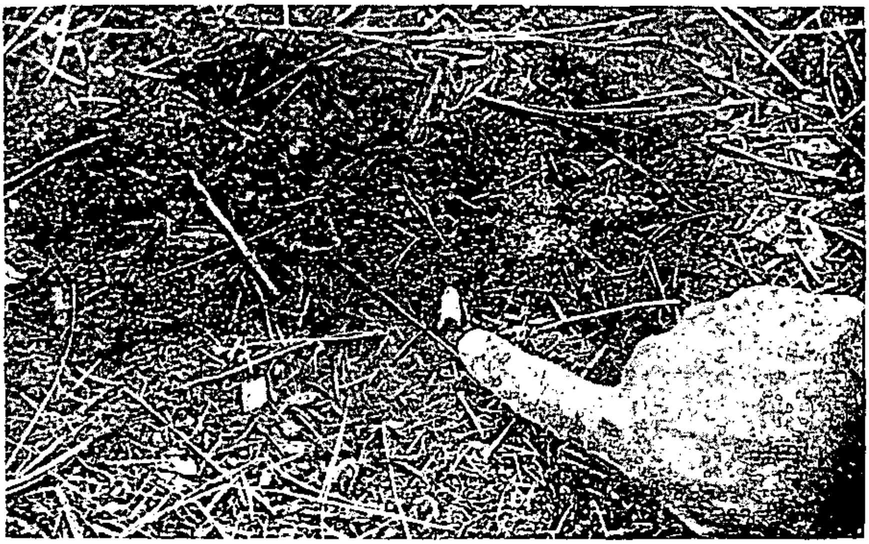
The Bombardier, when obtained in quantities that we need, will be a most effective fire control tool in our problem areas, and at other times it will provide us with a more effective means of carrying out other phases of our work.

☆ ☆ ☆

Here's Proof: Cigarettes Do Start Forest Fires

This cigarette-caused fire could have become a large fire, but fortunately it was found while still a "smoke."

Even though the dry grass and needles on the ground were sparse, the cigarette had started a smoldering fire that could have spread rapidly with the right conditions.



Some skeptics say that cigarettes will not cause forest fires. This photo is evidence that they will.—Danny On, *Assistant Ranger, Kootenai National Forest.*

WATER USE FROM LIGHT AND HEAVY TANKER-TRUCKS

JIM JAY, *Fire Staff Assistant, Lower Michigan National Forests,*
and STEVE SUCH, *Supervisor, Forest Fire Experiment Station,*
Michigan Department of Conservation

In Michigan, most forest fires are attacked initially by four-wheel-drive tanker-trucks. These units are capable of reaching practically all fires occurring in the State with the exception of fires along canoe routes or in swampy fuels. The very nature of the large areas of flashy fuels such as conifer slash and young conifer timber makes fast, mobile units essential. Years of experience have proved this type of equipment to be very practical and efficient for quick, decisive action in the early stages of fire in the woods.

The U.S. Forest Service and the State of Michigan both employ the four-wheel-drive truck as a water carrier because of its off-the-road performance characteristics. Michigan more often uses the heavier type truck, which carries as an accessory a hydraulically operated rear-mounted plow (fig. 1), whereas the U.S. Forest Service prefers the lighter units because of their greater flexibility for multiple purposes.

As a matter of practical tactics, tractor and plow combinations are used as an immediate followup to the tanker outfits, usually

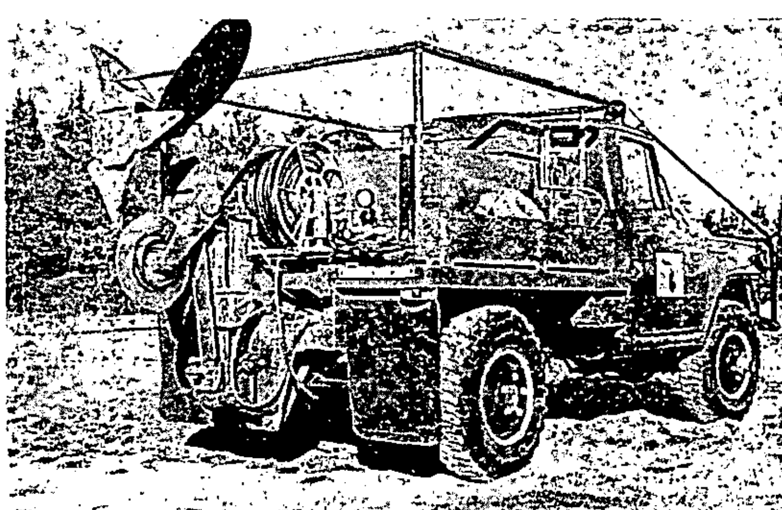


FIGURE 1.—Tanker-truck with mounted plow, Michigan Department of Conservation.

arriving on fires a few minutes after the pumpers begin their work. This "one-two punch" procedure insures effective, positive control of all but the most stubborn or explosive type of fires.

