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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.

Volume 14 Number 4

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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HALF-INCH FUEL-MOISTURE STICKS—HOW THEY ARE MADE

C. E. HARDY

Forester, Northern Rocky Mountain Forest and Range Experiment Station

Nearly 30 years ago the idea of using sticks of known dry weight as a criterion of the moisture content of forest fuels was conceived. The purpose of indicator sticks is to evaluate the relative dryness of fuels as one essential step in fire-danger rating. Richard E. McArdle, now Chief of the United States Forest Service, developed the idea of 1/2-inch square sticks and doweling 3 sticks together. The late Harry T. Gisborne, in Region 1, tested natural branches, 2-inch dowels, 1-inch dowels, and the square ones during the process of arriving at the present type of fuel-moisture indicator sticks. Prior to 1942 sets of sticks were not trimmed to any particular oven-dry weight. Either a special scale had to be used or a conversion table prepared for each set. Starting in 1942, all sets were trimmed to exactly 100.0 grams, oven-dry weight. This reduced computation work tremendously and minimized errors. It also meant that a set of fuel-moisture sticks could be used anywhere without having its little conversion chart tagging along.

After the sticks were generally accepted throughout the Western States, the California Forest and Range Experiment Station assumed the manufacturing task and started development of a mass-production method. In 1948 the manufacturing responsibility was assigned to the Northern Rocky Mountain Forest and Range Experiment Station. Development of efficient mass-production methods continued at the Priest River Experimental Forest in northern Idaho. Finally, in the fall of 1951, a manufacturing center to produce fuel-moisture sticks for the entire Western United States was established at the Forest Service Warehouse in Spokane, Wash. The Division of Procurement and Supply has an ingenious group of fellows at the Spokane Warehouse—they love to find easier and cheaper ways of doing things. This article will tell how they are doing the job.

A set of Forest Service standard fuel-moisture indicator sticks consists of four 1/2-inch ponderosa pine sapwood dowels spaced 1/4 inch apart on two 3/16-inch-diameter hardwood pins. The dowels are held in place on the pins by wire brads at each intersection. The resultant set of indicator sticks is 2-3/4 inches wide, approximately 20 inches long, and has an oven-dry weight of 100.0 grams.

The manufacturing process is a continuous one. When production is fully underway, material is in all stages of completion. Six or seven weeks' production by a 2-man team is sufficient to supply the normal annual demand for 1,800 sets. The sticks are made

during the winter months when warehouse work schedules can best be adjusted for the purpose.

The Division of Fire Research furnishes technical supervision to the project. The forester in charge of Fire Danger Rating research assists in instruction and inspection at the lumber mill when the dowel stock is purchased, training of new personnel at the place of manufacture, setting standards and tolerances, and inspecting the product through all stages of manufacture.

Procurement of good quality dowel stock makes the whole job easier. Specifications are strict: the dowels are cut from well-manufactured, sound ponderosa pine lumber, air-dried or kiln-dried to a uniform moisture content of not more than 15 percent. All dowels are round and accurately cut to a uniform diameter of 1/2 inch, tolerance of ± 1/64 inch, and to a length of 23 1/2 inches, tolerance of ± 1/8 inch. They are smoothly and accurately machined except for occasional minor imperfections that can be corrected by light sanding. The grade or quality of the dowels is such that at least a 20-inch section of the length is free of the following defects: heartwood, knots, pitch pockets, pitch streaks, excessive number of resin canals, splits, checks, shake, stain, decay in any stage, cross or diagonal grain in excess of 1/2 inch per foot, coarse grain or grain having noticeable percentage of summerwood, sweep in 2 planes, sweep in 1 plane in excess of 1/8 inch per 23 1/2-inch dowel. Specifications for the 3/16-inch connecting pins are similar except that these are maple or birch.

The primary pieces of equipment needed for the manufacturing job are: 2 electric ovens made so the inside rack turns continuously, drill press, drilling and assembly jigs, 4-inch power saw, 3 sets of balances (knife-edge types for the sorting table and the initial check-out at the oven, and a high quality torsion balance for final trim and final check), a tacking machine and tacks, GI brush, rubber stamp, and other incidental tools.

Fuel-moisture research shows that of the unsatisfactory indicator sticks, 80 percent are made from dowel stock either too light or too heavy to meet the length requirements. Dense wood containing excessive resin in the cells and wood that is very light in weight produce sticks that have erratic moisture absorption and drying characteristics. It is important that such woods do not find their way into a set of fuel-moisture sticks. However, the elimination of these types of wood is not easy because experience shows that such defects cannot be readily detected by observation.

One of the project men, an ardent disciple of Rube Goldberg, developed an ingenuous device to overcome the trouble. He wasn't sure that his idea of an automatic sorter would prove successful; so instead of making the contraption on official time, he performed the development work on holidays and weekends. The result of his work is a very successful sorting device that automatically detects woods of various densities. Figure 1 shows the sorter and its inventor, Arthur Mast. It consists of a series of No. 14 wires and counterbalances, with the fulcrums held in a wooden framework. The sorter is adjusted so that a dowel rolling along the top of the

frame will drop into a pocket when the weight of the dowel trips the counterbalance. There are 6 pockets—1 for the extremely heavy dowels, 1 for the extremely light dowels, and the other 4 for the usable dowels in order of their weights.

FIGURE 1.—The sorting machine.

After dowels are sorted by weight the next step is inspection to eliminate pieces with such defects as pitch streaks, heartwood, and other items listed in the specifications. A defect rack containing samples of every type of unsatisfactory wood has been assembled as a training aid and guide for the inspector. The culling process takes place in front of a large window, because experience has shown that defects are most readily detected under natural light conditions (fig. 2). Dowels passing inspection are placed according to weight in one of four bins.

Up to this stage in the sorting and inspection process each dowel has been treated as an individual. The next step is to select four matched dowels for assembly into a set of fuel-moisture indicator sticks. One dowel is selected from each of the four weight sorting bins so that no one set of sticks will contain a preponderance of the heaviest or lightest acceptable woods. The four dowels are weighed to determine whether or not the resultant set will meet final weight/length requirements. Proper allowance is made for the moisture content.

The hardwood connecting pins that hold the 4 ponderosa pine dowels together are cut by a power saw to a length of 2 1/2 inches. A special jig permits cutting 90 hardwood pins at a time. Less than one man-hour of labor will produce enough hardwood pins to assemble 1,800 sets of fuel-moisture sticks.

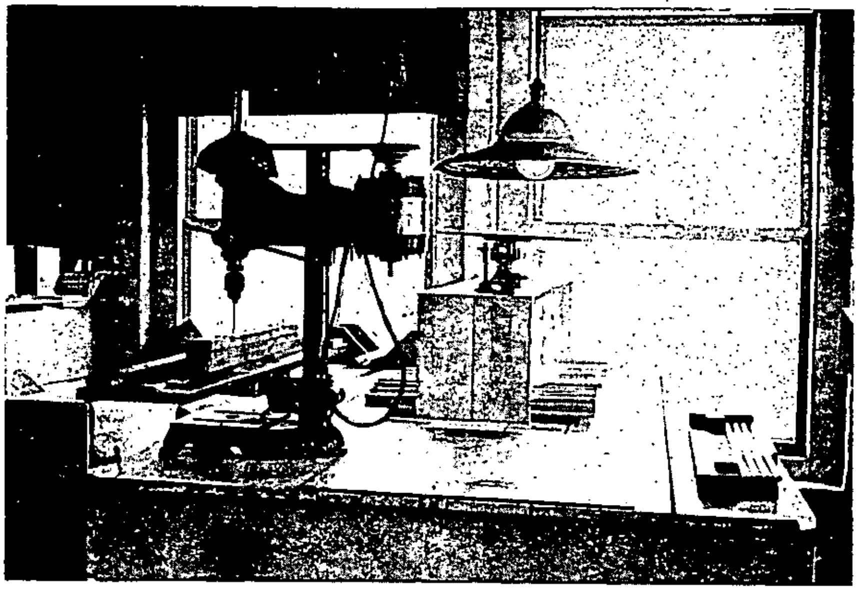

FIGURE 2.—Drilling and assembling layout.

Prior to the actual assembly operation a drill press bores two holes in each ponderosa pine stick for insertion of the hardwood connecting dowels. A special jig holding four ponderosa pine sticks is used in this operation. The two outside sticks are bored only to a depth of 3/8 inch so that the connecting pins will not protrude. This reduces the need for excessive sanding and finishing of the completed set. Holes for the connecting pins are bored through on the two inside sticks. The pins are put through the inside dowels, and the outside dowels are placed over the ends of the pins. The set of sticks is now ready for final assembly.

During final assembly, still another special jig is used to obtain proper spacing of 1/4 inch between each dowel, and to facilitate tacking of the hardwood pins (fig. 2). Tacking is performed with a hammer that automatically feeds the tacks into position. After tacking, little splinters around the holes are removed with a GI brush. Dirt and rough spots are removed with 1/0 sandpaper. Insertion of a screwhook in the end of one of the middle dowels completes the assembly job.

The next manufacturing step is oven-drying of the assembled sets of sticks. Each oven contains a constantly rotating rack that holds 56 sets of sticks in a vertical position. A clutch stops the racks for loading and unloading (fig. 3). Heated air passes uniformly around each set of sticks. The moisture-laden air is ejected through a port in the side of the oven.

Mass production techniques for a 2-man team have been developed for both the assembly and oven-drying operations during a 40-hour work week. New charges of fuel-moisture sticks are

put in the ovens every week day except Friday. On Monday after the ovens are charged, the entire day is available for sorting, drilling, and assembling. On other week days the work schedule is divided between these operations and the oven-drying procedures.

FIGURE 3.—Loading an oven.

After 18 to 20 hours of drying, four sets selected at random from each oven are marked, weighed on a sensitive balance, and the weight recorded. This procedure is repeated hourly until no further weight loss occurs. It is extremely important that all sets of sticks be absolutely dry before removal from the ovens. Any residual moisture will cause an error in all remaining work. When bone dry, the sets are ready for trimming to exactly 100.0 grams.

The two men—call them the initial weigher and the trimmer—must acquire a proficiency in the trimming step, because after a set of sticks is out of the oven for more than 2 minutes, it begins to absorb moisture and pick up weight. The initial weigher removes a set from the oven, weighs it, records the weight, and lays it on the small shelf just beside the trimmer (fig. 4). The trimmer picks up the set, glances at its weight on the chart, and saws it off just slightly longer than called for by a special trimming guide attached to the saw table. The trimming guide is a series of lines parallel to the saw blade, from 18 to 23 inches out from the saw. The guide lines are marked in grams and tenths of grams of initial weight. Guide-line positions are derived from the formula:

$$\frac{\text{Initial weight}}{\text{Initial length}} = \frac{100.0}{X}$$

Thus, a set of sticks with an oven-dry weight of 110 grams will be much longer when trimmed to 100.0 grams than one which has an oven-dry weight of 120 grams. After the first cut the trimmer weighs the set on a torsion balance to determine how much material remains in excess of 100.0 grams. The balance is adjusted so that each mark on the scale above the pointer means one-tenth gram. He saws off about the right amount and reweighs. This is done until the set weighs exactly 100.0 grams. After a very short time the trimmer is able to make the final trimming in one or two passes through the saw.

FIGURE 4.—Initial weighing and trimming.

After trimming, sticks are hung in a rack holding 20 sets. A full day's run, usually consisting of five racks, is placed in the conditioning cabinet, part of which is shown in fig. 5.

The conditioning cabinet is a ventilated closetlike structure where sets may hang until they come into balance with the surrounding atmosphere. It has been found that a week is long enough for a day's run to stay in the conditioning cabinet. At the end of that time any set that is erratic in its moisture absorption and retention capabilities can be spotted and either corrected or destroyed.

A simple procedure has been developed for testing sets of fuel-moisture sticks after their removal from the conditioning cabinet. Each set of the oldest day's run is weighed to the nearest 10th gram on a torsion balance. This weight is recorded on a chart that has a number for each set. The sets are then hung on the final check rack (fig. 6) in consecutive order so the hook number of a set corresponds to the number on the chart. The weights of the day's run of sets (100-110) are added together and

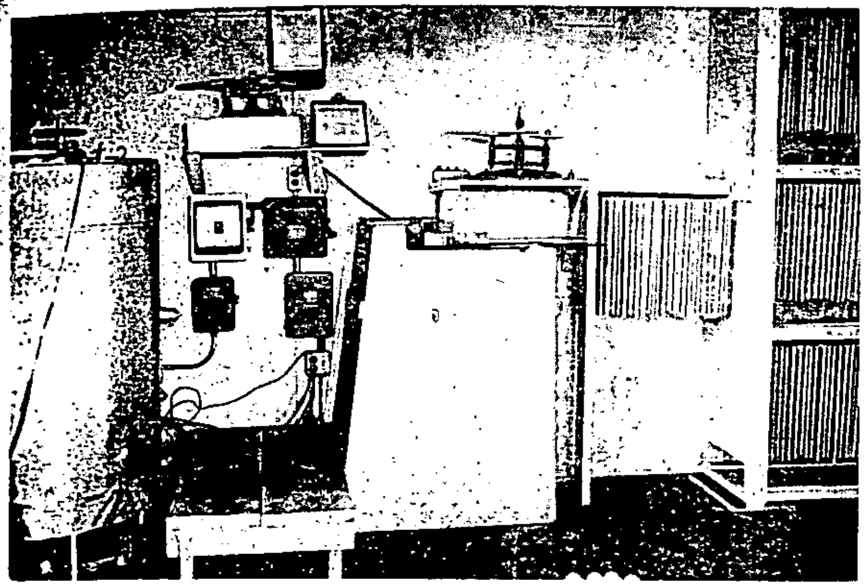

FIGURE 5.—Drying, trimming, and conditioning layout.

