FIRE CONTROL NOTES

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FIRE CONTROL NOTES

A quarterly periodical devoted to forest fire control

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Liquid Fertilizer Tested As Fire Retardant

William C. Wood[1]

Liquid Concentrate (LC) fertilizer (10-34-0) as a fire retardant has been given field evaluation by the Forest Service in the Pacific Northwest Region. There appear to be many advantages to use of LC over other retardants.

Faced with the prospect of a major expenditure in retardant plant overhaul, the Pacific Northwest Region made a survey to determine whether other long-term fire retardants might offer advantages over the standard retardant, ammonium sulphate slurry.

Fertilizer?

Pat Int-Hout, Fire Staff Officer of the Wenatchee National Forest, suggested that Tennessee Valley Authority's Liquid Concentrate Fertilizer (11-37-0) be considered. Liquid Concentrate is a syrupy liquid solution of condensed phosphates referred to in the fertilizer industry as polyphosphates. Polyphosphates, when exposed to the weather, tend to remain tacky and do not evaporate readily. Orthophosphate solutions such as DAP and water form salt crystals when dried.

Int-Hout's suggestion prompted a review of Forest Service fire research literature which indicated that nonviscous retardants have certain advantages over thick slurries. Of particular note was a Fire Control Notes article of April 1968, Vol. 26 (2): 13-16, written by R. W. Johansen and G. L. Crow, "Liquid Phosphate Fire Retardant Concentrates," which described convincingly the advantages of liquid concentrate retardant.

Contacts with the Southern Forest Fire Laboratory at Macon, Georgia, along with observations of the Southern Region's use of TVA (LC) 11-37-0, proved convincingly that Liquid Concentrate (LC) polyphosphate fertilizers should be evaluated for use as fire retardants. In fact, a survey of the Southern Region's air tanker base operations revealed that the mixing and handling advantages of LC over slurries are profoundly in favor of the liquid retardant.

First Step

First of all, a prospectus to obtain information on the cost and availability of LC polyphosphates was prepared and circulated throughout the fertilizer industry in Oregon and Washington. From this, it was learned that TVA's (LC) 11-37-0 required excessive delivery time and was not commercially available in the State of Oregon. LC 10-34-0 was readily available throughout the Pacific Northwest at a cost about 25 percent below the TVA product. Approximately 1,500,000 gallons of LC 10-34-0 are stored in Oregon and Washington agricultural areas.

LC 10-34-0 was selected for operational field trials. The main difference between 11-37-0 and 10-34-0 is that 11-37-0 is more concentrated. Since it is slightly weaker, less water is added to the 10-34-0 concentrate to produce an approximate 8 percent phosphate equivalent solution. Research by the Southern Forest Fire Laboratory indicates that an 8 percent phosphate equivalent will effectively retard fires in most forest fuels. An approximate 8 percent phosphate equivalent has been successfully used by the Southern Region for the past several years.

Field Test

For the field test project, one gallon of LC 10-34-0 was blended with 4 gallons of water to give an 8.7 percent phosphate equivalent solution. One gallon of mixed solution costs about

Figure 1.—P2V dropping 1,000 gallons of LC retardant from 200 feet.

[1] Equipment Specialist, USDA Forest Service, Region 6.

$.12. The corrosion inhibitor, sodium dichromate, in the proportions recommended by the Equipment Development Center at San Dimas is included in this cost. By comparison, ammonium sulphate slurry costs about $.17 per gallon.

The Wenatchee, Wash., and Lakeview, Ore., air tanker bases were each outfitted with a storage tank and a meter to accommodate LC. The provisions were relatively simple: the LC storage tank and the water line were each valved and piped into the suction side of a 300 g.p.m. centrifugal pump which discharged through a fire hydrant meter into the aircraft loading hose. Original batch mix facilities were left intact; thus, each base could furnish both slurry and LC.

In spite of the relatively light 1969 fire season in the Pacific Northwest, 117,000 gallons of LC retardant were dropped on 28 fires by air tankers working out of Lakeview and Wenatchee. Evaluation reports by air attack bosses were completed for all drops, and, in addition, about 75 percent of these fire drops were evaluated by ground forces.

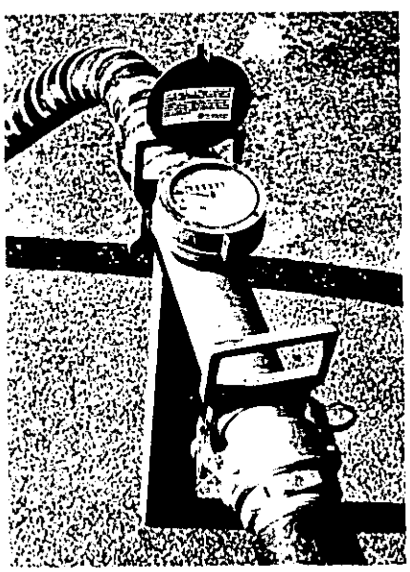


Figure 2.—Three-inch fire hydrant flow meter with quick-connect fittings installed between pump discharge and loading hose.

Compared With Slurry

On a number of fires, slurry and LC were dropped side by side. This gave fire research scientists and fire bosses a good opportunity to observe the comparative effect of each on wildfires. Personnel from the Southern Forest Fire Laboratory assisted in the evaluation. From comments of ground personnel and an analysis of evaluation reports, it emerged that LC is at least equal, if not superior, to ammonium sulphate slurry in holding and stopping fires.

The majority of fires occurred in pine-brush and pine-juniper-mahogany areas. However, several drops were made in grass-sagebrush, in coastal Douglas-fir, and on fires in pine and Douglas-fir slash units.

In all cover types, ground crews reported that more LC than slurry got through to the ground, and the cooling effect was more pronounced from LC than from slurry. Perhaps this was due to the temporary increase in humidity and smothering effect of vaporized LC. The LC appeared to have a more lasting effect and seemed to draw moisture from the air overnight. LC retardant deposited on fuels remained moist and tacky for several days after the drop, whereas the slurry dried completely after a few hours' exposure to sun and wind. Knock-down effect on crowning and running fires was more pronounced, and rekindling was delayed longer. Sections of fireline treated with LC required less crew holding action than those with slurry. With "High" fire-danger ratings and winds up to 15 m.p.h., several running and crowning fires in pine types were stopped completely with LC. On three running fires in heavy fuel, neither retardant was effective.