Although recent development of chemicals, retardants, and detergents as additives has greatly increased the efficiency of water, where the cost of these agents prohibit their use or their application is impractical, plain water is still superior to anything else yet known in producing a cooling and smothering effect in direct attack on forest fires. Consider the following from a recent report:

"The 300 gallons of water contained on the vehicle will provide 45 minutes of continuous fog, or as usually used on going fires, will provide intermittent operation up to several or more hours. The two 20-foot intake hose and injectors (tank refillers) permit filling of tank from any water source in less than 5 minutes. The high pressure fog discharge of the pump is instantly adjustable to any conical form from a wide bloom for close work to a driving, solid stream more than 30 feet long. High pressure fog puts out fire by cooling, smothering and blasting. The tiny water particles of the fog present a large surface area to the fire, and the heat of the burning fuel is almost instantly absorbed as these fine particles burst into steam, expanding the water to over 1,000 times its original cubic displacement. This steam replaces some of the air feeding the fire with resulting smothering or starving effect. Also, the tremendous velocity of the fog blasts the fire and tends to separate the flame from the fuel. The combination of the three aforementioned effects, plus the conventional dampening of the fuel, produces rapid extinguishment. A distinct advantage of high pressure fog is that it uses little water which is of vital importance in forest fire control. One gallon of water converted into high pressure fog will do the fire fighting work of many times that quantity at ordinary pressures."

Specifications for tankers may vary considerably, being generally dependent on the chassis rating of the basic vehicle. One-half-ton to two-ton trucks are commonly used. More accurately, these are identified by a gross vehicle weight rating such as 14,000 g.v.w. The g.v.w. determines the amount of payload that can be carried.

A broad specification outline and some major features embodied in state and federal tanker-trucks and their accessories is listed below:

Truck—any of many four-wheel-drive units up to 15,000 g.v.w., with transfer case and two-speed transmission permitting high and low range operation with 8 speeds forward and two in reverse. One specification for purchasing on a 11,000 g.v.w. truck calls for 130-inch wheelbase and 9.00 x 18 10-ply tires, as well as the transmission above.

Water tank—steel, hot galvanized dipped, capacity of 100 to 500 gallons, depending on truck size. Truck with 11,000 g.v.w. has 300-gallon tank.

Pump—any of several types and makes available, but positive displacement piston type is preferred for pressures up to 700 p.s.i and discharge to 20 g.p.m. Fog feature is important for best performance under certain conditions.

Hose reel—motor-driven re-wind live-reel type, usually with 200 feet of ½-inch high pressure (800 p.s.i.) hose.

Discharge nozzle—several commercial types available allowing straight stream to fog characteristics.

Winch—front mounted with cable to withstand maximum loads truck can exert.

Radio—two-way FM mobile units.

Supplemental—handtools, back pumps, emergency repair tools, first-aid kits, backfiring torches, tow chains, traction chains, water canteens, and emergency night lights.

Optional—attached hydraulically operated plows mounted on rear, used on trucks over 8700 g.v.w.

Tanker-trucks are conceded to have a top speed of 65 m.p.h. and may cost, depending on accessories, up to $8,500 fully equipped, including armor, which is standard on almost all units, to withstand rigorous use in rough and heavy cover.

Under actual fire conditions, water may be discharged from the tankers while the truck is in motion or when it is stopped. This implies considerable versatility in practical application. Refills are seldom required except on very large fires, but even then this requires only minutes, depending on the nearest source of water. For this purpose, large "mother" tankers are coming into more common usage. The mother tanker minimizes the "down" time on fire. They can be stationed in convenient locations along roads, trails, or in openings to best service the four-wheel-drive equipment in refills, and to provide a source of water for back pumps, water trailers, lighter tankers, etc. The use of mother tankers is similar to bringing the stream or the lake to the fire, especially if they are used in fleets.

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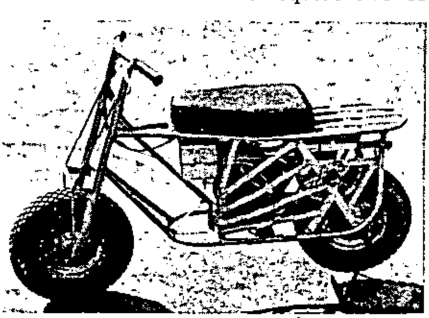
Fire Prevention By Motor Scooter

Many national forests have recreation areas with heavy concentrations of human use. For each of these areas the workload can often require two or more fire prevention technicians. One immediate need is an efficient, economical means of transportation for the prevention technicians while they are working in these areas of high risk. To meet this need we tested a motor scooter in the Lake Arrowhead area, where there is an urban type concentration of fire risks, and in the Lytle Creek Canyon area, which receives heavy streamside recreation and residential use.



The scooter was easy to handle in congested areas such as campgrounds and lakeshore and streamside zones, offered excellent visibility and maneuverability for powerline inspections, and was readily adaptable to inspection and prevention patrol of foot and riding trails.—R. F. Johnson, *Fire Prevention Technician, San Bernardino National Forest.*

THE OREGON STATE MOBILE FIRE WEATHER UNIT

CLIFFORD H. WATKINS
Meteorologist, Oregon State Board of Forestry

Introduction

Firefighting strategy depends upon the weather. The placement of men with regard to their safety, the location of a fire trail, and the planning of a backfiring operation are examples of the kind of decisions which must be made by the fire boss. These decisions are based largely upon knowledge of current and expected weather conditions.