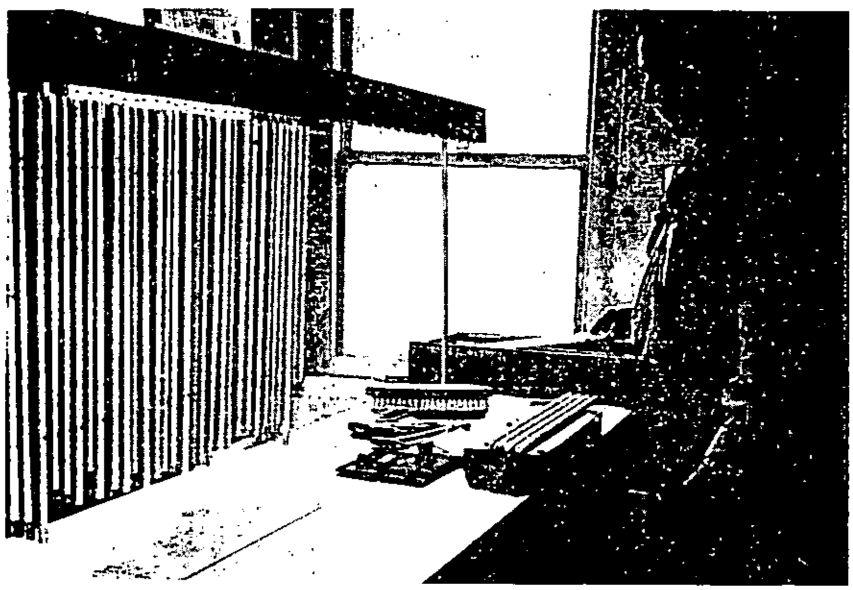

FIGURE 6.—Final check rack.

averaged. Any set whose weight deviates 0.5 to 1.0 gram from the average is corrected. If slightly overweight (0.5—1.0 gram), a set is trimmed down on the saw to the average weight. If slightly underweight (0.5—1.0 gram), brads are driven into one end to bring the weight up to average. If a set varies more than 1.0 gram

from the average, it is discarded. Manufacturing experience shows that only 2 or 3 percent of the sets need adjustment; rarely is it necessary to discard one. All of the previous sorting and culling has diminished the possibility of losing the manufacturing investment long before fuel-moisture sticks reach this point.

After the final weight check, each set of sticks is again examined for fingermarks, loose dowels, splinters, or other defects not previously noted. The set is stamped in red indelible ink on the screweye end: THIS END NORTH, and, THIS SIDE UP. It is slipped into an individual paper envelope, put into a tight box, and stored away under uniform temperature and moisture conditions until spring. Then, orders from New Mexico to Alaska begin pouring in for these indicators of that ever-so-important factor in rating fire danger—fuel moisture.

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Map Mounting

There have been a number of articles on methods of mounting maps for various fire control and administrative uses, but I have found the following method the easiest and most satisfactory for mounting maps on plywood or sheet metal. The materials used are regular clear nitrate dope; nitrate dope thinner; 1½- or 2-inch paint brush (spray equipment can be used); ruler or large drawing triangle or spueegee; map mount of plywood or sheet metal; map.

The nitrate dope is the same unpigmented finish used on airplane fabric. It gives a waterproof, wear-resistant surface that will take a lot of rough use in the field or on the fire finder and dispatching map. One quart of dope will cover about 150 square feet of paper or wood with one coat. The dope can be used without the thinner, but thinning makes the dope easier to handle. Two people can do a better job of mounting large maps than one person, because the dope dries rapidly and the alinement of the map on the mounting base must be completed quickly.

First apply about three coats of dope to each side of the map and to the side of the mount on which the map is to be placed. Each application of dope should be allowed to dry before the next coat is put on. This drying takes but a few minutes. Next apply another layer of dope about the width of the brush along one side of the mounting base and immediately aline the edge of the map on this fresh application before it dries, holding the opposite side of the map off of the base. Progressively apply dope to the mounting base and smooth the map onto the base with a straightedge or squeegee. Do not press the map onto the base any harder than is necessary to push out all of the air between the map and the base. A little extra dope for this operation will give more time to adjust the position of the map and remove the air bubbles.

After the map is positioned and stuck to the base, apply five or more additional coats of dope on the surface, allowing drying time between coats.

Printed, paper azimuth circles, or another map can be applied to the surface of the first mounted map by simply placing the circle or map on top of a fresh application of dope, allow time to dry, then put more dope on top of the new additions. Nitrate dope cannot be used on top of the Visitype azimuth circle because it will dissolve the printing.—BROOKE R. DAVIS, *Ranger, Chattahoochee National Forest.*

WE'RE PUTTING EVERYONE ON THE TEAM

DON M. DRUMMOND

Assistant State Firewarden, Nevada

Everything seems to be going up, including the number of man-caused fires on the wild-land areas along the eastern slope of the Sierra Nevadas, where the important communities of Reno, Carson City, Minden, Gardnerville, and Lake Tahoe are located. Sometimes it seems that not only the number of these fires, but quite sizeable parts of the most important watershed, recreation, and potential residential areas are going up too—*in smoke*. Theoretically, man-caused fires can be prevented. There are 8 agencies charged with fire prevention responsibilities in the 20-mile wide, 70-mile long area along the east slope of the Sierras: the State board of fire control, 3 counties, a rural fire district, the Bureau of Land Management, the U. S. Forest Service, and the Indian Service. These agencies have come to the conclusion they must exert even more effort at putting the theory of fire prevention into practice.

Factors that make our work of fire prevention a little more difficult each year, and which are perhaps typical of the situations existing around many communities in the Western States, are as follows:

1. As a result of past misuse and past fires, cheatgrass (*Bromus tectorum*) has taken over and is constantly invading new areas of wild land in the foothills, especially along the highways and access roads. Cheatgrass, so flammable that we are nearly correct in listing it as both a hazard and a risk, is probably the greatest single contributing cause to the increased number of fires and their size.

2. Automobile travel is growing at an astounding rate. More tourists, more commuters, and more travel by local people is shown by actual counts made by the State highway department. In other words, more people are traveling through our high-hazard areas each summer on both transcontinental and local highways.

3. Local residents are adding to the risk each year as they move out into newly developed suburban areas and subdivisions with their homes and stringer construction of motels, night clubs, and other business.

4. The reactivation of military bases is bringing into our area thousands of people who fail to realize the fire hazards existing in the semiarid country around them.

5. Literally hundreds of people commute 10 to 65 miles daily through areas that are so much a part of their daily routine they become oblivious to the fire hazards around them.

6. And the children, who constantly present new problems, apparently act by impulse and must learn by costly experience.

For the past several years the cooperating agencies have been meeting in March to map out the prevention plans for the coming fire season. And, although the prevention program is undoubtedly felt by the public, our fire occurrence records for the past few years make us believe that we are not getting ahead of the increasing risks and hazards, and the growing number of fires, as we should.

This spring when we realized that we should be doing better with our fire prevention job, we went to our interagency meeting determined to find out "why" as nearly as possible. Past fires were analyzed for cause, location, damage, and cost; classes of people responsible for fires were determined; possible new sources of man-caused fires for the coming year were examined. With this information we determined ways and means to reach the various classes of people who have been or may be responsible for starting fires.

It may be interesting to note that we divided the population into 50 classes, and then listed 50 different ways to reach them—a total of 2,500 general prevention jobs—with 3 methods devised specifically to reach each class. We find every class of people to be a problem at times, but children with matches and oil barrel incinerator users cause the greatest annoyance.

Having finished this initiatory work, we outlined in detail on a chart the total fire prevention campaign and made assignments to each agency and to each individual within the agency. Sometimes we feel that as the job of wild-land fire prevention comes closer and closer to its climax, more and more of it is left up to temporary summer employees, amateurs, and others not sincerely interested. The "regulars" are going to pitch a little harder and a little longer this season.

Smokey Bear, now a national forest-fire prevention symbol, has provided the way for public-spirited citizens to help. They can use Smokey to promote their fire prevention campaigns without feeling they are providing free advertising for public agencies. Our newspapers and radio stations support our fire prevention campaign thoroughly. Our merchants and theatres use our fire prevention material generously. Our highways and recreation areas are well signed and posted.

We have used the following ideas, in addition to the Cooperative Forest Fire Prevention material, with success: a fire prevention message on a large advertising balloon over Reno's largest gambling club; a street banner, carrying a fire prevention message, across the busiest street in town; fire prevention posters on the doors and endgates of all cooperating agency vehicles; small cartoon posters in such places as on the backs of cash registers, where everyone looks; special flier-type material for automobiles parked on city streets; judicious use of a mobile public-address system on weekend patrol of recreation areas; billboard-type signs on

roadside fire scars, pointing out cause and resulting damage; cartoon form letters and fire prevention inspection guides; telephone fire prevention tags, listing telephone numbers of nearest firewarden; Smokey Bear "Thank You" cards for use at end of season.

We are planning to add the following ideas for the coming summer: More personal contact, inspection, and follow-through on areas of new construction and in areas where home incinerators are used; more personal contact with children during the summer through their organizations and through the theatres which sponsor Saturday morning "kid matinees"; Smokey Bear and his fire prevention message on the back of State Highway Patrol safety inspection stickers, to be placed on every Nevada motorist's windshield; large Smokey Bear fire-hazard signs along the highways; special fire prevention calendars for hotels and motels; timely contact of cummuting military and civilian personnel, with fire prevention message.

Even now we feel we haven't found all of the answers to fire prevention, but by next spring we hope to have the area of "where to look" narrowed down considerably.

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Nonglare Shield For Lookout Cab Windows

An annual maintenance problem of repainting the upper tier of glass panes in lookout cab windows has been eliminated on the Cassville District of the Mark Twain National Forest. In the past, the window panes had been painted green to reduce the glare from above. The paint chipped and peeled with a change in temperature, and each repainting thickened the paint coat, thus inducing more chipping and peeling. On the basis of a successful 12-month trial, a green plastic called Visionade is the answer to our maintenance problem. This material was originally designed to stop rear-window glare in automobiles. Temperature extremes inside the lookout cab have in no way affected the adhesive properties of Visionade. The life of this material is expected to be indefinite, since some motorists who applied it to their automobiles claim that it is still satisfactory after 3 years' service.

Visionade is transparent, thus permitting vision through the upper tier of panes without glare and sunrays blinding the observer. If for any reason the shield must be removed, it can be peeled off carefully and remounted as many times as is necessary. The largest sheet available to us is 11 by 36 inches and has been purchased locally from auto-supply stores for about $1.—K. F. KAROW, *District Ranger, Mark Twain National Forest.*

HOSE WASHER

JOHN BOURQUE

Inspector, Quebec Forest Protection Service

District No. 2, Forest Protection Service, has developed a washing device that has proved most effective for cleaning fire hose before drying (fig. 1). It was designed for use with a regular fire pump.