Ground Coverage

The area of effective ground coverage from LC was almost twice as large as that obtained with slurry. LC patterns were consistently longer and nearly twice as wide. There appeared to be more uniform distribution of LC over a wider area while the thick slurry (1600-2000 centipoise) patterns tended to have large puddles and unequal distribution. Comparative drops, made later with the P2V Neptune on the Medford Airport, confirmed the increased pattern size of LC (fig. 1). The drop cloud of LC in descent resembled a heavy, swirling rain. The swirling effect apparently caused more complete coating of fuel. Examination of vegetation in LC patterns showed that standing grass, leaves, needles, and brush were usually covered on all surfaces.

Ground crews who left hand tools in the vicinity of drops where they were inadvertently sprayed with LC reported that handles became sticky and had to be rinsed. No toxic reactions were noted, but it was reported that minor cuts and abrasions would sting when exposed to LC spray. This is also true of slurry.

Air Personnel Opinion

Air tanker pilots and air tanker bosses reported no appreciable differences in piloting techniques with LC. One slight advantage is that the area covered on the ground is larger. Flight elevations above the ground and safety precautions to avoid injury to ground crewmen are the same.

Daily washdowns of aircraft, which are needed to minimize corrosion effects, are far easier when LC is used. LC is more soluble than slurry and is easily removed with low-pressure washing. No special modification to aircraft tanks is required except that gasketing must positively seal all compartments, bolt holes, and seams. Tanks which would hold slurry reasonably well leaked badly when filled with less viscous LC. Usually, each air tanker on standby was loaded to one-half capacity with plain water. Upon receipt of a fire call, the required amount of LC was pumped into the tanks and the remaining quantity of water was then added to fill out the load. This speeded up loading time and also flushed the pump and meter each time the aircraft was loaded. All contract air tankers in Region 6 have internal manifolds which provide for equal mixing of the LC and water in each tank compartment.

Long-Term Effects

The long-term accumulative effect of LC corrosion on mix plant hardware is unknown, but it is expected to be much less than that experienced with slurry. An analysis of mix plant operations, made by the Fremont National Forest, showed the man-hour production rate of the LC plant was more than 10 times greater than slurry. Two men can handle an LC plant during peak activity, while six to eight men are required to sustain a slurry operation. One man can handle an LC plant during routine activity. An additional advantage is that the meter provides a positive measure of the quantity of retardant loaded into the aircraft (fig. 2). Metering of slurries has been considered impractical.

Dye Marker

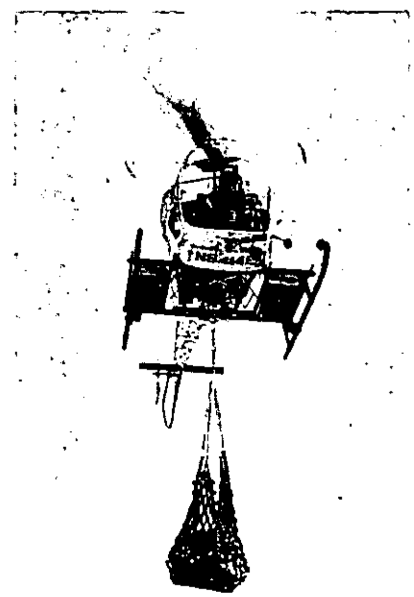
The LC used last year did not contain a dye-marker. It was decided to try to identify targets and dropped loads by means of a Flagmaster, a device which flips signal streamers off the wing of the lead plane. This was only partially successful. Although the field trial was completed without the benefit of a dye, it became obvious that LC should contain a dye especially for situations where multiple drops are made by different aircraft on several fires in close proximity. Commercial suppliers have indicated that they are prepared to furnish LC with a premixed coloring agent.

On the basis of the 1969 tests, it has been decided to convert all Region 6 air tanker bases to accommodate LC retardant. Existing stocks of slurry mix will be used up and mix plants will be converted as funds permit. Plans call for installation of mix plants similar to those used to blend liquid fertilizers in agriculture. △

Sector Camps Improve Fire Force Efficiency

BRIAN SCHAFFER[1]

The use of small sector camps, supplied by helicopter and/or roads, increases efficiency of crews. Reduction of hazard to crew safety is also an important result. An example of manning and supplying three sector camps by helicopter is given. It illustrates a feasible procedure.



The traveling distance from fire camp often results in extremely long work shifts. Shifts required by long travel times place unnecessary strain on the firefighter, and after a few days, his ability to perform adequately and safely is sharply reduced.

[1] Supervisory squadleader, North California Service Center.

Figure 1.—Firefighters scrambling for a helicopter lift to the fire.

Long traveling distances not only tie up men and equipment, they put a heavy load on plans and service operations. They also increase the accident risk for both men and equipment.

All these problems were observed in 1968 on the Liebre Fire, Angeles National Forest. The trucking route from fire camp to the unloading points was on a narrow, steep truck trail and took well over an hour, one way. As a result, the average work day was 18 hours, and one work day was 20 hours. The establishment of sector camps supplied either by air or truck would have eliminated unnecessary travel time and allowed the firefighters more time for rest in between shifts.

If a sector camp could be reached by road, the men required for day and night shifts could be trucked there initially, left, and supplied by truck until ready to come out. If the sector camps were inaccessible by road, they could be manned and supplied by helicopter. If copters aren't available for both manning and supply, fixed wing aircraft could be used as supplying vehicles. If there were a shortage of aircraft, the men could walk to their sector from the nearest road and remain there until the work is complete. Zone and forest fire caches could prepare sector drop camps in units of either 50- or 100-man camps. Several of these units could be prepared before the fire season begins.

Helicopters

If helicopters are used, each camp should have one assigned to it after the initial manpower lift. Helitack foremen would make ideal helicopter managers for this type of operation. They are already trained for loading and unloading 'copters and selecting safe helispots.

The sector camp should have a number for identifications placed near the helispot or cargo drop point. This number can be made from ground-to-air panels or paint spray cans. When sector camps are to be supplied by 'copter, sling loading is the most efficient and time saving method.

Two or three men could be responsible to the day sector boss for setting up each camp and heating two frozen meals per day. The use of frozen meals will eliminate the need for trained cooks at each camp. Lunches could be prepared by a catering service or base fire camp and flown in.

By assigning men to a sector, leaving them there until the work is complete and supplying them by air or truck, the need for long and sometimes arduous periods of travel between fire line and fire camp can be eliminated. Only safe areas should be selected for the camp location, however.