In order to provide the best possible weather advice for firefighting activities, the Oregon State Board of Forestry in cooperation with the U. S. Weather Bureau has developed a new mobile fire weather forecasting unit. The weather van is equipped to bring the very latest weather maps and weather teletype reports to the scene of a going forest fire. Hence, the fire weather forecaster, who operates with the fire behavior specialist as a member of the fire team, has at his disposal almost the same collection of weather data found at a major forecast center. These charts and reports are used to prepare the weather forecast.

The Oregon State Board of Forestry mobile unit is not a panacea for all the forecast problems that exist on fires, but rather it is a cure for a major ailment that has afflicted mobile unit forecasting in the past—that of inadequate weather analysis and reports. Undoubtedly occasional forecast errors will continue to occur, because of the limitations inherent in the science of weather forecasting. However, it is hoped that these errors will be reduced to a minimum by bringing the forecast office to the scene of going fires.

Radio-Facsimile and Radio-Teletype

The U. S. Weather Bureau Analysis Center in Washington, D. C., prepares most of the weather charts used by forecasters in preparing the daily forecast. Pictures of these charts are transmitted by a facsimile machine (similar to wirephoto) over telephone cables from Washington to the various forecast offices. The U.S. Navy at San Francisco and other places receives these weather pictures and retransmits them on several radio frequencies to ships at sea for use by shipboard weather forecasters. There, they are received by a radio-facsimile recorder which is essentially the same type of machine used at land stations except that a special converter is used to convert the radio signal to a facsimile impulse. In addition to map pictures, the Navy broadcasts weather teletype reports consisting mainly of weather observations and balloon measurements of upper wind and temperature conditions from various airport stations. These reports are received by a radio-teletype.

The Oregon State Board of Forestry Mobile Unit is equipped with radio-facsimile (fig. 1) and radio-teletype for intercepting the Naval broadcasts. The communication gear operates on a new converter principle developed by the Department's Radio Engineering Section and requires only a standard shortwave receiver, whip antenna, and 110-volt portable electric power source. The teletypes are two model 15 (one as a spare) surplus machines, and the facsimile is a continuous-roll model leased from the manufacturer.

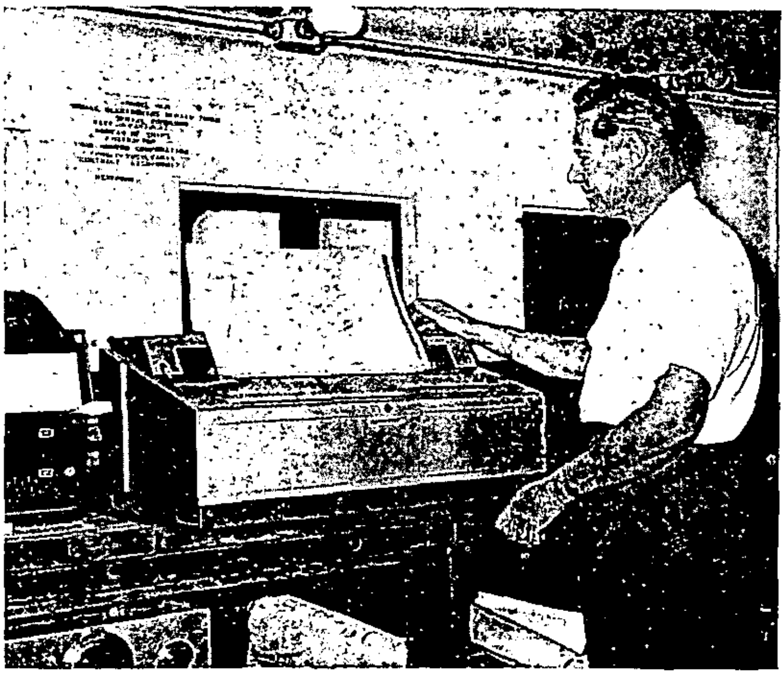


FIGURE 1.—Radio-facsimile.

Advantages of a Mobile Unit

The information received by radio-teletype and radio-facsimile provides the weather forecaster with a look at the broad-scale weather picture. The location, intensity, and movement of large pressure systems (storm, etc.) can be determined from these charts, and the meteorologist uses them to prepare the general forecast for a large area. However, the extremely local forecast that is needed for fire planning requires additional information about the terrain and vegetation at the fire plus local weather measurements in and about the fire area. The meteorologist gets this information by being on-the-spot at the fire scene.

An additional advantage of the weather unit being at the fire is in the improved communication that results from the close contact between the weatherman and fire boss. The meteorologist is continuously aware of any critical fire problems that exist. He is available for immediate conference at any time. Furthermore, the forecaster participates in fire strategy meetings, where he presents a detailed weather briefing. Thus all principal overhead are made aware of the weather forecast and can plan accordingly.

Often a very useful short-period forecast can be made by judiciously studying local weather signs. For example, the extreme turbulence that accompanies a thunderstorm downdraft can often be anticipated by the trained weather observer. Also, changes in low-level winds can at times be deduced from cloud motions and changes in air mass stability as indicated by the character of a smoke plume. The meteorologist at the fire scene is a trained observer who can use weather signs to best advantage.