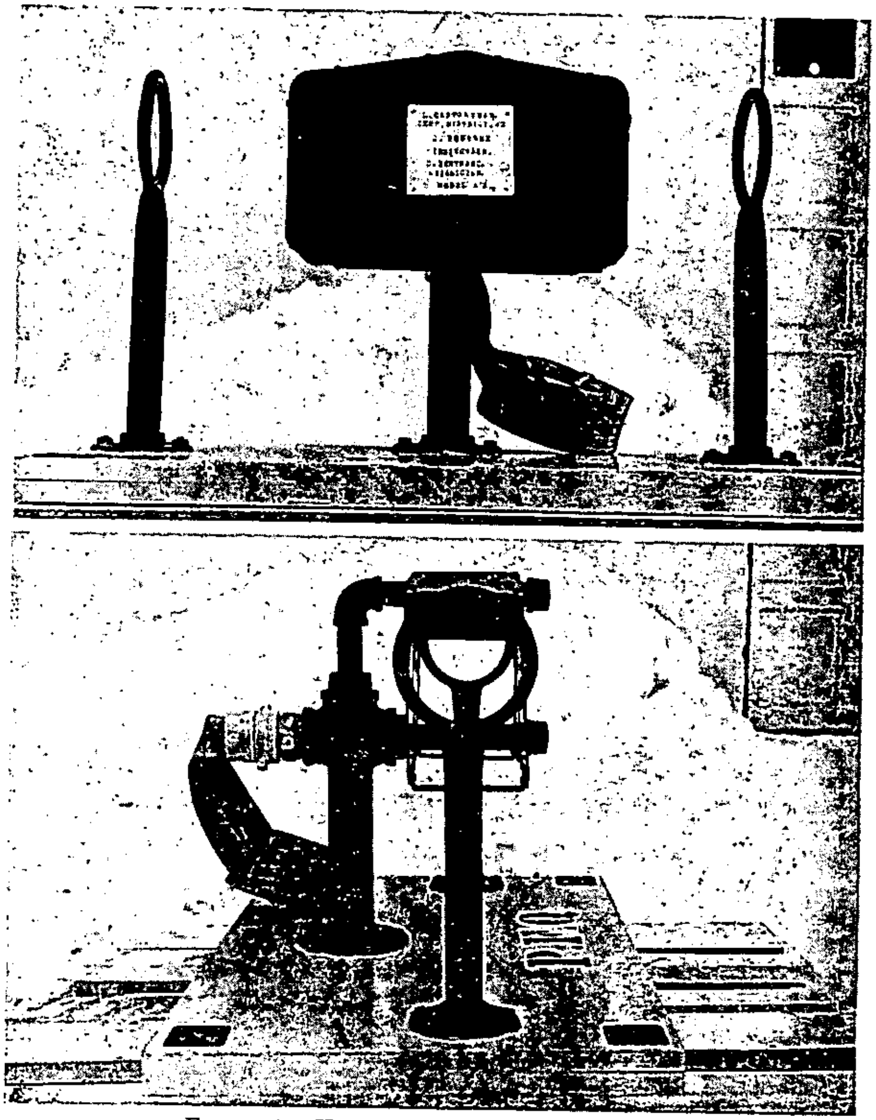

FIGURE 1.—Hose washer from side and end.

The overall dimensions of the machine are 17 1/2 by 18 by 30 inches. It is mounted on a wooden base of 18 by 30 inches and its essential components are 2 lateral guides, each 4 inches in diameter, and a central water-flowing apparatus. This water ejector, which is connected to the pumping unit through a 12-foot length of 1 1/2-inch fire hose, is composed of 2 horizontal pieces of 3/4-inch galvanized pipe about 5 inches long, between which the hose is drawn. Small perforations 1/8 inch in diameter are made at the lower side of the upper pipe and at the upper side of the lower pipe, through which streams of water under fairly high pressure are directed at the hose from above and below, thus washing the dirt and ashes off. The ejector is covered on 3 sides with a fender of galvanized sheet iron.

Dirty hose is pulled slowly through one guide to the water-ejecting device, from which it is drawn thoroughly cleaned through the other guide and out to the drying rack or tower. An advantage of this washer is that it can be made locally with ordinary pipe fittings, sheet iron, and steel rods.

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Glareproofing Tower Window Panes

The Division of Forestry of Oklahoma has experimented for the past 25 years with glareproofing tower window panes. We have tried colored panes as well as special paints that were either sprayed or brushed on the inside and outside of the tower windows. The colored panes were fine, but when broken, replacement was a factor in their utility. Painted panes were also satisfactory, but it was necessary to repaint about every 14 months because the paint would lose its effectiveness as a glare resister, and fade and peel.

In the past 2 years our best results have been obtained with a new material called Plyotron, which is manufactured in New York. It is the same material used on car windshields as an inside visor. Plyotron has proved itself as a glare resister, a haze filter, and a labor saver. After 2 years on a tower, it has not shown any signs of deterioration, and crystalization or buckling have not resulted from humidity or temperature changes. It also acts as an adhesive on broken glass. Glareproofing our towers with paint costs about $8.20 per job for travel, paint, and labor, and the towers must be repainted every 14 months. The Plyotron material costs 32 cents for a 13- by 12-inch pane, or approximately $12 for a standard aeromotor 100-foot lookout tower. Roughly, it costs $18 per tower, including travel, labor, and materials. One application of Plyotron has lasted 2 years without repairs, and from inspection it seems safe to state will last another 2 years. From every standpoint, we believe that Plyotron is the answer for relieving eyestrain and furnishing a built-in haze filter on Oklahoma's towers.—W. H. MITCHELL, *Chief of Fire Control, Oklahoma.*

SCALE-MODEL TOWER FOR CONSTRUCTION TRAINING

EARL M. BRADEN

District Forester, Tennessee Division of Forestry

A scale-model tower and footing layout proved very successful in demonstrating and discussing fire tower construction at a recent training session for our fire control personnel. This setup enabled us to study tower construction procedures from the layout of the footings to the final assembly of the steelwork. The model made the subject more easily discussed and also helped hold the attention of the trainees as various procedures were actually demonstrated.

Construction of the model was fairly simple and very inexpensive. The "ground" section was cut from the bottom of a 14-inch square corrugated cardboard box with 4 inches of the sides left on to give the depth (fig. 1). The footing holes were cut out and boxed in with other pieces of cardboard. To give added realism the top and inside of the holes were coated with water putty and then painted to resemble the ground around a tower site. The model forms for pouring the concrete footings were made to scale out of 1/16-inch gum veneer. Anchor rods were made out of No. 12 telephone wire and scale 2 by 4's were used to suspend the forms in the holes. To give more detail two forms were completely assembled and the other two were left in different stages of assembly. The forms could be placed in the holes, moved about, or taken out for examination. With this part of the model we could demonstrate the layout of the footing holes, the construction of the forms, the setting of the anchor rods and the final setting and alining of the forms for pouring the concrete.

The rest of the model consisted of the assembled first 20-foot section of a 60-foot tower and a few loose pieces of the next section. This was sufficient to cover all construction procedures in the erection of a full 60-foot tower. The base for this part of the model was also made from the bottom of a cardboard box, and footings were made from light cardboard and painted white to resemble concrete. All of the steel angle pieces were made from cardboard file folders. These pieces were cut to scale from a blueprint, then crimped to make the angle iron and painted with aluminum paint to give added stiffness and realism. After all of the pieces were ready, the section was assembled in the same manner as an actual tower, using airplane cement to hold the pieces in place. Later bolts were imitated with dots of black india ink. Scaffolding was made of 1/16-inch gum veneer cut to represent planks. A gin pole was represented by a piece of dowel, a carved balsa pulley, and twine for rigging. With this part of the

model we could demonstrate the actual erection of the steelwork, the placing and use of scaffolding and most important of all the raising of the heavy leg pieces by use of the gin pole.

The entire model was built to a scale of 1 inch to 2 feet, and all materials used can usually be found around any office. It was well worth the time spent on building because it made the discussion more interesting, brought out more questions, and it is always easier to "show how" than to "tell how."

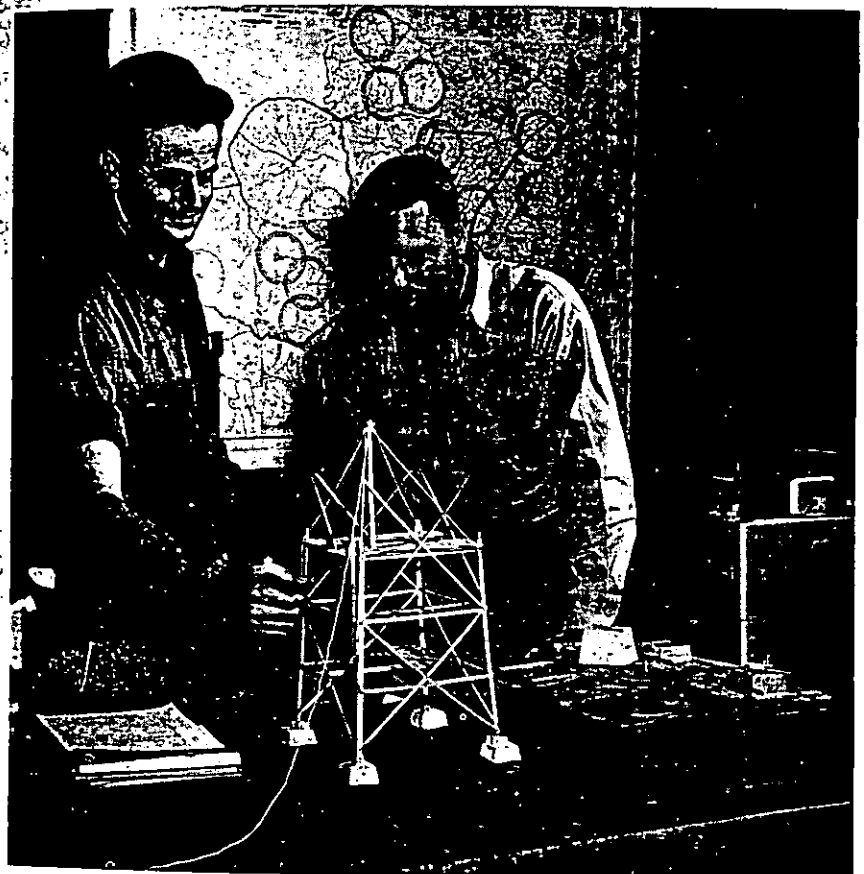


FIGURE 1.—*Right*, "ground section" showing holes and footing forms; *left*, 20-foot section of model tower under construction.

A "USE OF WATER" OUTLINE FOR TRAINING PERSONNEL AT GUARD SCHOOLS

RICHARD H. WOODCOCK

Timber Sale Officer, Olympic National Forest

For a national forest that is noted for its rain, the Olympic has had more than its share of fire fighting during the past two fire seasons. Out of the disastrous Forks fire of 1951, one of several needs was found to be a more thorough training course in the use of water in combating forest fires. In an area where the concentration of fuel is as heavy as it is on the Olympic and streams are abundant, the use of water is usually the best way to combat fire and sometimes the only way. Therefore, a course was conducted at spring Guard School (1952) on use of water. From limited material available the following outline was made up to be used as a guide in instruction as well as for later reference. Although it is presented here for what it is worth, some may not agree on all of the points included. We will welcome constructive criticism.

PART I. THEORY AND TECHNIQUE OF FIRE STREAMS AND HOSE LAYS

Time: June 18, 1:00 p.m. to 5:00 p.m. (Station 1)
Equipment: 1½-inch CJRL hose; 1½-inch linen hose; 1-inch CJRL hose; ¾-inch garden hose; assorted nozzles; tanker or pumper with accessories.

Introduction.—Water is Nature's most effective force in combating fire, and it is especially effective in the Pacific Northwest where it is plentiful and the fuel cover is heavy. Speed counts, and *water must be applied correctly.*

The first and most important requisite for effective use of water is a skilled nozzle man. Second, a reliable, foolproof pump or pumper. Third, a good pump operator. Fourth, a correctly designed nozzle with various size openings. Fifth, a quantity of good hose. Sixth, accessories to control water in the hose line, making the entire unit as flexible as possible.

I. The nozzle man

The most vital factor. A poor nozzle man can waste 60 to 80 percent of the water. He must be able to determine: (1) method of attack, i.e., once over or twice over; (2) type and size of nozzle to use; (3) direction of crew for highest effectiveness and speed of work.

II. The portable pumper

Its effectiveness depends on its portability, dependability, and volume of water that it can deliver at effective working pressures through various lengths of hose, and to various elevations above the pump settings. *The amount of fire that can be put out in any given period of time depends on the amount of water delivered.*

III. The pumper operator

Should be mechanically minded, reliable, and attentive. Not a job for catching up on the reading.

IV. Nozzles and tips

No one kind of nozzle or tip will perform with equal efficiency on all types of fires. To obtain largest effective stream, either nozzles of different size or nozzles with interchangeable tips should be used, the latter preferred. The tip or nozzle that will give the greatest number of gallons per minute at a given pressure should be used. The tip is cut down only to secure an effective stream for the work to be done. Small nozzles increase pressure but cut down volume and delivery. A small stream under high pressure breaks up and will not carry as far as a larger stream under lower pressure.

Nozzle pressures in excess of 60 pounds will break a stream and reduce both its vertical and horizontal range. Nozzles of 1/8-inch to 1/2-inch bore do not require more than 45 pounds nozzle pressure to produce efficient streams.

At specified nozzle pressures, the water delivery from various size nozzle tips is as follows:

	Nozzle pressure				
Orifice size (inch)	40 *pounds* (*g. p. m.*)	45 *pounds* (*g. p. m.*)	50 *pounds* (*g. p. m.*)	55 *pounds* (*g. p. m.*)	60 *pounds* (*g. p. m.*)
1/8	2.96	3.13	3.30	3.46	3.62
3/16 (garden hose)	6.64	7.03	7.41	7.77	8.12
1/4	11.8	12.5	13.2	13.8	14.5
5/16 (rounded)	18.0	19.0	20.0	21.0	22.0
3/8	26.6	28.2	29.7	31.1	32.5
1/2	47.3	50.1	52.8	55.3	57.8

Fog nozzles

Cold-water fog extinguishes fire by quickly absorbing heat and cooling the burning material below its ignition point and also by blanketing the fire to exclude oxygen. A given quantity of water, in vapor form, will absorb many hundred times more heat units than will be absorbed by an equal volume in the form of a solid stream. The small water particles are rapidly converted to steam, which blankets the area.