Rest Helps

More time for rest between shifts will decrease the accumulative fatigue factor and the accident risk. The risk of motor vehicle accidents on traffic-jammed truck trails will be reduced. Plans and service operations will be simplified. Gains will include more productive working time on the line, higher morale of the men, increased productivity on the fire line, and increased safety.

Whenever the driving time from fire camp to sector exceeds 30 minutes, the establishment of sector camps should be considered. The fire boss may want to keep one or two hotshot crews available at the base fire camp for trouble-shooting hot spots or working the head of the fire. The concept of air manning and supply is flexible enough to handle most situations that arise. The keys to its success are training, planning, organizing, and coordinating.

A Sample Problem for Manning and Supplying A Three Sector Fire By Helicopter

Assume 100 men per sector and at least seven light turbine helicopters available initially. Helitack crews under supervision of the service chief or line boss should have already selected and completed construction of sector camp helispots. During the initial air lift, two light turbine copters (Hiller 1100 types), or one large one (Bell 204 B, 205 A), should be assigned to each spot. After the men and fire camps have been transported to their sectors, one helicopter per sector camp will be sufficient to bring up daily supplies and for necessary crew movement within the sector. The day shift should be lifted first and early enough so that the fire camp can be sling-loaded up next. The fire camp can then be set up by a few men while the night shift is being brought in. Two men are enough to heat the steamed meals and manage the camp.

The helicopter manager's job during this type of operation will require close coordination with the air attack boss, line and sector bosses, and the plans and service chiefs. When there is an air tanker operation going in a certain sector, the helicopter operation in that sector can be suspended temporarily and that sector's 'copters assigned to speed up the air lift to other sectors.

Daily Supply

Water: The minimum water necessary is 2 gallons per day per man. Our drop camp supply sheet lists the weight of water with containers as 90 lbs. per 10 gallons. One hundred men will require 1,800 lbs. of water or about two to three sling loads. Loads or trips for water can be reduced if water is brought up during other routine missions.

Food: One frozen food company lists the weight of a 10-meal box of supper meals as 20 lbs., and 10 breakfasts as 18 lbs. The total for one day's meals for 100 men comes, then, to 580 lbs. Food for the day can be brought up in one load, early in the morning, or brought up late afternoon for the next day.

Additional supplies: Replacement tools and other necessities can probably be brought up during some of the routine missions during the day.

Additional Pointers

1. *Cost*—The average cost per man to fly to his sector camp is about $15.00 per 5-mile flight.
2. *Aircraft*—It would be advantageous to have at least two aircraft per sector camp available for the initial air lift. The extra helicopter per camp can be released after the air lift.
3. *Density Altitude*—When operating at extremely high temperatures and/or elevations, the density altitudes can be high enough to considerably lower the freight loads. There are no hard and fast rules as to what the helicopter can carry. Payloads depend on environmental conditions. The pilot has to make the final decision.
4. *Tooling Up*—When the men arrive at base camp, they should each be issued a tool and a gallon of water. They should keep their fire bags with them (fig. 1). These items should be airlifted with the men. There may be times when one man has to be dropped from a load due to density altitude. Files, headlights, batteries, and paper sleeping bags are included in the drop camp.
5. *Breaking Camp*—When the work is completed in a sector, the men can either be flown out or walked out. The drop camps can be sling loaded in two trips per 50-man camp.

△

Oscillating Sprinklers Backup For Burnout

JOHN D. DELL[1] and
GEORGE I. SCHRAM[2]

An oscillating sprinkler system serves effectively as a backup for burnout. It was used on the Eagle Rock Fire, Willamette National Forest, in 1967 to hold a difficult section of control line near the bottom of a V-shaped canyon where radiant heat was a major concern.

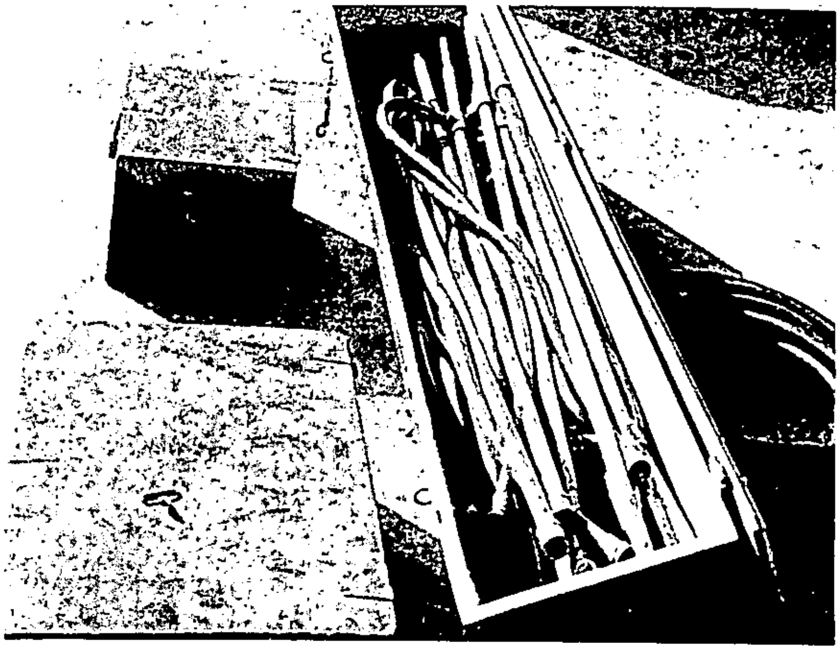


Figure 1.—All equipment for 20 sprinkler units is assembled in a kit for easy transport and handling.

A fireline is not complete until the unburned fuel between the fire edge and the control line is reduced or eliminated—usually by burning out. This operation is a routine part of the fire suppression job—unless the burnout must be done under conditions of adverse topography, wind changes, or heavy fuel concentrations. In this event, the operation is usually reinforced with extra holding crews and equipment, air drops of chemical fire retardant, or both.

Oscillating Sprinklers

An oscillating sprinkler system was used effectively as a backup for a difficult burnout on part of the 1,300-acre Eagle Rock Fire on the Willamette National Forest, western Oregon, in 1967. This same sprinkler system, and its application for slash burning, has been described by Orr and Dell.[3] It is now assembled in kit form for easier transport and handling. The kit (fig. 1) weighs about 175 pounds. It has 20 galvanized steel conduit standpipes, 20 sprinkler heads, and accessory hardware for connection to a 1½-inch fire hose. Cost of parts for the 1,000-foot, 20-unit system is about $350, and it takes about 2 man-days to assemble it. Assembly instructions, equipment list, and sources for parts supply were reported by Orr and Dell.