Prior to the development of the new mobile weather system, the meteorologist was equipped with a two-way radio hookup with the central forecasting headquarters. This equipment was used to transmit long lists of coded weather reports to the fire. The weather forecaster then spent hours plotting and analyzing this data on weather charts and had little time to study the terrain and vegetation complexes, to make weather measurements, and hence to localize the forecasts. Also, charts prepared in this way were only a meager sample of the many kinds of charts used by modern-day weather forecasters. In addition, under this system communications were often impossible because of the vagaries of fixed-frequency radio, and the forecaster was forced to provide weather advice without benefit of the necessary forecasting tools. Multifrequency radio-facsimile and radio-teletype have solved these problems.

The new mobile unit had its first test run last summer when it was dispatched to the Twelve-Mile Creek Fire in Douglas County, Oreg. Although the weather on this fire was not critical enough to have caused many fire problems after the initial run, the value of the mobile forecasting unit was proved. Radio-facsimile and teletype weather data was being received within one-half hour after the unit arrived at the fire, and fire weather and fire behavior forecasts based on the information were prepared and used immediately for planning fire strategy.

Portable Weather Shelters

Four portable weather shelters have been designed for use with the mobile unit. These weather stations were designed by the weather section for easy installation about the fire. They provide atmospheric measurements for use in forecasting and for future study of the effects of weather on fire behavior. The instrument package includes a standard recording hygrothermograph, an electric fan-aspirated psychrometer, a wind counter, and a plastic rain gage. These shelters effectively complement the other equipment of the weather van.

Plans

Theodolite and helium-balloon equipment will be added to the unit as soon as possible. This gear will enable the meteorologist to measure the winds aloft over the fire area, which is an important variable to be considered when making local wind forecasts. In addition, it is hoped that the low-level wind profile thus obtained can be related to blowup conditions in a manner similar to that reported by Byram.[1]

The Oregon State Board of Forestry is investigating the possibilities of establishing a two-way, transmit-receive radio-facsimile system between the main headquarters and the mobile unit. This equipment would enable the headquarter's weather office to transmit to the fire a selection of weather charts that are better suited to local forecasting than the ones currently transmitted by the Navy. In addition, fire progress maps, polaroid photos of the fire, press releases, supply orders, and other communications could be transmitted back to headquarters via the radio-facsimile. Hence, the mobile unit may become a highly valuable tool to the firefighting organization, other than an aid to more accurate weather forecasting.

Conclusion

The Oregon State Board of Forestry has introduced a new concept to mobile fire weather unit operations. This entails radio-facsimile and radio-teletype. A big advance in mobile unit operations has been made.

1. Communication will no longer be a problem to the meteorologist who is providing on-the-spot fire weather forecasts. Naval weather data is broadcast simultaneously on several frequencies, thereby allowing the receiving station to select the best frequency.
2. More complete and timely weather charts and reports will be available to the forecasters than was previously possible.
3. The home office will be freed of the long job of transmitting raw data to the mobile unit.
4. More time will be allowed the field forecasters to study the effects of local terrain on the weather and to collaborate with the fire behavior specialist.
5. Communication between these two specialists will be greatly improved by having the meteorologist at the fire.
6. This equipment should result in more timely and accurate weather forecasts for use in the planning of firefighting strategy.

[1]Byram, George M., In *Forest Fire Control and Use*, by Kenneth P. Davis. Ch. 4, 108 pp. McGraw-Hill. 1959.

WATER-BOMBING WITH THE DeHAVILAND BEAVER

R. O. STROTHMANN, *Research Forester, Lake States Forest Experiment Station,* and L. J. MCDONALD, *Superintendent, Ely Service Center, Superior National Forest, U.S. Forest Service*

In June 1959 the Superior National Forest and the Lake States Forest Experiment Station cooperated in testing the water-drop pattern of a pontoon-equipped DeHaviland Beaver. The plane has been used successfully for several years by the Forest for initial attack on fires and for suppression of small fires.

The plane has a 125-gallon fuselage tank fitted with a snorkel loading tube that extends into the water between the pontoons. With this arrangement the tank can be filled in about 14 seconds while the plane taxies across the surface of any of the many lakes in the area. Thus, a nonstop shuttle service can be operated between a fire and the nearest lake large enough to allow the plane to land and take off.

Twenty water-drop tests were made over a 3-day period at the municipal airport at Ely, Minn. Of these, 14 were with plain water and 6 with "wet" water. The pilot flew at altitudes between 80 and 100 feet and at speeds between 80 and 100 miles per hour (fig. 1). Information on temperature, relative humidity, wind direction, and wind velocity was obtained just prior to each drop.