The basic principle of creating cold-water fog is the impingement of 2 equal streams of water at a 90-degree or sharper angle. A number of such impinging streams are grouped to produce the fog pattern desired. Low-velocity fog for flammable liquid fires is created in a circular pattern nearby the applicator nozzle head. High-velocity fog for general service is projected to a greater distance. Both types require approximately 100 pounds nozzle pressure to produce efficient operation.

Fog offers the quickest and most efficient method of wetting down outside of fireline prior to backfiring or on inside of fireline to prevent blowing of sparks until more complete mopup can be made. A fog tip on an applicator is efficient as a mopup tool.

V. Hose

A. *Types and characteristics.* The two general types are rubber-lined cotton (CJRL) and linen. The following is a comparison of the 2 in the practical 1 1/2-inch size, adopted by most protective agencies as standard.

CJRL hose.

1. Weighs approximately 27 pounds per 100 feet.
2. Has no seepage factor.
3. Must be dried after using and stored in a cool place where there is plenty of dry, fresh air.
4. Can be cleaned by scrubbing machines.
5. Will stand more abrasive wear than linen hose.
6. Will deteriorate under the sun's heat.

Linen hose.

1. Weighs approximately 13 pounds per 100 feet—one half the weight of CJRL.
2. Can be used in the packsack lapping-in method of laying hose.
3. Generally treated against mildew and much longer lasting than CJRL hose.
4. Has a seepage factor of 0.3 ounce per lineal foot at 150 pounds which amounts to approximately 2 gallons per 1,000 feet of line.
5. Cannot be burned with a blowtorch while water is running through it.
6. Has 10 percent greater friction loss than CJRL hose.
7. Can be stored wet without deterioration.
8. Should not be washed in scrubbing machines.

B. *Handling hose.* Should use special packboards and sacks for carrying hose. With board, 1 man can carry 200 feet of CJRL hose or 400 feet of linen hose. Lapped-in method quickest for linen hose and also protects hose. (Demonstrate.) Can be layed as fast as man can walk. Roll CJRL hose from center with male end approximately 4 feet short. Protects male end and enables hose to be pulled out easily, free from bends and twists. (Demonstrate.) Avoid dragging all hose on exposed sand, gravel, or rocks. Always use good gaskets so hose can be tightened by hand without use of spanner wrench. Never drive vehicles over hose. Demonstrate half-hitch method of rolling booster hose when live-reel is not available.

C. *Water friction in hose.* Friction in a given hose will increase as pressure is increased or as the volume of discharge is increased by using larger nozzle or tips. One-inch hose can be used for short lays and relatively small water deliveries (under 15 gallons per minute). Over 15 gallons per minute (free flow) the friction loss is 7.2 times greater in the 1-inch hose than it is in 1 1/2-inch hose. Use tables for realistic examples. (Demonstrate.)

D. *Hose threads.* Brief explanation on diversity of threads. Comparison of maximum external distance of male thread for various standards, which follow:

Standard	¾-inch hose Outside diameter	¾-inch hose Threads per inch	1-inch hose Outside diameter	1-inch hose Threads per inch	1½-inch hose Outside diameter	1½-inch hose Threads per inch
USFS Nat. Std.	1.2951	11½	1.2951	11½	1.8788	11½
U.S. parallel pipe	1.0353	14	1.2951	11½	1.8788	11½
American Nat. Std.	1.375	8	1.375	8	1.990	9
Chemical and booster	1.375	8	1.375	8	....	....
U.S. Navy Nat. Std.	1.2951	11½	1.2951	11½	1.8788	11½
American Nat. Std., water and garden hose	1.0625 (½" & ⅝" same)	11½	1.2951	11½	1.8788	11½
American Nat. Std., air-oil-steam	1.0353	14	1.2951	11½	1.8788	11½

VI. Accessories for controlling and diverting streams—a *must* for a versatile and complete fire fighting unit

A. *Unit siamese valve.* Uses: (1) Y main line; (2) pumping in relay; (3) pumping against head; (4) assist in coupling or uncoupling of hose line.

B. *Bleeder valve.* Provides a means for drawing water from hose lines without disconnecting the hose or shutting down the pumper. No projections. Will work under any pressure.

C. *Pressure relief check valve.* Enables pump to be started against head. Prevents water from flowing back through pump when pump goes down. Provided with bypass that can be opened while pump is being started.

D. *Siamese connection.* Simple Y coupling with no valves.

E. *Pressure relief valve.* Automatically bypasses discharge from pump when nozzle is shut off or pressure in hose line becomes excessive. Usually set at a pressure of approximately 200 pounds.

F. *Hose tee.* Provides means for taking off from 1 1/2-inch line with a 1-inch or 3/4-inch line.

VII. Hose lays

A. *Simple hose lay.* (Demonstrate and practice.) Use of siamese forward and in reverse. Teamwork—practice coupling and uncoupling hose. Method of carrying folded hose forward. Lay hose straight, untwist hose.

B. *Progressive hose lay.* (Demonstrate and practice.) Use of tees or several siamese valves.

Part II. Pumps and Water Relay

Time: June 19, 8:00 a.m. to 12:00 Noon (Station 3)
Equipment: Type Y pumper, Edwards Model 40 pumper, 500 feet 1½-inch CJRL hose, pulaski, shovel, canvas sump, gas, oil, and accessories including nozzles, tools, check valves, take-offs, suction hose, siamese valves.

Introduction.—The best all-purpose pump for work on forest fires is the portable pumper, a self-contained unit whose principal qualifications are simplicity, dependability, pressures developed, and volume of water thrown.

I. Fire pumps generally fall into two categories, centrifugal and positive displacement pumps

A. *Centrifugal pumps.* Will handle large capacity, high pressure, or both. No close clearances. Will handle a moderate amount of abrasive material and have a long service life. Pressure relief valves are not required except for large capacity pumps. Maintenance and repair costs are low and they provide more dependable performance than positive displacement types, are slightly larger, have a higher initial cost, and are not self-priming.

B. *Positive displacement pumps.* Rotary gear, cam, and piston pumps are examples. Compared to centrifugal they are cheaper, self-priming, smaller, and more compact. They are quickly damaged by sand and other material in the water, require more power to do a given job, and need relief valves to handle surge pressures and overload. They also cost more to repair and maintain. Pump pressures are generally limited to the burst point of 2-year-old hose, which is approximately 200 pounds. Theoretical lift for 200 pounds pressure is 460 feet ($200 \div 0.433$) at sea level. Hose friction and elevations above sea level cut this theoretical lift to a maximum of about 400 feet.

II. Instruction and maintenance on two sample pumps

A. *Pacific Type Y.*

Motor.—2-cycle, 2-cylinder, 2-port type with alternate instead of simultaneous firing. 9.8 horsepower at 4,000 r. p. m. 3,500 to 4,000 r. p. m. under normal working conditions. Water-cooled. 0.025 is correct setting for breaker points and spark plugs. Spark plugs should be Champion No. 13 plugs or any 18 MM plug of equal quality.

Fuel mixture.—1 pint SAE 30 oil to 1 gallon of gasoline, unleaded preferred.

Pump.—Positive displacement, self-priming, rotary-gear type. Performance data:

Pressure (pounds)	100	125	150	175	200	225
G. p. m.	63	59	53	46	40	20

Pump lubrication.—Good grade SAE 30 oil in gear case. Lightweight grease every 10 hours on pump bearings. Waterproof grease every 4 hours on pump packing. Always squirt lube oil over impellers through discharge side before starting pump.

Starting hints.—Place timing lever in vertical position. Open carburetor needle valve two full turns. Move carburetor lever to choke position. Flood carburetor and pull starting cord. When engine starts, raise carburetor to fast position. Adjust needle valve, closing it about one turn. Move timing lever against engine rotation to speed pumper up and with engine rotation to slow down. Special instructions for flooding warm engine.

Total weight of unit, 70 pounds.

At 51 gallons per minute, 1 gallon of gasoline will last 42 minutes.

B. *Edwards Model* 40.

Engine.—4-cycle, 1-cylinder, L-head, all-aluminum, 4.1 hp., 1,400 to 2,600 r. p. m. Mechanical type governor; crankcase oil capacity, 3 pints; weight, 72 pounds.

Pump.—Positive displacement, self-priming, rotary-gear type.

Performance data.—Up to 50 g. p. m. and pressure up to 250 pounds.

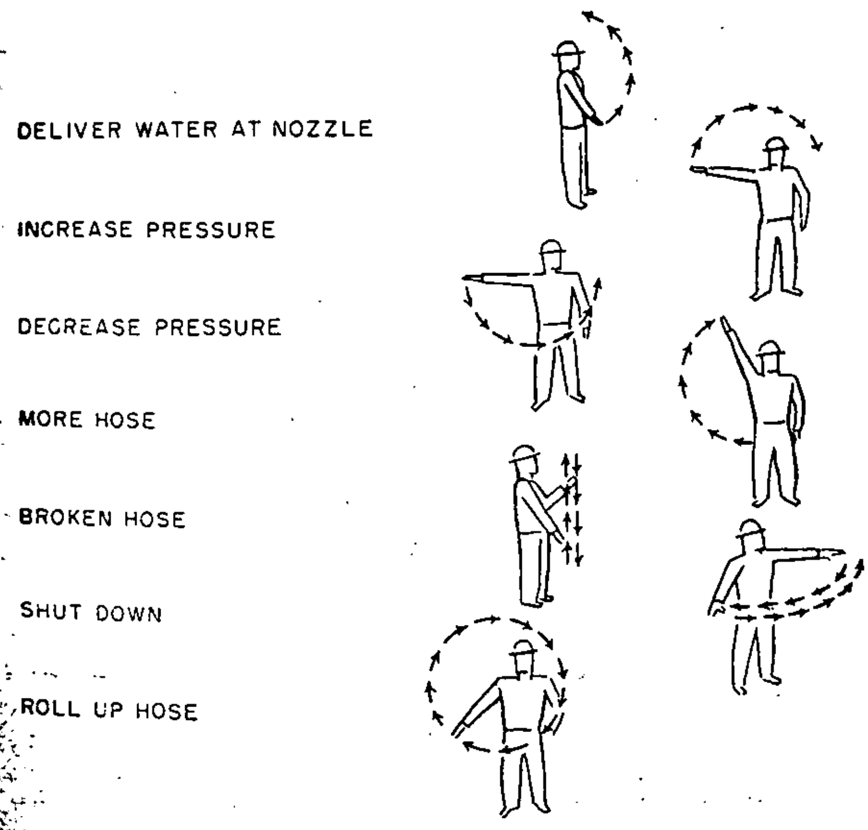
Total weight of unit, 112 pounds.

III. Proper pump setup

Problem. Find all errors in sample setup.

1. Placement of suction hose.
2. Air leaks.
3. Placement of pump. Theoretical suction lift is 33.95 feet at sea level with 26 to 28 feet common practice. If machine is used to draw water to its maximum ability, it will not be able to push water to its maximum ability. (Every added foot of suction lift will decrease the possible discharge as much as 10 percent.)
4. Lack of fittings and miscellaneous.

IV. Hand signals, used for communicating with the pump operator or other crew members



V. Pump relays

Pump relays are necessary at times to overcome excessive "head." The term "head" means back-pressure created by gravity where water is pumped to a higher elevation. It amounts to 4.33 pounds for each 10 feet of rise. Generally 2 feet of elevation is equivalent to 1 p. s. i. of pressure when using 1 1/2-inch hose. There are 2 methods of lifting water higher than can be reached with 1 pump.

A. *Relay system* (for raising water as high as 1,500 feet above its source).

1. With relay tanks. Canvas tanks; optimum spacing of pumps, 240 feet, 260 feet, 280 feet, 300 feet. Rough method for measuring these distances—five or more pumpers may be used in a series—simplest, easiest, and best method.
2. Without relay tanks. (Demonstrate.) Same spacing. Use of siamese connections and unit siamese valves. Calls for attentive pump operators.

B. *Tandem or booster setup* (for raising water a maximum of approximately 700 feet). (Demonstrate.) For use at bottom of steep mountain or cliff. 2 pumps in a series; limited to 2 because pump casings not built to withstand additional pressures. This method will produce approximately 350 to 400 pounds. Both machines should be started in unison.

PART III. CONTROL AND MOPUP OF FOREST FIRES WITH WATER

Time: June 19, 1:00 p.m. to 5:00 p.m. (Station 3)
Equipment: F.S. White slip-on unit with Model 120 Edwards pump and accessories. Shovel, pulaski, adz hoe.