Eagle Rock Fire

The situation at the Eagle Rock Fire required burning out more than a quarter mile of critical control line. This line was near the bottom of a "V"-shaped canyon (see fig. 3). Fire control was difficult because the topography included numerous steep cliffs and rock outcroppings. Use of tractors for line construction was impossible. Although the control line for the burnout was in a difficult location, it was the best that could be found—the line was as close to the fire's edge as a crew could work. If it had been necessary to build this line at the nearest natural topographic break, at least an additional 100 acres of timber and watershed valued at $15,000 might have had to be sacrificed in the control effort. A 50-foot path on the fire side of the control line was cleared of smaller trees, brush, and standing snags. Most of this debris was deposited in the bottom of the draw. Ignition of outside fuels by radiation from the burnout was a major concern.

Water Supplied by Ground Tanker

A thousand feet of fire hose was laid next to and just above the control line (fig. 2). The sprinkler kit was unloaded at a roadhead, and unit components were carried or placed in backpacks for transport by the

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[1] Forester, Pacific Southwest Forest and Range Experiment Station, stationed in Portland, Oreg.

[2] Fire control technician, Sweet Home District, Willamette National Forest, Sweet Home, Oreg.

[3] Orr, William J., and John D. Dell. Sprinkler system protects fireline perimeter in slash burning. Fire Control Notes 28(4): 11-12, illus. 1967.

assembly crew to the burnout area. Hose line fittings were placed at each 50-foot coupling, and the 20 oscillating sprinklers were connected to the line. Stream water was not available for the operation, so the water had to come from a 3,000-gallon slip-on tank on a dump truck, with a Pacific Mark 3 pump providing pressure. Four additional nurse tankers were used for resupply. Water was hauled 2 miles from the nearest natural source. Since the Eagle Rock Fire, we have determined that 20 full circle oscillating sprinklers (7/32-inch nozzle) on a 1,000-foot, 1½-inch cotton jacketed-rubber lined (CJRL), hose-lay require a 4,500 gallon per hour water supply.

Burning out at Eagle Rock started late in the afternoon. Sprinklers were not turned on until burning was underway so that they could not adversely affect the firing. As firing crews progressed down the draw from the top, sprinklers were turned on behind them. The sprinklers were set on 180° rotations so that only the area outside the control line was wet down.

Sprinklers Assist Holding and Mopup

Heat from the burnout fires became intense, but no spot fires started in the areas covered by sprinklers. Holding crews were able to use the sprinkled area as a heat shield.

Firing was completed at 0200 hours the following morning, with fire in the upper sector of the line already diminishing. Sprinkler heads were readjusted to full circle, so that the burned-over area inside the line would be cooled off for mopup the next day.

Through the critical hours of the burnout, an estimated 40,000 gallons of water were used. In the opinion of the fire over-

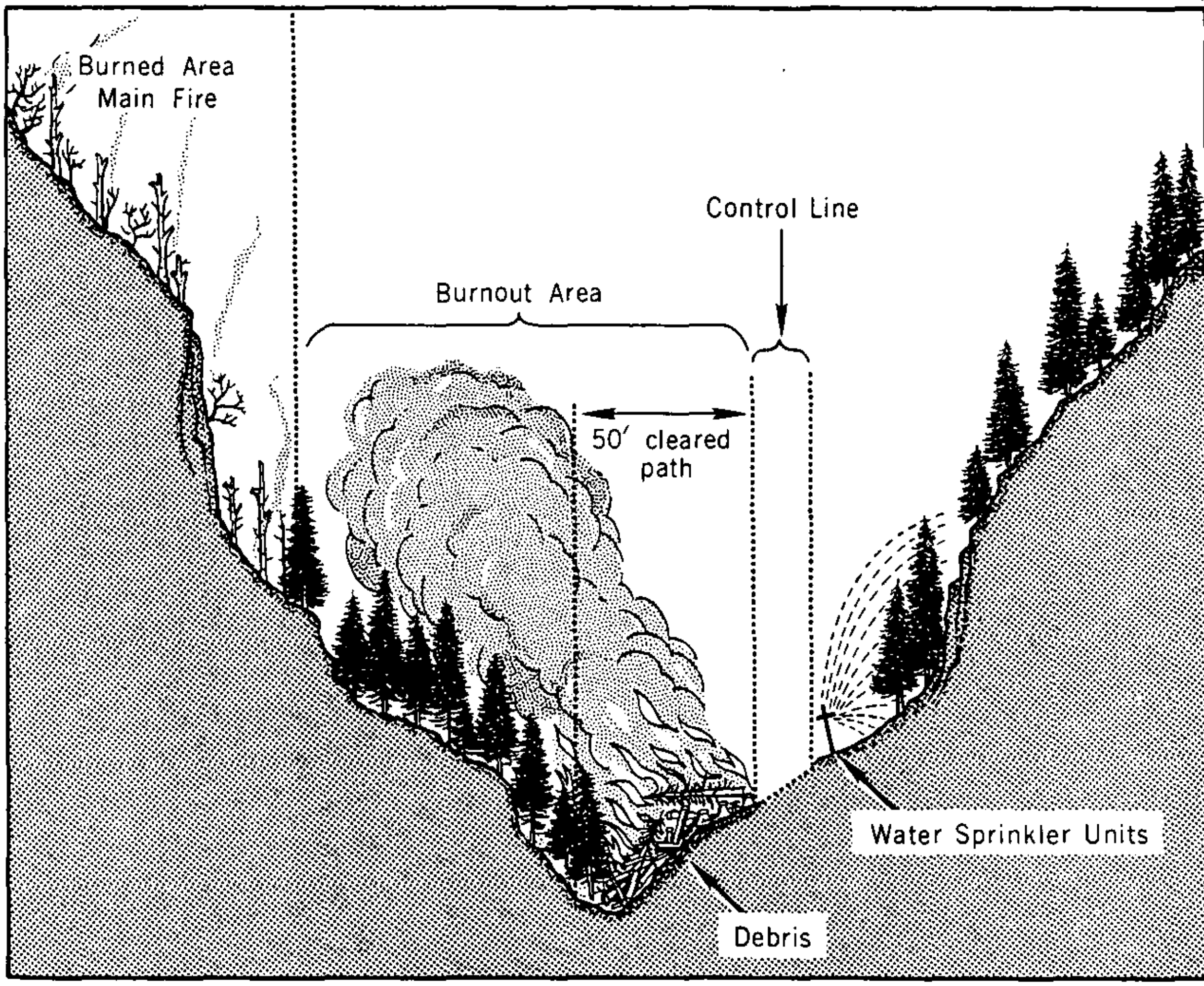


Figure 2.—In this burnout situation, a 20-unit sprinkler system was used to reinforce the fire control line in the 1967 Eagle Rock Fire. Clearing for a burnout control line resulted in a dense concentration of debris in the canyon bottom. The sprinklers, placed just above the control line, prevented spotting over the line from radiated heat.

head who observed the operation, the line could not have been held without the sprinklers.