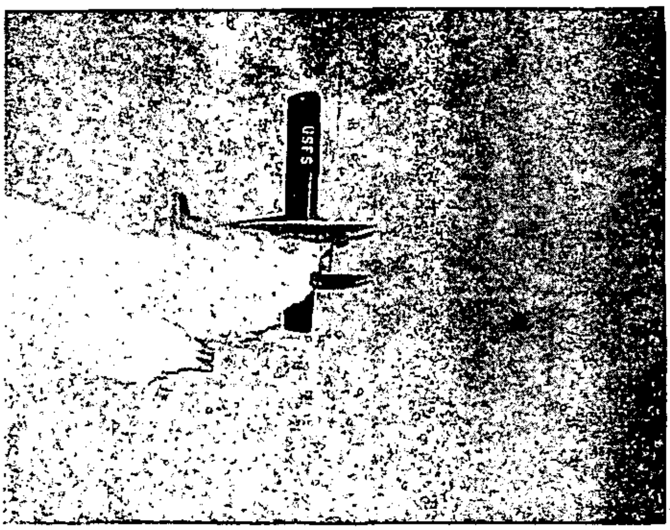


FIGURE 1.—Water drop from a pontoon-type DeHaviland Beaver.

The average size of the total measurable pattern was 75 by 400 feet. Water volume around the edges, however, was as low as 0.1 gallon per 100 square feet. Under certain circumstances water concentrations of 0.2 or 0.3 gallon per 100 square feet might be of value if dropped on a fast-spreading fire in grass fuels. In most situations, however, the concentration would have to be at least 0.4 gallon per 100 square feet to be of value. On this basis, the dimensions of the Beaver's effective pattern are reduced to about 45 by 150 feet.

The only measured variable that had an unmistakable influence on the amount of water reaching the ground was relative humidity. When relative humidity was high (60 to 70 percent), more than twice as much water reached the ground in concentrations of 0.4 gallon or more per 100 square feet than when it was low (35 to 40 percent). Also twice as much area was covered by the higher concentrations of water when the drops were made under the more humid conditions.

In comparing plain water and "wet" water, the plain water generally covered a larger area and reached the ground in larger quantities. Since the number of "wet" water drops was limited, these findings should not be regarded as conclusive. Observations indicated that the "wet" water remained suspended in the air longer and dispersed into a finer mist.

The amount of water reaching the ground (combining both the plain water and "wet" water trials) averaged 50 gallons, or 40 percent of the total amount released from the plane. At the lower humidities (35 to 40 percent) only about 28 percent of the water released actually reached the ground, whereas at the higher humidities (60 to 70 percent) about 49 percent reached the ground.

The size and shape of the patterns of the Beaver resembled those obtained elsewhere in water-bombing trials with a Stearman and other small planes except that they were measurably longer (up to 100 feet). The big difference was in the concentrations of water reaching the ground. The maximum concentration at the pattern center for the Beaver was about 1.0 gallon of water per 100 square feet, whereas in comparable patterns for the other planes the maximum concentrations exceeded 2 gallons per 100 square feet.

The total area covered was about the same as that reported for a Stearman. The Stearman had the same tank capacity as the Beaver—125 gallons. However, when the Stearman flew at comparable altitudes and airspeeds, the coverage at concentrations of more than 0.5 gallon per 100 square feet was between 6,000 and 7,000 square feet compared with less than one-half this area for the Beaver patterns. On the Stearman patterns, approximately 3,000 square feet received water in concentrations of more than 1.0 gallon per 100 square feet, whereas the Beaver pattern never had more than 400 square feet covered with this concentration.

The one factor largely responsible for the low volumes delivered by the Superior National Forest's Beaver is the size of the release hatch. Tests at the Arcadia Equipment Development Center show that optimum size of release openings should be about 1,000 square inches per 250 gallons. The opening in the Beaver is a 17-inch circle which provides only about 225 square inches; it is less than one-half the optimum size for a capacity of 125 gallons.

In addition, the effective size of the opening is further reduced because of the design of the release mechanism. This mechanism is two semicircular plates hinged across the diameter of the opening. When opened, the plates do not fall free, but stay partially closed in an inverted "V" position with the apex alined across the diameter of the opening.

In summary, the tactical possibilities of the basic unit are very good. In the lake country of northern Minnesota, the plane can make repeated drops on a target area at short intervals because of the snorkel loading tube which permits filling the tank while the plane taxies across the water. The one big improvement needed is a larger and more efficient release mechanism for discharging the load.

After modifications of the tank release mechanism have been made, further tests of the water-bombing pattern are planned. These will probably include test drops on brush and in timber as well as drops over an open field.

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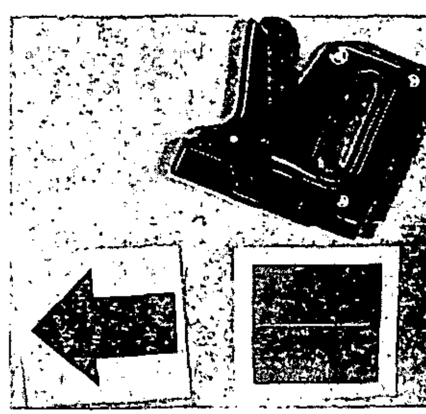
Dozer Spotter's Kit

A canvas packet containing a staple gun, extra staples, and a bundle of cards with squares of reflective tape on one side and arrows of reflective tape on the other has been tested by the Missoula Equipment Development Center, following a suggestion by James E. Wilson of the Lolo National Forest. A red, pressure sensitive tape is used. These reflective cards when stapled to trees make markers that are more visible than tree blazes in daylight or at night. The cards can be removed for relocating courses; blazes cannot. The square designates straight ahead, the arrow, a change in direction.