Introduction.—Water is the natural element for combating and extinguishing fire. A good stream of water is infinitely more effective than any other method for knocking down and extinguishing rapidly advancing fires, doing mopup work, extinguishing spot fires, etc., when applied correctly. With modern equipment, water can be delivered through hose lines a mile or more and lifted in relays to an elevation of a thousand feet or more.

I. Three stages of control with water include checking the advance, making a water trench, and following up

A. *Checking the advance.* Requires knocking down hot spots on the ground and in stumps and snags. Use the greatest amount of water with the largest nozzle opening possible. Hold water to an advancing front, generally on a strip 2 to 3 feet wide and never more than 10. Fundamental idea is to stop the spread until fire can be confined by means of a water trench. Back-pack pumps and take-off connections are used as follow up before trenching.

B. *Making a water trench.* Mainly a sluicing action around the fire edge. Width depends on conditions. Never more than 5 feet wide. Use large nozzle openings, dropping down only to increase pressure. Nozzle to be 1 foot or less from ground. In duff a twice-over procedure advisable. Assistant should point out smokes skipped, cut logs, dig out pockets, etc. Use of patrolman between once-overs advisable.

C. *Follow up.* Immediate mopup or allow interior material to burn out. Concentrate water on smoldering edge; takes approximately 2 inches of water to extinguish a fire. (At 20 gallons per minute, it takes 47 minutes to extinguish a 2-foot strip 375 feet long while only 50 feet can be covered in the same time if a 15-foot strip is attempted.) Don't spray everything the stream will reach. Straight stream close to ground or a fog applicator nozzle.

II. Use of water with conventional trench methods

A. *Blanket method.* After the trench is completed and the hose is strung, a 10- to 15-foot strip outside trench is thoroughly wet down (2 inches). Interior then burned out from trench inward. (Fog most efficient and quickest.)

B. *Mopup method.* Start from trench and work inward in 15- to 25-foot strip. Mopup in continuous strips.

III. New developments—wet water, foam, fog, etc.

IV. Explanation of Forest Service White slip-on tankers with Edwards 120 pump

Engine.—2-cylinder opposed, L-head, 4-cycle, air-cooled, internal-combustion, high-compression type. Governor speed control and heavy-duty magneto ignition. Uses standard gasoline and 2 quarts detergent SAE 30 motor oil. Spark plug gap of 0.020 inch.

Pump.—Positive displacement, self-priming, rotary-gear type. Performance data (Size B Rotor, 2,600 r. p. m.):

Pressure (pounds)	100	150	200	[1]250	300
G. p. m.	50	45	42	40	30

[1]Recommended maximum.

V. Recommended nozzle accessories

Small-capacity tankers normally use small amounts of water, usually 5 to 15 gallons per minute. However, in some situations such volumes will not do the job. Nothing is gained by wasting water while the fire gains headway. In the Navy Fire-Fighting School, the toughest fire is either put out or lost in a minute's time with 52 gallons of fog.

A. One-inch combination straight-stream, fog, and shut-off nozzle with 3/16-inch straight stream and either 6 or 8 gallons per minute fog head (for use on fires not requiring large volumes of water).

B. One 1 1/2-inch nozzle with lug for spare tips (1/4-, 5/16-, and 3/8-inch tips). All tips and lugs to be 3/4-inch garden hose thread. 3/8-inch tip (37.6 g. p. m.) gives the farthest reach with these slip-on units.

C. One 4-foot by 3/4-inch aluminum applicator with 3/4-inch garden hose female swivel coupling on nozzle end and 3/4-inch male garden hose thread on tip end.

D. One 30-g. p. m. fog tip for use on applicator when mopping up, on 1 1/2-inch straight stream for wetting down, or for a building fire. (Fog when used on an enclosed fire where it is converted to steam expands 1,700 times.)

E. One 15-g. p. m. fog tip for brush fires or fires of heavy intensity.

THE DIESEL LOCOMOTIVE FIRE CONTROL PROBLEM IN MICHIGAN

DELL F. WEIR

Supervisor, Railway Fire Prevention, Michigan Department of Conservation

The introduction of diesel locomotives to Michigan was made several years ago, and their use was confined to switching service in railroad yards of our larger cities, or to the operation on short-line railroads for hauling light-tonnage trains. A rapid change to diesel locomotive power for freight and passenger service, however, has taken place in more recent years. Michigan's railroad locomotive power today is about 50 percent diesel. Individual railroad company diesel power varies from 5 to 100 percent.

In Michigan, reported diesel locomotive-caused forest fires increased from 8 in 1950 to 28 in 1952. These fires were 37 percent of the total railroad-caused forest fires reported for that year. During this 3-year period we cooperated with some of our railroad companies in experimenting with devices for arresting sparks from the stacks of diesels. While we have not yet determined which type of spark-arresting device is the most efficient, we can see the possibility of eliminating the worst offenders.

After the close of the 1952 forest fire season we felt that a conference should be held for all those concerned with control. It was believed that a careful and complete analysis of the problem should develop some constructive recommendations for the control of these fires. Accordingly, a conference was held at Milford, Mich., March 5 and 6, 1953. It was attended by representatives from the American Locomotive Co., the Electro-Motive Division of General Motors Corp., and Fairbanks, Morse and Co.; officials from the operating, engineering, and mechanical department of nine railroad companies operating diesel locomotives in Michigan; representatives from the forest fire agencies of the United States Forest Service, the Wisconsin Conservation Department, and the Michigan Conservation Department.

The discussion of the many ramifications of the diesel locomotive as a cause of forest fires was sincere and frank. Every representative attending the conference was eager to contribute to the solution of the problem. The following general conclusions were reached.

1. That diesel locomotives cause fewer forest fires than do steam locomotives.

2. That ignited carbon deposits ejected from the diesel locomotive exhaust stacks are a major cause of right-of-way fires.

3. That carbon deposits formed in the diesel locomotive exhaust chamber are a residue of fuel oil combustion; when ignited, loosened, and ejected from the exhaust stack such deposits, if large enough to hold a high temperature until they land, set fires when forest fuels on the right-of-way are conducive to quick ignition.

4. That detergents or other additives in lubricating oil used in diesel locomotive powerplants are not a serious contributor to the fire problem. Carbon deposits formed by these additives are small in size and of a flaky texture. When they are ignited, loosened, and ejected from an exhaust stack they are incapable of holding high temperatures for any length of time. The sparks called floaters, and easily observed at night, are no doubt part of these ignited carbon deposits.

5. That, as far as has been determined, ignited carbon ejected from the diesel locomotive exhaust stack is formed by: improper setting or adjustment of the fuel-oil jet, which causes improper combustion; the locomotive being operated for long periods with the motor throttle at or near idle, which causes a buildup of combustion residue in the exhaust chamber; the residue from lubricating oil.

6. That certain types of railroad services are more conducive to the formation of carbon deposits than other types of services.

7. That the cause of carbon deposits being ignited, loosened, and ejected from the diesel locomotive exhaust stack are high temperatures in the exhaust chamber; high velocity of combustion gases ejected from the exhaust chamber; moisture in the exhaust chamber, which tends to loosen the carbon deposits.

8. The methods used for arresting ignited carbon deposits are (a) deflector or baffle plates placed at various positions and angles in the exhaust chamber; a supercharger that breaks up by centrifugal force, ignited carbon deposits before they are ejected from the exhaust stack; (c) screened hoods placed over the exhaust stack.

9. Diesel locomotive spark-arresting devices have limitations: (a) The arrangement of deflecting or baffle plates in an exhaust chamber must not materially reduce the ratio between the area of opening of the motor exhaust ports and that of the exhaust stack or the motor will become overheated. (b) The height of any spark-arresting hood over an exhaust stack is limited because of the clearance necessary for the locomotive to move through tunnels, and under bridges, buildings, etc.

10. Train crews need fire prevention education. Representatives of the Wisconsin and Michigan Conservation Departments agreed that a properly worded forest fire prevention sign and ashtrays placed in the locomotive cabs and cabooses would be a good fire prevention measure. They also agreed to intensify efforts to educate train crews.

Owing to the fact that the diesel locomotive fire control problem in Michigan is new, our data is not adequate for determining what make or type of diesel locomotive is the offender. Nor have we yet been able to be positive about the results of the spark-arresting devices we have experimented with. However, with forest fire agencies, railroad companies, and builders cooperating in the correlation, analysis, and utilization of the statistical information compiled, there is certain to be a reduction in the number of diesel-caused forest fires.

FIRE PROTECTION IN THE BRADFORD OIL FIELDS

L. E. Stotz

District Ranger, Allegheny National Forest

A part of the Bradford Oil Field, the second largest, and one of the oldest and most valuable oil fields in the United States, is located on the Northern District of the Allegheny National Forest near the city of Bradford, Pa. This intensely developed oil field lies in a heavily forested area of the northern hardwood type, and the danger of forest fires damaging or destroying oil-well equipment is always present during the spring and fall fire seasons. Not satisfied with enriching the subsurface with Pennsylvania-grade oil, Nature was lavish in clothing the hills above this famous oil pool with a forest which, following clear cutting, has a preponderance of second-growth black cherry, one of America's finest cabinet woods.

Perhaps no other forested area in the United States has so much capitalized value per acre as the Bradford Oil Field where, in the secondary recovery of oil through water-flooding of the oil sand, an average of 210 oil wells and 220 water wells per square mile exist. In addition to the many producing wells in the Bradford Field, heavy investments have been made in the miles of surface and underground pipelines, electric powerlines to service the wells, and countless pumphouses, water-treatment plants, and storage tanks. Allegheny National Forest is "pockmarked" with oil well openings, lease roads, and many other installations necessary for the secondary recovery of oil. The average investment per acre in this field for the recovery of oil and gas is between $5,000 and $6,000, not including the investments in mineral rights which are extremely variable. Naturally, such heavy on-the-ground investments for the recovery of highly flammable products make the participants in this venture extremely fire conscious.

In the days of the wooden derricks, lumbering operations in the field created heavy slash through the liquidation of the old-growth timber stands, and many large fires occurred that often destroyed the wooden derricks, causing the oil-well tubing to drop into the well. Now the derricks are no longer a feature of the landscape, and selective-cutting methods on national-forest land create a minimum of logging slash, widely scattered. However, some of the private land within the Bradford Field is still being clear cut for chemical wood or pulpwood, and the heavy slash presents a high fire hazard until it rots down.

Present-day wells are pumped by electrically driven pump jacks, and the grass is kept mowed around the well openings. Any accumulation of waste oil around the well is burned during times of low fire hazard. Today, greatest danger to the oil field from forest fires is the shutting down of the wells if a fire burns down electric-line poles supplying current to the motors on the pumps.

For the protection of the surface of their underground holdings, from the ground line to the tree tops, the oil companies are dependent upon their own field men working on the oil leases, the Pennsylvania Department of Forests and Waters, and the United States Forest Service. Where a fire occurs on private land the Department of Forests and Waters is responsible for its suppression, and the cost of suppressing it. Where it occurs on national-forest land, on which the oil companies own the subsurface rights, the suppression and cost of suppressing the fire becomes the responsibility of the Allegheny National Forest.

Fire wardens in this area are appointed by the Department of Forests and Waters as State Fire Wardens, and are subject to call by either agency for suppression of fires on both private and national-forest land. It is significant that many of the most active and valuable fire wardens are supervisory field employees of oil companies in the Bradford Oil Field. These men, and the roustabouts, truck and tractor drivers who work under them, are strategically dispersed throughout the woods on their regular round of duties and make excellent organized fire crews.

Ten- and twenty-five-man fire tool boxes, equipped and maintained by the Forest Service, are located throughout the oil field in company buildings near a telephone. There is also a heavy concentration of bulldozers, jeeps, heavy trucks, and other valuable equipment in the oil field, which belongs to the oil companies and is available for fire fighting at any time.

The heavy network of highways, secondary roads, and lease roads makes the forested area within the Bradford Field one of the most accessible timbered areas in the United States. These roads, in addition to making it possible to reach a fire in record time, also are of considerable potential value for backfiring purposes should the need ever arise.

In the intensively developed part of the Bradford Field, individual workers are so fire conscious as they go about their daily work that any occasional fire is usually so quickly controlled that State and Federal agencies have only to take whatever followup action is necessary for statistical purposes. With water wells 300 feet apart, and equipped with an extra T and valve, a hose connection for fire fighting can usually be made within 2 to 5 minutes. Two lookout towers, 1 State and 1 Federal, look directly into the heart of the Allegheny National Forest part of the Bradford Oil Field. Any fires not immediately observed from the ground by the oil workers are picked up from these towers, and crews are quickly dispatched.

Thus, all of the factors for successful fire protection are at hand in the Bradford Oil Field on the Allegheny National Forest, and if adverse weather conditions should create an emergency fire situation, the oil industry can be counted upon to throw its trained manpower and heavy equipment into the fight along with the Federal and State agencies that are charged with protecting the surface of this oil empire.