Observations

The use of a sprinkler system can contribute to the fire control effort in both prescribed burns and wildfires. We believe the system has these specific advantages. It:

- provides an even, measurable (gal./min.) water diffusion over the fuel area to be treated.
- allows a sprinkler to be shut off anywhere along line to conserve water when it is not needed.
- allows connection of additional hoses and nozzles for covering spot fires across a line.
- can have a favorable effect on burning conditions within several hundred feet of the sprinkler line.
- generally conserves water supply because of low flow rate from small orifices on sprinkler heads.
- can be used to help protect special areas, such as recreation sites, plantations, buildings, and homes.
- can be used to reinforce narrow control lines.
- can be used to reinforce and wet grass-covered fuel breaks on fire perimeter.
- serves as a heat shield for line crews during holding, backfiring, or burnout operations.
- can be used in helping mop-up by gradually moving the system inward from the fire's edge.

The Eagle Rock Fire marks one of the few instances in the Pacific Northwest Region where sprinklers have been used on a wildfire. Improvements in some of the equipment and assembly methods we used can be expected. Distributing water by sprinklers offers excellent possibilities for conserving manpower and promoting safety in fire control work. △

Retardant Sacks Baled For Disposal

James C. Allen[1]

The disposal of empty retardant sacks has long been a problem around retardant bases. Methods vary from throwing the sacks on the ground or onto a truck or trailer to throwing the sacks directly into an incinerator for burning on the spot.

Disadvantages

Each of these methods has disadvantages. During periods of high fire occurrence, the entire area around the retardant mixing plant is covered with sacks when they are thrown indiscriminately on the ground. It is expensive to keep a vehicle on hand for carting sacks away, and air pollution restrictions have outlawed the use of the incinerator in many areas.

Retardant Plant Foreman Robert H. Mayfield designed a baler that was installed at the Redmond Air Center plant in 1968. It has since been adopted for Service-wide optional use. The sacks are now baled and stacked until they can be hauled away at the end of the day. A savings estimate of $10 per operating day in handling costs is realized from the use of the baler. Intangible benefits include: air pollution abatement, improved appearance of the plant, and better utilization of available working space.

Construction

The unit is constructed of ¾" pipe (fig. 1) and includes a foot press and a latch to hold the press in place while the sacks are being tied. The sacks are tied with twine, and each bale consists of 25 sacks, one mixer load.

The cost of the unit was $46 for pipe, welding, and assembly. Scrap material was used for the foot press and other small parts. Pipe cutting and painting was done by the plant foreman in his spare time. Estimated cost to have the unit constructed by a commercial source is $125-150.

Plans

Plans are available from Forest Supervisor, Deschutes National Forest, 211 East Revere, Bend, Oreg. 97701 △

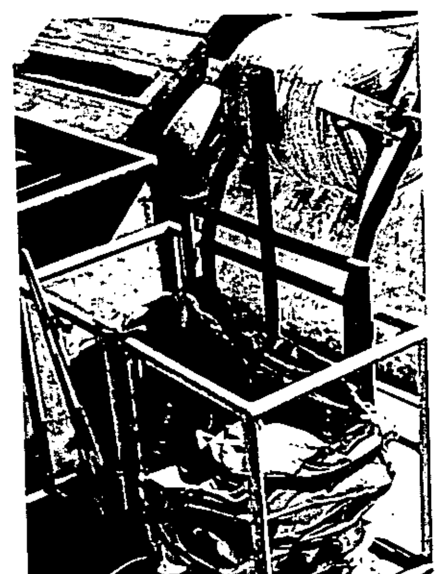
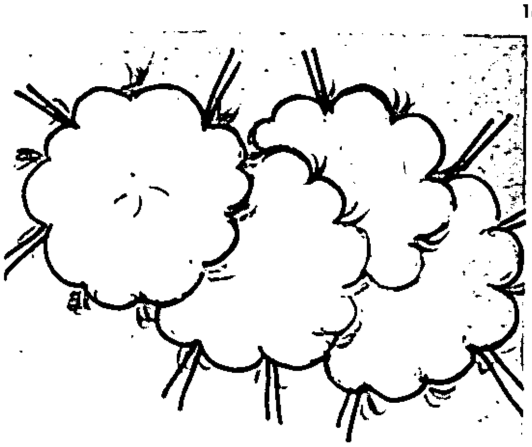


Figure 1.—The baler is conveniently located where slurry is mixed and empty sacks can be dropped in the baler. One mixer load of 25 sacks compresses into a bale of approximately 2' x 3', convenient to handle and neatly and easily stacked.

[1] Air Center Manager, Redmond Air Center, Deschutes National Forest.



162. We call it an EXPLOSION! This is why —

163. If you walk into a dusty place smoking a cigarette —

164. This can happen!

Structural Fire Prevention Training Pays Off

RICHARD R. FLANNELLY[1]

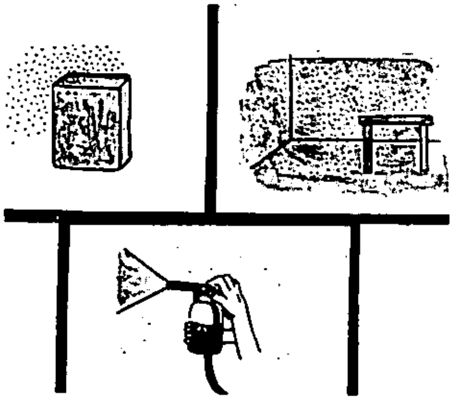
A trainee-oriented fire prevention program sharply reduced the number of structural fires at Forest Service Civilian Conservation Centers. The program contained a basic and a review course, as well as a self-contained course for staff members and advanced Corpsmen.