A card 4 inches square has a 2- by 2-inch square of reflective tape on one side and a 1- by 4-inch arrow of the tape on the other. Cost per card for the reflective tape is 6½ cents.

A card 5 inches square has a 4- by 4-inch square of reflective tape on one side and a 2- by 4½-inch arrow on the other. Cost per card for reflective tape is 16½ cents. The kit is a good addition to any dozer spotter's equipment.—Missoula Equipment Development Center, *U.S. Forest Service, Missoula, Mont.*

MORE ON AERIAL DROP ACCURACIES

LOYD M. LAMOIS
Forester, Division of Forest Fire Research, U.S. Forest Service, Washington, D. C.

In an article in Fire Control Notes (April 1961) the author explored, rather superficially, the logistics of air attack on forest fires. The assumption of "randomness" was called to question in cases where aim was primarily dependent upon pilot judgment. It was suggested that over a series of successive drops on a fire the distribution of retardant patterns about the target may *not* be of a random nature—that corrective action on the part of the pilot may result in pattern distributions from which predictions of success cannot be made under the assumption of random error.

The question remains, then; "how random are errors resulting from pilot judgment?"

The author cited a series of test drops in Montana during 1947. As reported in the article, the distribution of absolute errors in range was described almost perfectly by a frequency curve of the exponential form: $p = ae^{-ax}$ where "p" is the probability of a pattern center being within "x" feet of the target point, and "a" is the reciprocal of the mean absolute error.

Subsequent analysis of the complete report of these tests revealed a rather upsetting fact. *The twenty-one test drops were not made during a single day;* rather, they were made on separate occasions consisting of *two successive drops per trial.* Aside from the fact that the author's account of these trials may have been misleading in context with the FCN article, this new discovery allowed for a quick check on the nature of corrective action by a real, alive pilot in northern Montana.

On eight of the occasions where two successive drops on the fire target were made, significant differences in the placement of the drop patterns resulted from adjustment in aim. On *three* of these occasions placement of the second pattern resulted in improved coverage of the fire target. On *one* occasion overcorrection led to placement of the second pattern farther from the target than had been the initial drop—on the other side of the target. On all the remaining *four* occasions the second drop was farther from the target on the same side—a complete failure in corrective action.

In summarizing the above observations, it is noted that in only 50 percent of the cases did corrective action result in shifting pattern coverage in the *proper direction.* While there is no statistical proof that correction of aim is unattainable in this type of operation, the results here show that *within certain accuracy limits* there probably is a large element of "randomness" in the results of corrective action by glide bomb pilots.

A further modification of observations on the Montana tests results from the fact that these tests were made with 165-gallon drops of *"contained"* water. In developing the prediction formula, the absolute error of any single drop was computed to be the distance from the target to the point of impact, as recorded in their tabulated results. The author assumed that aiming a tank of water at a fire was the same thing as aiming the "center" of a free-drop pattern at a fire.

Apparently the pilots fell into the same error—impacting seven of their tanks within 20 feet of the fire. Four of these, being overshots, were completely wasted. Two more were right on target—wasting most of the pattern.

At any rate, the distribution of these patterns about the target was re-examined with respect to the pattern centers instead of impact point. Lo and behold, when the probability of any single pattern center being within a specified distance from the target was computed, the prediction was according to the *normal curve* of errors—a more conservative estimate than that arrived at via the exponential formula.

In final comment, then, evidence which would tend to indicate the random nature of pilot aiming errors, and at the same time bear witness to the Gaussian, or normal, distribution of those errors, serves to simplify and substantiate some of the author's original speculations on this problem. In addition, it points out that there is much we can learn, through experimentation, about dropping accuracies in air attack.

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Safety In Fire Retardant Drop Areas

Fire retardant dropping from an airplane can be dangerous for those on the ground. To reduce the hazard, the U.S. Forest Service is issuing instructions for people who may arrive at a fire ahead of regular Forest Service personnel. One man was killed in the West last summer and others have been injured when they were hit by a load from a low flying, fast moving plane.

The Forest Service TBM bomber can be easily recognized. It is a midwing, single engine plane with stubby, thick fuselage. It will circle the fire and then make one pass over it. This pass is the line of flight for the "drop." The drop is made on the second pass, with the drop pattern about 300 to 500 feet long and 75 feet wide at the center.

When the plane makes its first pass, personnel are cautioned to move at least 150 feet to one side. Anyone trapped and in danger of receiving the full force of the load should lie face down flat on the ground with the head in the direction of the oncoming plane. If possible, he should lie directly behind a tree and wrap his arms around it. No one has been injured by the sheer force of the blow, but men have been knocked over cliffs or thrown up against trees or rocks.

PENNSYLVANIA'S INITIAL AIR ATTACK OPERATIONS—SPRING 1960

SAMUEL S. COBB,
Division of Forest Protection, Pennsylvania Department of Forests and Waters

During the spring of 1960, the Division of Forest Protection of the Pennsylvania Department of Forests and Waters conducted experiments in the use of aircraft in direct attack as a fire suppression tool. Both fixed wing aircraft and helicopters were tested.