SOME OBSERVATIONS ON SLASH BURNING

JACK HEINTZELMAN and CLARENCE EDGINGTON

Olympic National Forest

In broadcast burning of slash during the past season on the Quinault District of the Olympic National Forest we were concerned with the difference in burning conditions on north and south slopes, particularly when both were located in the same unit under the block system of cutting.

Most of our slash burning was done in the dry-up period, and the south exposures were the first to get in shape for burning. Several times we ended up with a good clean burn on the south side of the hill and a large number of small fires scattered through the slash on the north side. Ordinarily this situation wasn't critical, because the north side was fired in the days that followed until a good burn was obtained. However, with this procedure it was always possible that something would interrupt the usual routine, or that high-cast winds might arise, and the north slope would burn out under unfavorable conditions and cause damage.

To improve this procedure, we have decided to vary our method of using fuel-moisture sticks. In the past, we have placed our fuel-moisture sticks only on the south slope, the place most likely to dry out first, and in the green timber. We found that we could obtain a satisfactory burn when the sticks in the slash reached 13. Ordinarily the sticks in the green timber at this time would be 20 or higher. It is our assumption that sticks on the north slope at the same time would be 16 or higher. We now plan to use fuel sticks on north as well as south exposures, and to burn each exposure when its fuel-moisture condition becomes right. This procedure will, we believe, help considerably in keeping the control of burning in man's hands rather than having the fire in control.

Another procedure that we have followed in the past has been the building of bulldozer firelines around the staggered settings in advance of burning. In heavy slash, this results in a large windrow adjacent to the timber, though separated by a cat line. Under adverse burning conditions the windrow gets extremely hot and holds the heat, and we have had trouble trying to keep fire from spotting to the timber. This system has been varied by burning the slash first and then building the cat line. The fuel-moisture condition in the timber is ordinarily such that the timber is relatively safe at the time of the burn, and the cat line is easier to construct after burning and acts as a better control line in the subsequent dry up. While this procedure has worked well in some cases, it cannot be recommended in all cases.

A third observation we wish to make is that for lighting slash we prefer the fusee to the pneumatic flamethrower, drip torch, etc. It is lighter, more convenient to carry, and will light the slash quite satisfactorily when the slash is *right* for burning. However, for those who contend that the pneumatic flamethrower is better for lighting slash when the slash isn't *quite right* for burning, we would answer that the slash shouldn't be burned until it will burn readily enough for the fire to spread over the logged area.

These points are made in order to present some of our preliminary thoughts on broadcast burning, and to elicit a rebuttal.

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Railroad Bulldozes Firebreak

For many years forest fires have originated on the right-of-way of the Louisville and Nashville Railroad along a 4-mile stretch between Livingston and Hazelpatch, Ky. The railroad is located at the foot of a western slope that averages 20 to 30 percent. It was necessary for fire fighters to wade or boat across Rockcastle River, paralleling and west of the tracks, to reach the fires, or to walk in from either end of the 4-mile section. In any case it was impossible to control fires before many of them had reached the top of the ridges to the east. The chief litter was Appalachian hardwood leaves. Most of the area above the tracks is national-forest land.

Two railroad sections meet in this area, making it necessary to deal with two foremen. In spite of frequent contacts with foremen and track supervisor, the right-of-way was seldom fully fireproofed, as required by State law, before fire season rolled around. The section crews used a roughly raked line at the edge of the right-of-way from which to backfire. As a result these fires sometimes escaped the crews' control. Although the L & N usually paid damages to the United States, collection was often a slow and expensive process. To make matters worse, an incendiary was suspected of starting fires to throw suspicion on the L & N, and perhaps to allow private owners to collect high damages.

Ranger S. W. Campbell of London suggested that the L & N construct a firebreak with a bulldozer at a safe distance back from the tracks, and his suggestion was passed on to the company. John T. Metcalf, an attorney for the L & N, recommended company cooperation. The company then accepted a special-use permit to build and maintain the proposed firebreak on national-forest land, because the railroad right-of-way was too narrow for safety.

The firebreak was constructed in October and November 1952. It is 10 to 15 feet wide, including the cast-over ridge of earth, and varies in distance from the track from 40 to 250 feet, averaging about 100 feet. It is not suitable for a jeep road without additional work. The job required 176 hours and the cost was approximately as follows: bulldozer at $6 an hour, $1,056; operator at $1.73, $304; helper at $1.20, $211; total, $1,571, or $393 per mile.

This firebreak should pay for itself in several years by reducing damage claims from the Government and private parties, making a safe line from which section crews can backfire, and allowing productive timber growth on slopes badly ravaged by repeated fires. It is likely that if fires start on the right-of-way not fireproofed, the firebreak would stop or delay the fire from spreading and allow fire fighters to reduce the area burned. It may be necessary to redoze the break every 4 or 5 years.—HENRY SIPE, *Assistant Forest Supervisor, Cumberland National Forest.*

METHOD FOR FINDING THE PERCENTAGE BURNED ON UNPROTECTED FOREST LAND

J. EDWIN MOORE

Florida Forest Service

Estimating the amount of unprotected forest land burned has always been a problem. Figures to compare the percentage of protected land burned with percentage of unprotected land burned are always desirable, particularly in Florida where approximately half the unprotected forest land burns each year while 2 to 4 percent of the protected land burns. During the past year 1.7 percent of the protected land burned.

Adequate records can easily be kept by fire fighting personnel to show whatever information is desired for fires on protected land, but obviously this cannot be done on unprotected land. Until recently it was guessed at, but one person's guess was as good as another's. Several years ago, in order to obtain a more accurate figure, a statistical method for counting sample plots from an airplane was devised. The Southeastern Forest Experiment Station greatly assisted in planning this procedure by providing the statistical background for a satisfactory technique.

First, a random course of approximately 1,650 miles was sketched on a map. Thirty-six segments, each 20 miles long, on which sample plots were to be tallied, were indicated on the course. The course was located in such a manner as to fly over unprotected land as much of the time as possible, but no attempt was made to avoid towns, lakes, or other nonforest land.

Next the course was altered slightly so as to locate each of the 20-mile segments between 2 points that could be recognized easily from the air. Most frequently used recognition points were railroads, lakes, and small towns. County lines were not taken into consideration except insofar as it was necessary to keep the 20-mile segments outside of the protected counties. Black tape was pasted in a 2 1/2-inch square on the side window of the plane. This was located beside the observer approximately 14 inches from his eyes and in such a position that the observer could sit comfortably and look through the square at the ground.

It was necessary to have some sort of timing device that would notify the observer to tally a plot at regular intervals of approximately 15 seconds. A little experimenting showed that a satisfactory timer could be made from a clock that had a sweep second hand. The glass was removed and 4 small, flexible wires were evenly spaced around the edge of the face. These wires were insulated from the clock and bent in such a way as to make contact with the sweep second hand as it came around. Leads from the wires were fastened together. Another wire was fastened to

the metal frame of the clock. The clock then served as a switch in a buzzer and dry-cell circuit. This mechanism was placed in a small box that the operator could hold in his lap. On top of the box was attached a tallying device for tabulating 3 sets of figures.

Once in the air and on the plotted course, the pilot held the air speed at 100 m. p. h. When the plane was over the starting point of a segment on which plots were to be tallied, the pilot advised the operator who turned on his timer. Whenever the buzzer sounded he looked through the 2-inch square on the window. What he saw was tallied in one of three categories: burned forest land, unburned forest land, or nonforest land.

The results of the 1953 survey showed 364 unburned plots, 500 burned plots, and 796 nonforest plots, or a total of 1,660 plots. Considering that 500 out of 864 forest plots were in burned woods, 58 percent of the unprotected woodland burned. While this seems high, and it is higher than the 47-percent burn found by a similar survey last year, it is undoubtedly correct within reasonable limits. A check can be obtained by referring to the forest survey of 1948-49 in Florida which indicates that 56 percent of the land in the unprotected counties included in our aerial survey is forest land. According to the sample plots tallied in the aerial survey, 52 percent of the area is forested.

This survey required a total of approximately 12 hours of flying over and between the segments on which sample plots were tallied, plus a few hours travel between the airport and the chartered course. While flying the chartered course, sample plots were being tallied two-thirds of the time. During the other one-third, the plane was flying from one segment to another and this gave the pilot and the operator an opportunity to relax and prepare for the next 20-mile segment.

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ILLINOIS FIRE DAMAGE APPRAISAL SYSTEM

RICHARD THOM, *Staff Assistant*, and MARTIN ANDERSON,
District Forester, Illinois Department of Conservation

Fire damage in Illinois is based on the following factors, each of which affects the final damage figure: (1) Average annual growth per acre of the timber type; (2) average stumpage value, by types, per 1,000 board feet; (3) site types, based in part on the timber types as outlined by the Illinois Technical Foresters' Association; (4) years fire has set back growth; (5) stocking; (6) fire history of the stand; (7) damage other than that to timber.

These factors are all considered when making an appraisal, and are used on merchantable stands where breast-high tree diameters range from 10 inches upward. One can readily see that each of the first 6 factors, which can be varied from 3 to 5 different degrees, provide numerous possible combinations for arriving at a damage figure for a specific stand of timber.

The site types considered are described below:

Upland Mixed Hardwoods. Includes Illinois Technical Foresters' Association site types Cove Mixed Hardwoods, Lower Slope Mixed Hardwoods, and Mixed Oaks. Species common to the Upland Mixed Hardwoods type are red, white, and black oaks, beech, hard maple, ash, sweetgum, tulip poplar, and hickory.

Oak-Hickory. Includes black, white, scarlet, southern red, and post oaks, and hickory.

Blackjack and Post Oak.

Bottom-land Softwoods. Includes soft maple, ash, elm, sycamore, sweetgum, cottonwood, boxelder, hackberry, swamp white, cherrybark, and water oaks.

Bottom-land Hardwoods. Includes water, white, and red oaks, hickories, ash, sweetgum, soft maple, elm.

The average growth per acre for the above site types, and average stumpage value, is designated by the service forester. Because Illinois is a very long State, variations in growth rates and stumpage values are pronounced.

The number of years that fire has set back growth is dependent on the severity of the burn. Fire intensity varies with the nature of the fuel, time of day, humidity, wind velocity, and other factors. For purposes of fire damage appraisal, fires are described as follows:

Creeping fire. Burns only the top layer of leaves and duff. Growth set back 3 years.

Hotter fire. Consumes twigs and small slash (up to 2 inches). Growth set back 7 years.

Very hot fire. Burns all slash, scorching tree trunks and destroying pole and sapling size timber. Growth set back 15 years.

The stocking of the woodland stand will affect the appraisal figure, since a poorly stocked stand does not have as many stems to be damaged by the fire as does a well-stocked stand. Stocking classes are described as follows, with the assigned factor for each:

Good. Area well stocked, stand practically complete, little or no waste growing space. (Factor 1 1/2.)

Medium. Area fairly well stocked but not completely; trees wider spaced than in good-stocking class, or bunched so that considerable growing space is not utilized. (Factor 1.)

Poor. Area poorly stocked; trees widely spaced, or large openings numerous. Less than 50 percent of the growing space utilizing. (Factor 1/2.)

A woodland that is repeatedly burned year after year cannot be damaged as much as one burned infrequently. Therefore, the fire history is described as follows, and a factor assigned to each condition.

Little evidence of past burning. Accidental; few scars allowed on edge trees. (Factor 1 1/2.)

Evidence of fire in the past. Few scarred trees. Some healed larger trees. No young trees (under 10 inches) scarred. (Factor 1.)

Evidence of periodic fires in the past. Many large trees scarred. Young trees (under 10 inches) scarred. (Factor 1/2.)

Evidence of repeated annual fires. Abundance of scarred trees in young and old classes. Leaf litter, duff, and seedlings very scarce or absent. (Factor 1/10.)

The formula for computing the estimated damage per acre is

$$S \times Y \times D\,A\,F + K$$

A=average annual growth per acre.
S=average stumpage value per M board feet.
Y=years fire has set back growth.
D=stocking factor.
F=fire history factor.
K=other damage per acre.

As an example, let us consider the following fire: A 10-acre stand of poorly stocked blackjack oak-post oak timber, with an average growth of 50 board feet per acre per year and stumpage valued at $5 per M board feet, is burned over by a fire described as very hot. This stand of timber has been burned yearly. Forty dollars worth of cut mine props are also destroyed.

Growth × stumpage = 0.25
0.25 × 15 (very hot fire) = 3.75
3.75 × ½ (poorly stocked stand) = 1.87
1.87 × 1/10 (fire history factor) = 0.19
0.19 per acre × 10 = $1.90
$1.90 + $40 = $41.90 total damages.

Training is very essential for this appraisal method, since most of Illinois' appraisals are made by the district fire wardens, who are not trained foresters. Field trips are arranged to acquaint the wardens with the various timber types and to familiarize them with the terms described. In a surprisingly short time most men can accurately identify the timber types, stocking, fire history, and intensity of burns.