In 1966, the pace of establishing 45 Forest Service Civilian Conservation Centers was so hectic the potential problem of structural fires was not placed in the proper perspective.

These Centers are in isolated locations and must depend primarily on their own resources to suppress fires. By February 1967, 18 fires had occurred, resulting in a financial loss of $84,000. By phenomenal luck, no one was killed or injured. Safety experts say that whether or not a given exposure to accident results in no injury, minor injury, major injury, or death is merely a matter of luck. Our assumption was that we had just about run out of luck.

The Forest Service is noted for its prowess in preventing and suppressing forest fires but has limited experience with structural fires. For this reason, we decided to start a training program for structural firefighting and open this program to proposals from private training contractors.

[1] Employee Development and Training Branch, Division of Personnel Management, Washington Office, USDA Forest Service.



165. Turn to page 2 and answer this question.

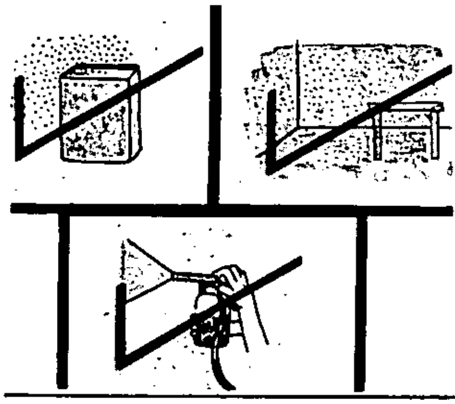
Where can a spark cause an explosion?

—A spark in a room of gasoline vapors.

—A spark in a dusty room.

—A spark in a room of paint fumes.

—ALL of these.



166. The answer is ALL of these. MANY kinds of dust, vapors, and fumes can explode.

TECO Instruction, Inc., of Atlanta, Ga., was awarded the contract. TECO staff talked with Corpsmen and Job Corps personnel, observed fire related behavior and attitudes, and attempted to determine common fire hazards at several Job Corps Centers.

Data collected outlined the differences between the Corpsman's actual fire prevention behavior and their desired behavior. The training program, then, had to be planned around the following constraints.

1. At least 40 percent of the Corpsmen in every Center have a reading ability below the third grade level.

2. Corpsmen's attention spans are short in the classroom.

3. The Center cannot use programs that require outside assistance.

4. Centers are limited in audio-visual equipment, and there are no provisions for purchasing new equipment.

The Training Course

Entitled "Structural Fire Prevention and Control," the training course consists of 1,014 color slides and 16 booklets. It is divided into three major units: The Corpsmen Basic Course, Corpsmen Review Course, and the Self-Contained Course for staff members and advanced Corpsmen. The Basic and Review Courses involve the use of 35 mm. color slides, instructor manuals, trainee response booklets, and demonstrations. The Corpsmen booklets contain pictures only—no words.

The instructional method in the Basic and Review Course includes classroom presentation and demonstrations. The instructor shows a series of slides while reading a prepared text from his manual. At key points, the Corpsmen are required to respond either orally or by checking in their response booklets. The following sample from the instructor's manual demonstrates this technique:

Insert Illustrated Frames

In frame number 3, the instructor tells the Corpsman which page to turn to in the Corpsman's answer book. The same picture appears in the Corpsman's answer book as appears on the screen. The Corpsman indicates his response by checking the picture.

The Basic Course covers seven subject areas by units:

A. Some Facts About Fire and Fire Safety.
B. Explosions and Fire Preparedness.
C. What To Do if Fire Occurs.
D. The Fire Triangle and the Fire Extinguisher.
E. What To Do if Fire Occurs—Some Special Cases.
F. Special Fire Hazards (Smoking, Clothes Dryer, and Electrical Appliances)
G. Other Fire Hazards.

During the Basic Course, fire demonstrations are provided that build on knowledge learned in the classroom. These demonstrations include Fire Plan Orientation, Hazard Hunts (each becoming more specific), Fire Extinguisher Practice, and Fire Evacuation and Rescue Practice.

The Review Course covers the same subject matter and demonstrations as the Basic Course, but with less detail and explanation. It was designed as follow-up and refresher training for Corpsmen.

The Self-Contained Course has the same content as the Review Course, but the printed message is printed alongside the corresponding visual. The Self-Contained Course is for use by staff members and by Corpsmen who are advanced in reading skills.

The finished product was demonstrated to officials of the Interior Department. They decided to adopt the program in their Conservation Centers.

One Year Later

There has been a sharp reduction in fire losses since the program was initiated. Only two buildings have been lost and one damaged, and no injuries or loss of life were involved. All three fires were caused by arson, a problem which we knew about but did not believe could be prevented by a training course. But the lack of injuries may be traced to improved evacuation of buildings. Obviously, one training course cannot be given full credit for reducing fires or saving lives. A great amount of management attention was focused on the Center fire problem by adoption of the training, policy statements, and inspections.

The concern and involvement of management has been a critical factor in this program as it is in any safety or training program. Those Centers which had not implemented structural fire training listed lack of time as the primary reason. A manager must always weigh the investment of time for safety and training against the consequences of what may happen if he does not invest the time. In his safety role, a manager has to be accountable not only to the law but also to his supervisor, his subordinates, the total organization, and his own conscience.

We will never know the ultimate value of structural fire training because the effects should stay with a Corpsman long after he leaves the Center. The same fire prevention principles will apply equally as well in his home.

If you wish more information about this course, contact the Training Branch, Division of Personnel Management, Forest Service, USDA, Washington, D. C. 20250. △

LC Retardant Viscosity Reduced In Alaska

C. W. GEORGE,
R. J. BARNEY,
and G. M. SHEETS[1]

More than 4 million acres of forest and rangeland were burned by wildfire in Alaska during the summer of 1969. Airtankers played a major suppression role by dropping more than 2 million gallons of viscous fire retardant chemical. Some of the numerous drops were investigated, and follow-up discussions with fire control personnel indicated that changes in the physical properties of the chemical solution might improve fuel penetration and coverage, thus enhancing suppression characteristics.

A preliminary evaluation of nonviscous liquid concentrate was undertaken to determine whether retardant effectiveness could be improved in the Alaskan fuels by reducing the viscosity and surface tension.