The basic objective for the air attack program was initial attack on any fire within the effective operational range of the equipment at the earliest possible moment. The aim was to achieve the initial water drop when the fire was small enough for the drop to prevent a strong run before ground forces arrived. It was not assumed that complete suppression would result from air drops and the normal fire control organization was continued on the existing pattern.

When the incidence and timing of fire starts within the operational area permitted followup drops on a fire, or when large or dangerous fires within the general area of the air operation occurred, two secondary objectives were recognized: (1) On large fires aircraft could be used for holding action to permit assembly of sufficient ground control personnel and construction of control lines. (2) Where exceptional property values were threatened, timber or other, drops could be made to protect them.

All high fire incidence areas of the State were plotted for the past 5 years and the two worst areas set up as operating units to be serviced during the spring of 1960. These two units centered at Hazleton City in the east-central anthracite coal mining area and at Black Moshannon on the eastern rim of the Allegheny Mountains in west-central Pennsylvania.

To achieve useful initial attack, as determined on the basis of the performance characteristics of the aircraft to be used, the water volumes available, and the rate of fire spread for average conditions in Pennsylvania, operational circles of 20-mile radius for the airplane and 15-mile radius for the helicopters were set up.

In actual practice under normal flight conditions these proved to be generally correct. The helicopter was subject to greater fluctuations in speed due to wind direction and velocity than was the airplane.

The airplane used was a Stearman A75N, with a cruise speed of 110 m.p.h. This two-place biplane with open cockpit was modified by installing a 180-gallon tank with drop gates in the area occupied by the front cockpit. About 150 gallons was found to be the maximum safe operating load.

The helicopters were Bell 47 G models. These are a two-place, bubble canopy type with an operating speed of 60 m.p.h. One ship was rigged to carry a 35- or 50-gallon coated fabric bag attached to a cargo sling beneath the copter. The other ship carried two aluminum side tanks connected by an equalizing pipe and equipped with three drop valves. The tanks were attached like saddle bags on each side of the fuselage, just behind the bubble and motor mounting. The volume carried by this unit was 60 gallons.

The airplane worked the Black Moshannon Unit for 2 weeks while one helicopter worked the Hazleton Unit. The airplane then shifted to Hazleton, the second copter unit moved into Black Moshannon, and the copter at Hazleton moved to a third experimental area in the Pocono Mountain area. Then a second 2-week operation was conducted.

The control center must be convenient to the aircraft service area to allow for rapid communication and consultation between the pilots and the control center chief. It should be large enough to permit installation of a desk, a sizable map, radio, telephone, and other necessary equipment.

Radio and telephone communications are essential to insure immediate receipt of smoke sighting reports from towers and for communication with the normal fire control organization when information or coordination of action is required.

For the airplane a reasonably good airfield is required. Gas and oil supplies are mandatory, repair facilities desirable. The service area should be at sufficient distance from the airport building to eliminate interference with its normal operation, but close enough to avoid loss of time in operational servicing. Basic personnel are the control center chief and the pilot. Where the control center is any distance from the water service location, an additional man is necessary to operate the pump. A suitable pump should be fitted for instant and rapid loading. A tank of 1,000-gallon minimum capacity should be provided and arrangements made to keep it filled at least twice daily under extreme conditions.

The helicopter can be operated from any clear, level area suitable for safe takeoffs and landings. A heavy sod or surfaced ground cover to eliminate dust is highly desirable. An established airfield is preferred, however, to insure adequate servicing (gas and oil) for the 'copter. Because of the noise of the 'copter the operation area should be some distance from the airport service buildings. Basic personnel where coated fabric bags are used would be the control center chief, the pilot, and a man to handle the hose from the pump. If the control center is not adjacent to the service area, an additional man to operate the pump is required. A hose man is not required for loading side tanks. A water storage tank of not less than 500 gallons is required; it should be filled at least twice daily.

During the 1960 operations the airplane flew a total of 54 missions. In all, 115 drops were made and 15,000 gallons of water used. In about 90 percent of these drops the results were considered to be helpful in the control action. In several instances the fire was completely extinguished.

The Hazleton operation was typical of all helicopter operations. Fifteen fire missions were flown, 27 drops were made, using 1,070 gallons of water. Results were considered to be of value in assisting in the control of the fires in about 60 percent of the missions. Two cases of complete extinction were recorded.

Helicopters were also used in a number of types of control action other than water drops. Scouts and the fire boss were flown over several large fires for reconnaissance purposes. Firefighters with backpack pump cans and fire rakes were taken in to ten fires in the Hazleton area. After some fires were controlled men and tools were recovered by 'copter. Food and water were taken into inaccessible areas on several large or remote fires. Fires were surveyed and fire control personnel taken on flights to familiarize them with certain areas.

Tentative arrangements have been made to expand the airplane operations to five units on a one-month, simultaneous basis during the spring fire season in 1961. One helicopter is planned for use in the Pocono Mountain area. Another 'copter may be placed under contract for general and emergency use statewide.