The district fire warden is given a damage appraisal card that does most of the computation (fig. 1). The card is set on the intensity of burn. The figure that appears to the right of the correct fire-history classification, beneath the proper timber type, is multiplied by the stocking factor. This result is the damage per acre, to which other damages are added. Each item necessary to the appraisal is recorded on a fire report form. Thus, the completed form gives a description of the fire and timber in great detail to the forester in charge.

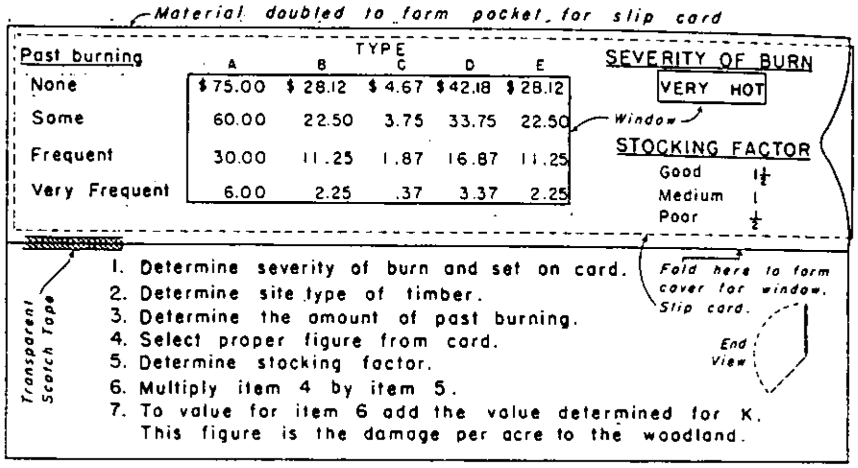

FIGURE 1.—Sample damage appraisal card, before folding.

This method of appraisal is simple to teach and use, and provides uniformity among field personnel. It considers the lack of uniformity of fires and woodlands, and makes greater accuracy possible because it is used on the fire and not in a distant office. As men become more proficient, the degree of accuracy can be increased by closer definition of timber types.

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A Lighted Clip-Board

If you've ever had to keep records in a fire camp at night, then perhaps you'll agree that a clip-board with a built-in light would be a mighty handy item. There is such a clip-board equipped with a reflector, unit, bulb, and battery case, all neatly and permanently attached for convenience. It is operated by a switch on the clip, and two standard flashlight cells and a bulb provide an ample amount of light for the entire board.

Several boards hung at a single location could provide an illuminated bulletin board for display of fire maps, camp layouts, etc. For persons engaged in maintaining records on vehicles, personnel, supplies, and other items in fire camps during the hours of darkness, a lighted clip-board can be a help. This board is manufactured in various sizes and it costs approximately $3. Possibly this cost would be less for large quantities. For further information contact the Arcadia Equipment Development Center, U. S. Forest Service, 701 N. Santa Anita Ave., Arcadia, Calif.

PLANNING FOR THE USE OF FIRELINE PLOWS

FRED G. AMES

Forester, Region 8, U. S. Forest Service

INTRODUCTION

Early in the spring of 1944 the dreams and hopes of southern foresters and landowners started toward reality. At that time the development of the various types and size classes of plow units common in use today began.

At the present time, the various State forest protective agencies and many of the large private landowners, as well as the United States Forest Service, are largely dependent on the use of fireline plows for fireline construction in the Coastal Plains. These plows are now playing another important role in southern forestry, because they are an essential tool in the extensive prescribed-burning program carried on in this section of the country. Through their use, fire is safely and economically employed as a silvicultural tool in forest management. Without the use of fireline plows, progress would be far less or much more expensive, the resulting fire damage would be higher, and adverse conditions occurring during burning could not be quickly handled.

The Forest Service, State protective agencies, and large private landowners have proved that the use of fireline plows in fire suppression pays big dividends both in savings of acreage that might otherwise be lost and in savings in the cost of suppression. Fire suppression by the use of handtools is now seldom practiced in the low and upland sections of the Coastal Plains.

PLANNING

Planning for the use of fireline plows on new areas is as essential as planning for any other new procedure. It is desirable that the planners have a knowledge of forest conditions and organizational angles that contribute to the success or failure of fireline plows in line-construction work. In addition, the capabilities and limitations of the various types of plows and plow-unit size classes must be understood. This understanding is most easily reached through the demonstration or trial of proved plows operated by experienced operators. It should be realized that proved plows may be only the beginning in the development of fireline plows.

In the past decade, forest fire suppression men have learned a lot that can benefit those planning for the use of fireline plows on new areas. The important elements that should be considered in such planning are discussed here briefly.

ANALYSIS OF FOREST CONDITIONS

It is important that an analysis be made of plowing conditions on the area. This should cover forest type, stand classification and density, rough types, soil and sod conditions, topography, physical obstacles, and seasonal factors.

Forest type, stand classification, and density.—Designation of an area by forest type actually means little, but stand classification and density are often the deciding factors for determining plow-unit size-class limitations. A simple cruise should be made of several miles of typical forest stands on the area. The cruise line should be located on the same basis that a fireline location is made for a handtool line-construction crew. Two items should come out of the cruise—average number of stems and average basal area per acre. Ordinarily, only stem sizes between "over 5 feet high" to 10 inches d. b. h. need be considered in this cruise, because stems within these sizes are usually the only ones affecting the plow unit. We used 1/20-acre plots at 2-chain intervals in our analysis.

Rough.—This term is used to describe the accumulated mass of living and dead plant materials that occur on or close to the ground. Insofar as the use of fireline plows is concerned, the density of this rough and its allied root system sometimes limits the plow-unit size class. For example, the tough root systems of the palmetto and swamp brush in the open stands of the lower Coastal Plains prevent successful use of the light- and medium-size class of plow units.

Soils.—First and foremost in an analysis of the soils is the presence or absence of rock. Disk-type plows will successfully handle small pockets or small quantities of fine gravel, but they are not satisfactory in the more rocky soils. Soil textures have some effect on the plow, but the greatest factor is the reaction of the soil to extreme weather conditions. Does the soil become very hard in periods of drought? Does it retain excessive moisture long after heavy rains?

Topography.—Our observations have been that rolling land with short slopes not exceeding 40 percent can easily be plowed with the conventional type of wheel plow—a plow carried on wheels. However, where slopes are greater and are long and frequent, a tractor-mounted plow is desirable. It has the advantage of being able to back up slopes that are too steep to move up in a forward position.

Physical obstacles.—Physical obstacles, such as roots, holes, down timber, wet physiographic features, topography, soils, rough, timber stand, and rock should be analyzed for quantity, prevalence, and type. After all, the ability of a plow unit to do a satisfactory job of fireline construction is its ability to overcome, with a reasonable amount of good operation, the resistance offered by the physical obstacles.

Seasonal factors.—We have found from our long fire season in the South that the seasons of the year have some bearing on plow-unit capabilities. Hard dry soils and the excessive moisture retained by the soil following heavy rains have already been mentioned. The hard dry soils usually occur in periods of drought during July and August. The excessively moist soils occur on areas having impervious subsoils and in the swampy areas of the lower Coastal Plains.

In some areas the hardwood reproduction is so dense that during the summer abundant leaves materially affect fire-plow production because the plow-unit operator has difficulty in seeing forward. The plow-unit leadman is a help, but on mountainous terrain he, too, may have difficulty in seeing ahead.

FIRE OCCURRENCE LOCATIONS

An analysis should be made of the patterns of fire occurrence on the areas under study. Definite fire patterns will reflect where the plow-unit should be located, and the intensity of occurrence within these patterns will reflect the number of plow units needed.

On some of our areas, the pattern and periods of occurrence of fires varies with the seasons of the year, and so require a shift in plow-unit headquarters as the centers of fire occurrence move.

MAPPING PLOWABLE AREAS

From the economic angle of planning alone, it is essential that at least the proportion of plowable area be sufficient, or that portions of the area covered by the active fire patterns be sufficiently large, to justify the expenditure for equipment.

Later, when fireline plows are available for use on the area, a detailed plowable-area map should be available for the dispatcher and all fire planners as an aid in day-to-day planning and for use by the dispatcher and fire bosses in their plans of attack on a going fire.

ECONOMICS

Today the State protective agencies, many large private landowners, and the Forest Service are using approximately 1,500 plow units in the Southeast. They are almost wholly dependent on these machines for fire suppression in the lower and the upper Coastal Plains section of the country. Fireline plows are now being effectively used in the mountains of Arkansas, Georgia, and Tennessee. These plows can construct high-grade fireline at production rates up to 3 miles per hour in reasonably dense timber in the flatwoods and rolling uplands of the Coastal Plains, and up to 1 1/2 miles per hour on mountainous terrain.

Through the use of fireline plows, both the acreage burned and the cost of suppression have been materially reduced. From time to time analyses have been made comparing the results of the use of fire plows in fire suppression with the results of fire suppression by the Civilian Conservation Corps handtool crews. One comparison showed three significant figures: (a) A reduction of 82.5 percent in average size of fire; (b) a reduction of 22.6 percent in the number of fires reaching Class D and E size; (c) a reduction of 48.1 percent in average cost per fire. These figures proved to us that an organization with any appreciable "plow country" to protect cannot afford to be without fire-plow equipment. This thought is also borne out by the increase in the extent State fire protective agencies and private landowners have increased the number of their fire-plow units in the past 6 years.

The question of just how far one should go in an investment

in fireline plow equipment is difficult to answer. The logical approach to the answer seems to be that depending on the local rate of fire spread, there needs to be an outfit to attack the fire before the fire gets to be of critical size. The critical size would be determined by the values at stake where the fire is burning and by the values at stake in the direction in which the fire is traveling.

In assessing the question of how far one should go in an investment in fireline plow equipment, it must not be overlooked that pressure is on the protective agency. Never before has standing timber had the monetary value it has today, and even with a recession in business it would probably continue to have higher values than was ever thought of in the past. The general public and wood-using industries are placing high values on the remaining stands of timber, and protective agencies are behooved to do a better and more effective job.

EQUIPMENT

At the beginning of the past decade there was a change in ideas concerning the necessary weights and size classes of fireline plows. One of the new thoughts was to work from the light-size plow unit up to the heavy-size plow unit only as necessary. On an area suited to light-sized plows, the light plows will outplow and outmaneuver many of the heavier plows on the same area. Some of the considerations that follow will be helpful in choosing and adapting the type of plow unit to be used. They cover the plow unit as a whole, or the tractor or plow separately.

An organization about to enter the field of fire-plow use needs a clear-cut specification for a satisfactory fireline, and particularly for width. There is no justifiable reason to construct a fireline wider than is actually required. In spots where a wide line is needed, double firelines can be plowed—a common practice in the Southeast. Reduction in fireline width means a reduction in plow pull, the use of smaller and faster tractors, and faster fireline production.

Actual tests indicate that the average pull of a plow should not consume more than 40 percent of the drawbar pull of its tractor in the gear in which the tractor is operating. For example, when using an OC-3 Oliver tractor operating in 2nd gear, the average plow pull should not be more than 1,000 pounds (40 percent of 2,512 pounds, the rated pull of the tractor operating in 2nd gear). A heavier pulling plow results in a sluggish plow unit that fails quickly in the inevitable tough-plowing spots found on any fireline.

Consideration should be given the type of line constructed by the plow. Plows constructing flat-bottomed furrows are best adapted to use in soils without rocks. Plows constructing V-shaped furrows work better than flat-bottom plows in rocky soils; they also move less dirt and construct a higher quality line. The question of line quality is of importance here. During our test work, all test lines were graded for quality. Satisfactory fireline was found to have an average grade as low as 82 percent perfect.

Checks of 835 chains of fireline constructed for actual fire suppression confirmed this.

The plow depth adjustment must be simple, fast, and easy to operate; only one adjustment should be necessary. There should be sufficient range in adjustment so that the most shallow plow line possible can be constructed.

Plow units that have a maximum of flexibility both vertically and horizontally are most effective. Vertical flexibility ensures that the plow remain in contact with the ground as the tractor moves over rough ground, across rock and tree branches. Horizontal flexibility ensures short quick turns of the unit with the plow in the ground, reduces side bind on turns, and results in a lower average plow pull. Ideal horizontal flexibility is reached when the plow beam is free to turn 90° to the right or left of the center line of the tractor.

The pros and cons of hydraulically operated versus gravity-fed plows can be argued at length. The decision is one that must be made by administrators. Hydraulic plows when operating under *down pressure* invariably have greater average pulls than gravity-fed plows. All obstructions in the soil, such as roots and rocks, reflect greater stresses than if the plow was allowed free movement. A properly designed plow should ordinarily take the ground without down pressure. If hydraulically operated plows are used, there must be no sacrifice in flexibility of the plow unit.