[1] Respectively, research forester, Northern Forest Fire Laboratory, Intermountain Forest and Range Experiment Station, Missoula, Mont., project leader, Pacific Northwest Forest and Range Experiment Station, at the Institute of Northern Forestry, College, Alaska; assistant fire control officer, Bureau of Land Management, Fairbanks, Alaska.

The Alaskan Study

Thickened ammonium phosphate (Phos-Chek® 202[2]) has been used to combat wildfire in Alaska for the past several years. An evaluation of drops on wildfires during July 1969 near Fairbanks indicated fuel coverage and penetration were not complete. The slurry effectively coated spruce, birch, aspen, and associated aerial fuels but exhibited limited penetration into heavy ground fuel. (Slurry samples taken had a viscosity of 1500 centipoise and diammonium phosphate salt content of nearly 12 percent by weight.) This coverage was effective in halting the rate of spread through aerial fuels. Although flaming combustion was sometimes extinguished for as long as an hour, the retardant did not prevent smoldering and glowing which continued beneath and through the treated fuel.

Penetration and coverage by Phos-Chek 202® can be improved by lowering the viscosity of the solution or possibly by adding a wetting agent, but not without a concurrent decrease in the salt content. Thus, use of nonviscous liquid ammonium phosphates is an approach which can improve application characteristics without impairing the salt concentration.

The following liquid concentrates, which had demonstrated desirable characteristics in preliminary laboratory tests at the Northern Forest Fire Laboratory, were also evaluated for Alaskan use:

1. Fire-Trol 930[3] (liquid 10-34-0 manufactured by Allied Chemical Corporation and containing 1.5 percent by weight $Na_2Cr_2O_7$ as a corrosion inhibitor).

[2] Phos-Chek® 202 is a product of the Monsanto Company.

2. Fire-Trol 934[3] (Fire-Trol 930 with a surfactant or wetting agent added).

The limited amount of liquid concentrate available (enough to mix 6,000 gallons of retardant solution) allowed only a few airdrops of Fire-Trol 930 and 934. Both materials were evaluated, h o w e v e r , using Phos-Chek 202® drops as a basis for comparison. All retardant drops during the tests were made from a PB4Y2, capable of carrying 2,500 gallons in eight individually gated tanks.

By opening two gates together, 625 gallons could be dropped; to stretch the limited supply of liquid retardant, a 500 or 1,000 gallon drop size was used. The drops were made from as close to 100 feet (tapeline altitude) as possible at a speed of between 110 and 120 m.p.h., in winds of less than 5 m.p.h.

The retardant was dropped on uncontrolled fire fronts in the Fairbanks area when conditions and logistics were favorable. The evaluation was made by teams both in the air and on the ground at the time of the drop. The duration and extent of effectiveness for each drop were noted. The date, size, and number of drops evaluated are given in table 1, with the chemical analysis of each retardant.

[3] Fire-Trol 930 and 934 are marketed by Arizona Agrochemical Corporation.

Results

Apparently the three retardant solutions where the Fire-Trol 930 and 934 stopped the fire, Phos-Chek 202® acted as a suppressant also. Where both liquids failed or only reduced the rate of spread, Phos-Chek 202® had similar effects. Where none of the three was successful, the spread could be attributed to flaming or smoldering through unpenetrated or uncoated fuel. Where ground fuels were heavy and tussocks numerous, all retardants were ineffective.

Drop patterns for the unthickened 930 and 934 were similar though larger than those for Phos-Chek. Under the drop conditions described elsewhere in this article little difference in the effective pattern area could be resolved. Fire-Trol 930 and 934 dispersed and more uniformly coated aerial and ground fuels. Phos-Chek tore up turf and broke trees, but little evidence of Fire-Trol 930 and 934 impact was apparent.

Discussion

The low viscosity of the liquid retardants (less than 50 centipoise) did not hamper their effectiveness. This was attributed to:

1. Drops being made from 100 feet or less (tapeline altitude), made possible by relatively low canopies and smooth terrain.

2. The largest percentage of the drop ending up on ground fuel. Normal fire spread was through ground fuels, although crowning of individual trees far behind the flame front sometimes contributed to fire spread by spotting. A thick retardant coating on aerial fuels was not necessary.

3. A 30-percent higher salt content in the liquid retardant (nearly 8.5 percent compared with 6.0 percent P_2O_5 equivalent for Phos-Chek). Greater dispersion and less solution retained on fuels could be tolerated, yet an effectiveness equal to that of Phos-Chek would still be maintained.

The only noted disadvantage of Fire-Trol 930 and 934 used under these conditions was lack of color. These unthickened solutions were not visible to the pilots and made tying together consecutive drops nearly impossible. Lack of coloring may be a minor consideration, though, if the retardant is used primarily for *initial* attack on *small* fires.

Table 1. — *Characteristics of retardant dropped*

Retardant	Drop Date	No. of drops	Size of each drop	Desired mixing ratio	Density	Viscosity	Salt content: Percent DAP by weight	Salt content: Percent P_2O_5 equivalent
			Gallons		*Lbs./gal.*	*Centipoise*		
Phos-Chek 202	July 6	4	500	1.14 lbs./gal.	8.90	940	11.21	6.02
	July 10	10	1,000	1.14 lbs./gal.	8.89	920	11.08	5.96
Fire-Trol 930	July 6	4	500	5 to 1 by vol.	9.13	<50		8.69
	July 9	2	500	5 to 1 by vol.	9.12	<50		8.57
Fire-Trol 934	July 10	2	1,000	5 to 1 by vol.	9.06	<50		8.28

Summary

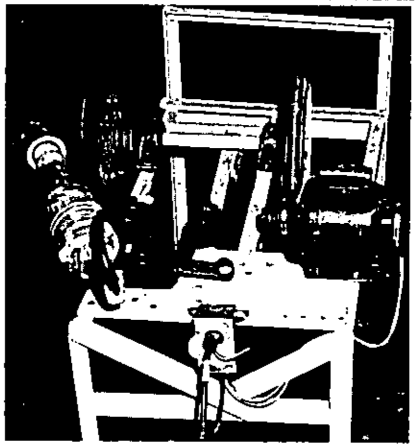
Obviously, from the limited number of drops made, definite conclusions cannot be drawn. The evaluation did indicate that unthickened liquid retardants can be successfully used in the Alaskan fuel type under difficult fire conditions and at drop heights that minimize dispersion. Success in the Alaskan situation will be greatly enhanced by development of an adequate coloring agent. Possible advantages, such as simplicity of mixing and cost of material, should also be considered. Transportation costs, logistics of summer storage, and overwinter storage of excess concentrate in Alaska's long periods of extremely low temperatures may prove to be limiting. △

FROM BACK COVER

Forward rates of spread vary with many factors from region to region. The estimated rate of spread to be used in calculation of probabilities should be developed from local studies. Most regions include rate of spread information in their Firefighting Overhead Notebook.