Observations

The airplane was considered to be highly successful as an initial attack weapon to hold fires in check pending ground attack. To achieve this success dispatch must be immediate on any smoke sighted. Efforts to identify smoke cause before dispatch of the plane only serve to reduce the effectiveness of the first drop because of additional elapsed time from start to attack and consequent increase in fire size. The airplane also showed promise when used to hold dangerous portions of line on large fires.

Slower speeds and low water carrying capacity of helicopters limit their effectiveness. Self-loading facilities to utilize water sources close to fires and elimination of time consuming flights to and from the control center would increase helicopter effectiveness. Their maneuverability and ability to land in a restricted space make them useful tools if water supply problems can be solved. Their usefulness in fire scouting and transporting men, equipment, and supplies also makes them excellent control tools where they are available or where fire incidence warrants their use on a standby basis.

HOT MEALS FOR FIREFIGHTERS

JOHN D. WHITMORE, JR., *Fire Control Officer, Glenwood District, Jefferson National Forest*

Providing food for firefighters is a most important job—appetizing, nourishing, and well-scheduled meals restore energy and maintain high morale. But, as most everyone knows, this job is usually laden with problems.

The Glenwood District has successfully solved its feeding problems by having food prepared by a caterer and delivered at or near the fire by car or pickup truck. This food service is provided by the Bureau of Prisons which operates a camp for juveniles on the district. They have been most cooperative. We furnished their kitchen force with two basic menus and explained the use of our containers, including the nesting and storing of all components. As soon as a fire is manned, we call the prison camp and request "a stew meal or a chili meal for 10 men." Even if the request were for food for 100 men, the fire boss could expect the food to be on its way to the fire in 3 to 4 hours.

Providing hot food prepared and delivered by a caterer—

1. Gives all firefighters hot, nourishing meals on schedule.
2. Eliminates the need for cooking facilities and food preparation at the fire.
3. Returns the men as quickly as possible to the fireline after a meal without tying up supervisory personnel.
4. Relieves the fire boss of detailed food arrangements.
5. Keeps food costs in line with other aspects of the total fire-suppression job.

For this system to work successfully, detailed arrangements with a restaurant or other caterer are necessary. Hot food containers should be furnished the caterer, as well as other necessary service equipment. Our equipment is assembled in 25-man units (fig. 1).

We use menus of beef stew and chili because they are easily prepared and furnish a well-rounded meal; they are also acceptable to nearly all firefighters. For 10 men, they are as follows:

Beef Stew	*Chili*
2½ lbs. diced beef	1½ lbs. kidney beans
5 lbs. potatoes	3 lbs. ground beef
1 lb. onions	½ lb. onions
1 stalk celery	1 cup catsup
1 lb. carrots	

Either of these menus is accompanied by

3 loaves of bread	10 apples, oranges, or bananas
2 gallons of coffee	1 pound of cookies

Each spring we conduct a daylong training session for key wardens and cooperators. One man has the responsibility of directing the feeding of others. At noontime the trainees are given one of our "catering service meals," and our field service equip-

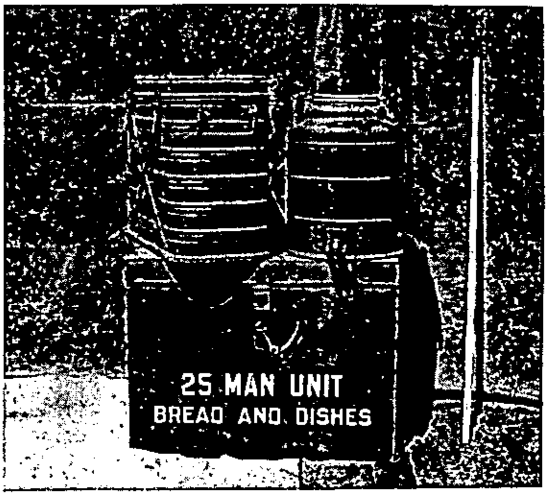

FIGURE 1.—Food service equipment for 25 men: *Top left*, 4¾-gallon hot-food container; *top right*, 2-gallon coffee container; *bottom*, box for dishes, cups, spoons, bowls, bread, fruit, and cookies.

ment is used. This demonstrates to our cooperators how many of the problems of feeding firefighters can be eliminated by a catering service, and also what their crews can expect at mealtime when they participate in fire suppression on the Glenwood District.

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Colville Smokey Danger Meter

Smokey Bear shows visitors the fire danger for today (current 24-hour period) on the Colville National Forest. Smokey is about 7 feet tall and has a moveable arm.

This life-size sign stands on the front lawn of the Colville Ranger Station at Colville, Wash., next to U. S. Highway No. 395. The same information appears on both sides of the sign so travelers in either direction can quickly read the fire danger for the day.

The sign was designed and constructed by Bob Lynds, Fire Control Aid on the Colville District, and Mickie Lewis, Payroll Clerk in the Supervisor's office.—E. Arnold Hanson, *Northern Region, U.S. Forest Service.*

INFORMATION FOR CONTRIBUTORS

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

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

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

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

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

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


GROWING TIME- MANY YEARS
BURNING TIME-
ONE CARELESS MOMENT
SMOKEY
Remember– ONLY YOU CAN PREVENT FOREST FIRES!