This table is an estimating guide only. Like other aids, its value is related to the skill with which it is used. Forward advance and shape of fire must be adjusted for actual conditions.

When placed in a source commonly carried in the field during fire season, such as the Firefighting Overhead Notebook, the table is readily available and can easily be used to reduce the margin for error in determining control requirements. △



Coulters Sharpened

MAINE FOREST SERVICE

Cliff Chapman, Maine Forest Service, Unit Ranger at Gorham, has developed a device for sharpening a coulter disc.

The basic concept of this coulter disc sharpener is to mount the coulter in such fashion that it rotates and brings the emery wheel of a hand grinder into contact with the disc at the correct angle. This eliminates the danger of overheating and insures the correct bevel around the entire cutting edge of the coulter.

The Setup:

- A ⅓ h.p. motor with a 2″ pulley drives a 12″ pulley mounted on a 1¼″ shaft to which is attached a 3″ x 3½″ pulley on the opposite end. To the 3″ x 3½″ pulley is welded an 8½″ x ⅛″ circular disc. Four holes are drilled in this circular disc to match the four holes in the coulter. This is the way the coulter is attached to the circular disc.
- Four additional holes are drilled in the circular disc approximately ½″ from the outside edge. On the side of the disc away from the coulter (when it is mounted) are welded ⅜″ nuts over these holes. ⅜″ cap screws are inserted in these nuts which are used to aline the coulter disc to insure it is rotating in a true circle.
- A 6″ Milwaukee hand grinder is mounted on a flat 2″ x 14½″ x ½″ bar in which a hole has been drilled at each end of the bar. The handle of the grinder is removed to enable the stud that holds the handle to be used to mount the grinder on the flat bar.

The Operation:

- In positioning the grinder wheel against the coulter, the correct bevel is obtained before tightening the two bolts in the flat bar (one securing the grinder and the other securing the bar to the platform on the framework). The pressure of the grinder against the coulter is maintained by hand or by attaching a spring to the grinder. After grinding one side the coulter will have to be reversed to grind the other side.
- To convert the device to a power grindstone, the flat bar and hand grinder are removed and an 18″ grindstone set up on bearings mounted on the framework. The grindstone is turned by a belt running from the 3″ x 3½″ pulley to a 10″ pulley on the grindstone shaft.
- An electrical junction box is mounted at one end under the platform. This junction has outlets to plug in the hand grinder and one for the ⅓ hp. drive motor.

For more detailed information, contact the Maine Forest Service, Augusta, Maine 04330. △

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Table Speeds Fire Spread Estimates

GARY E. CARGILL[1]

Fire perimeters can be quickly estimated using a "rate of spread/elapsed time" table. This eliminates the need for plotting the fire acreage in order to determine the perimeter of the fire, and control force requirements based on fire perimeter can be determined quicker.

Present methods of determining fire control requirements generally involve calculation of area with reference to an area perimeter table in order to find chains of fire line to be constructed. Because of the calculations involved, existing guides for estimating initial attack and reinforcement requirements are not always used as often as they might be.

Calculating the area involves plotting the perimeter and using a dot grid or map scale.

These methods, while generally more accurate for larger fires, are time consuming and require maps and hardware. When calculation of probability information is needed most during the first few hours of suppression, time, maps, and hardware are scarce. Occasionally this results in action which is too little, too late, or too much.

This article provides a table which is a quick means of figuring control requirements, because perimeter is given directly from rate of spread and elapsed time, without first calculating area or plotting the fire.

The assumption is that forward rate of spread in chains per hour multiplied by elapsed time will equal the forward advance of the fire and that the forward advance is approximately equal to the diameter of a circle which would enclose the fire area. The perimeter of the fire is then circumference of that circle with adjustments made to reflect more nearly the actual shape.

The factors involved are:
p = perimeter
$\pi = 3.1416$
c = circumference
d = diameter or forward advance of fire

The formulae are:
Minimum perimeter $= c = \pi d = 3.1416d$
Usual perimeter $= 1.5c = 1.5 (\pi d) = 4.7124d$
Maximum perimeter $= 2c = 2 (\pi d) = 6.2832d$

SEE P. 15

TO USE THIS TABLE

1. Determine forward ROS for fuel type and wind velocity from your Firefighting Overhead Notebook.
2. Determine elapsed time for which perimeter is desired.
3. Determine approximate shape of fire; i.e., circular, fan shaped, or rectangular.
4. On the table, locate forward ROS and elapsed time. Read perimeter from intersecting column. Use minimum perimeter for circular fires, usual perimeter for fan shaped fires, maximum for rectangular fires.
5. Acreage may be found by referring to area perimeter table.

RATE OF SPREAD (ROS) PERIMETER TABLE

Forward ROS in Chains Per Hour	Elapsed Time in Hours: 1			2			3			4		
	Chains of Perimeter											
	Min.	Usual	Max.	Min.	Usual	Max.	Min.	Usual	Max.	Min.	Usual	Max.
1	3	5	6	6	9	13	9	14	19	13	19	25
2	6	9	13	13	19	25	19	28	38	25	38	50
3	9	14	19	19	28	38	28	42	57	38	57	75
5	16	24	31	31	47	63	47	71	94	63	94	126
6	19	28	32	38	57	75	57	85	113	75	113	151
8	25	38	50	50	75	100	75	113	151	100	151	201
12	38	57	75	75	113	151	113	170	226	151	226	302
17	53	80	107	107	160	214	160	240	320	214	320	427
20	63	94	126	126	188	251	188	283	377	251	377	503
33	104	156	207	207	311	415	311	467	622	415	622	829
40	126	188	251	251	377	503	377	565	754	503	754	1005
60	188	283	377	377	565	754	565	848	1131	754	1131	1508
80	251	378	503	503	754	1005	754	1131	1508	1005	1508	2011
120	377	565	754	754	1131	1508	1131	1696	2262	1508	2262	3016

[1] Division of Fire Control, Southwestern Region, USDA Forest Service.