In an effective plow unit, the tractor and plow must be properly outfitted for fireline construction use: (1) The tractor must be provided with brush guards to protect the operator. (2) When a plow unit is to be used on steep slopes, the tractor should be equipped with an electric fuel pump and provision made to prevent fuel from spilling from the air vent in the tank cover. (3) The tractor should be properly armored with belly pan, radiator grill shield, and track guards for protection of the operator. (4) The tractor bumper should set close to the tractor frame and the ends curve toward the track to prevent saplings and small poles slipping in between tracks and bumper. The absence of this feature can cause considerable trouble in dense stands and in mountain plowing. (5) The tractor should be properly and adequately lighted. front and rear, for night fireline construction. The tractor should also be equipped with a swinging spotlight.

The tractor should be as narrow as practical. Tractor width is a vital factor in timber-stand resistance to the plow unit.

Special attention must be given tractor-mounted plows. When in a raised position for deadheading, the plow must fold back as closely as possible to the tractor and be securely fastened. Very little if any movement of the plow should be allowed. This is not only a desirable feature for deadheading but it is an extremely important safety feature.

The plow unit should be equipped to carry a few of the more common mechanic's tools, a shovel, an ax, a chain, a first-aid kit, and lights for use by the crew on night work. Also, a hard-boiled hat and goggles.

The plow-unit transport must be sufficiently adapted to the use as a plow-unit transport so that loading and unloading is easy, simple, and safe, and the plow unit can be quickly and securely fastened to the transport bed.

Plow-Unit Distribution

Plow-unit distribution during the fire season is of great importance. Even though transportation of the plow unit and the line construction is fast, the plow unit needs to arrive on the fire in a hurry. In the Southeast, ranger districts with high rates of fire spread have as an integral part of their fire plan definite plow-unit locations. Project work is planned within these areas to occupy the plow-unit crews when not on fire duty. Under this plan the plow unit is always close by its crew. Usually, the equipment remains in the area, only going to headquarters for shop repair. Most of the trucks are equipped with mobile radio; otherwise portable radio is available for crew use.

Organization

Basically, a fireline plow unit is a fireline building tool, and its crew might be considered under conventional fire organizations as fireline builders. On this basis, the crew will be small. For effective fireline construction each man must fit into the team as an integral part. Each man must be a qualified fire fighter and in addition qualified in the task he is to perform as a member of the plow-unit crew. Each member of the crew, like the Army tank crew, must be a specialist.

Briefly, for fireline building only a 3-man crew is essential. This crew consists of the following: (a) The plow-unit leadman, whose duties are to walk ahead of the tractor picking the route of travel for the plow unit, for fastest line construction consistent with the location outlined or marked by the fire boss; (b) the plow-unit operator, whose prime duty is to construct a satisfactory plow line with care to prevent getting stalled or mired in soft ground; (c) the follow-up man, working just behind the plow unit, whose duties are to clean spots of the low-quality line and to assist the plow-unit operator when difficulties are encountered.

Overall forest conditions will allow variations in organization. For example, a good plow-unit organization used in the Southeast, where the plow-unit crew is expected to handle all phases of fire suppression, consists of (a) crew foreman, to plan attack, to serve as a leadman if a leadman is necessary, and to serve as a backfire man immediately behind the plow when not serving as a leadman; (b) plow-unit operator; (c) two fire fighters who serve as safety men along the fireline, one of whom serves as backfire man when the foreman has to scout the fire or serve as leadman.

The forest administrator should work out the best plow-crew organization for his forest and overall fire organizational system. He should also not fail to work out details for fitting the plow unit and its crew into large fire organizations.

Training

Training each member of the plow crew individually as well as a team is absolutely necessary. It is as important here as in any phase of fire control work, and administrators should work out detailed training plans. Individual members of the crew must know how to execute their jobs efficiently, and the plow-unit operators and leadman must definitely know the plow-unit capabilities and limits. Training and practice is the only answer. Essentially as important as original training is refresher training. Use charts and training aids.

Operation Instructions

The key members of the plow-unit crew should be provided with written instructions pertaining to the proper use and care of the plow unit as a whole, the forest policies covering the use of the plow unit, proper plow depth adjustments, accessories to accompany the plow unit, the place of the plow unit in the fire organization, and the safety angles to fire-plow operation.

Plow-Unit Maintenance Standards

There should be written plow-unit maintenance standards prepared for the field personnel. These maintenance standards should cover all phases of preventive maintenance, allowable wear tolerances, and care of both the tractor and the plow.

These elements may seem elementary, but every one of them is an essential part of fireline plow-use planning. Every element is a necessary part of the plan to put fireline plow units to effective use on a new area in the least possible time.

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Fire-Pump Engine Storage Damage

[This is based on a USDA Employee Management Improvement Suggestion made by Arden E. Robinson of the Sellwood Shop, Portland, Oreg. The suggestion was accepted and adopted throughout Region 6. In approving Mr. Robinson's suggestion, the Regional Equipment Engineer noted: "I concur wholeheartedly in Mr. Robinson's proposal. . . . The cost of a crankshaft alone is in the neighborhood of $40. Replacement of bearings is very costly to say nothing of damage to cylinder walls and other working parts. Failure of many pumps on fires can be traced to damage by acid action and rust while in storage.—Ed.]

Fire-pump engines were being packed and stored with other pump equipment in the Region 6 warehouse at Sellwood for long periods of time. Consequently, the engines sat in the same position for the whole storage period. During this time, the lubrication drained away from the upper surfaces, and condensation formed in the engines because of temperature changes. The lack of lubrication on the surfaces, and acids formed by moisture in the lubricant, caused rust pitting and etching of the cylinders and bearings. Etching is especially noticeable at the contact points of steel and iron when these metals rest in the same position for long periods.

The pump units are now stored on racks where they can be rotated at least once a month or oftener. This changes the point of contact of the bearings and other parts, and redistributes the lubricant over the surfaces again. This film of lubricant and change of contact point retards rusting and etching.

DUAL SERVICE COMMUNICATION—SIX RIVERS NATIONAL FOREST

C. E. BELL

Radio Technician, Six Rivers National Forest

In addition to the more or less standard FM radio system that interconnects the Supervisor's office with various field stations and mobile sets through the use of a single repeater station, the Six Rivers Forest has for the past 2 years operated a supplemental radio-telephone service in conjunction with the Pacific Telephone and Telegraph Company office in Eureka. Basically, this tie-in provides for connecting commercial telephone lines directly to our radio network through the local P.T. & T. switchboard. The primary reason for this hookup is to provide reliable communication between the field and Eureka on a 24-hour day, 7-day week basis. By using the services of established commercial operators, the need for standby Forest Service operators is eliminated.

The telephone company switchboard marine operator has no radio equipment of her own, but she uses the Supervisor's office transmitter through a connecting wire circuit between the two offices. She also has a speaker connected by means of a wire circuit to our receiver in the Supervisor's office and can monitor all forest network traffic. Through her own switchboard and the local switchboard, she can connect any telephone in Eureka directly to the radio circuit. It is also possible for her to connect the radio channel to any telephone in the United States by going through the long-distance switchboard.

The marine operator calls the ranger stations by means of a dialing system that activates a bell or buzzer at the respective ranger station. She does not call by voice, and does not use the station's call letters. In return, a ranger station calls the marine operator by means of a tone, *not* voice. The system is designed primarily for use outside regular office hours (nights, weekends, and holidays) but can be used any time. This connection with the telephone company switchboard does not interfere with the normal operation of our radio network. Calls between the field stations and the Supervisor's office made during regular office hours, or at other times when the sets are manned, are made by voice and with the regular station call letters.

To serve as a radio-telephone, it has been necessary to incorporate into the system several units not usually found in Forest Service radio networks. The transmitting frequency at the Supervisor's office was changed to a third frequency to provide duplex operation to the repeater station (fig. 1). Added units consist of a Quik-Call (Motorola) receiver with a small audio

amplifier, a relay panel with relay for changing control automatically, a speech amplifier for boosting the telephone speech to the transmitter, and a Western Electric termination panel for the telephone circuits (figs. 2 and 3). Four telephone circuits are required from the Supervisor's office to the telephone office—one for receiving, one for transmitting, one for transmitter control, and one for signaling the operator. The last two circuits are phantom. These lines terminate in a G-2 panel with hybrid filters located at the telephone office.

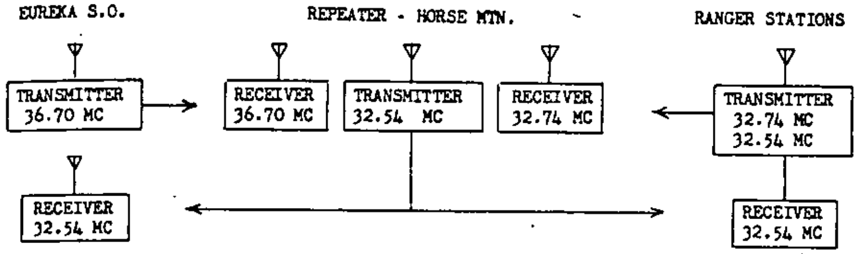

FIGURE 1.—Transmitter and receiver frequencies and locations.

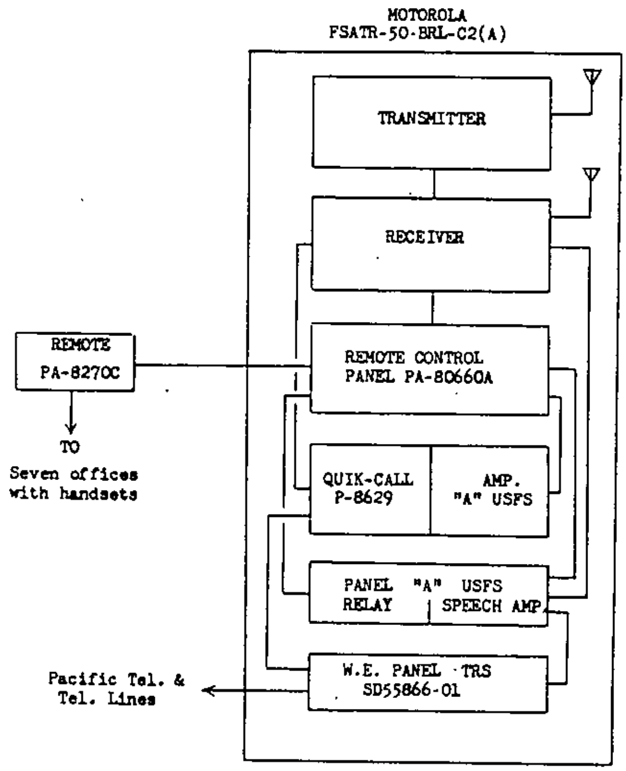

FIGURE 2.—Basic radio setup and added units, Supervisor's office, Eureka, Calif.

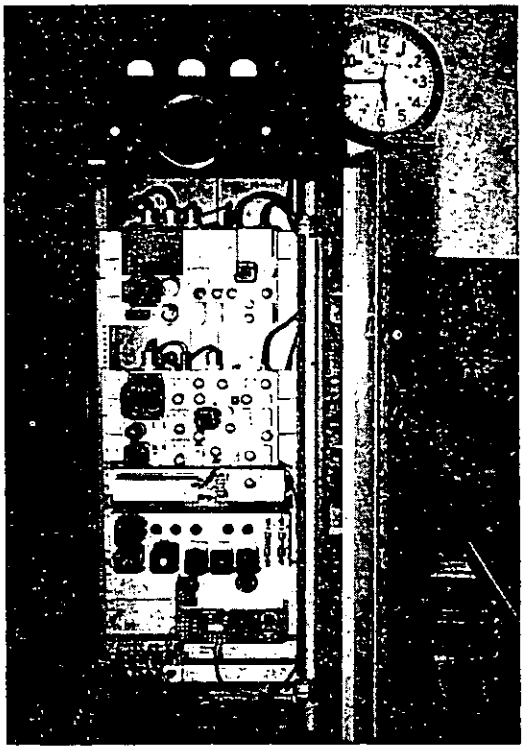

FIGURE 3.—Radio-telephone panel, Supervisor's office, Eureka, Calif.

Two receivers are used at the repeater station. The second receiver is necessary for duplex operation required for connection with standard telephone circuits. Both receivers control and feed equal audio to the transmitter and may be used simultaneously.

Added equipment at the ranger stations include Motorola Quik-Call sender, Western Electric selector unit, termination panel with audio control and signaling booster for the selector (fig. 4). One or more residences are wired for remote control, signal buzzer, and call button for signaling the telephone operator.

When the telephone operator plugs into our circuit through the G-2 control panel at the telephone office our control relay is energized, turning the transmitter on and holding the receiver on. Normally the receiver shuts off during transmission. The operator is now able to talk and receive at the same time (duplex). With a key, the operator connects to our transmit line a dial tone system having 2 tones—600 cycles and 1500 cycles. Dialing causes a shift from one tone to the other, each change acting as one impulse on the selector units at the ranger stations. Each selector has a stepper relay with a code wheel that has 5 hold pins preset to correspond to the station's number. Each pulse moves the code wheel one step, so if the number of pulses dialed moves the code wheel to a hold pin, the second number dialed will be added

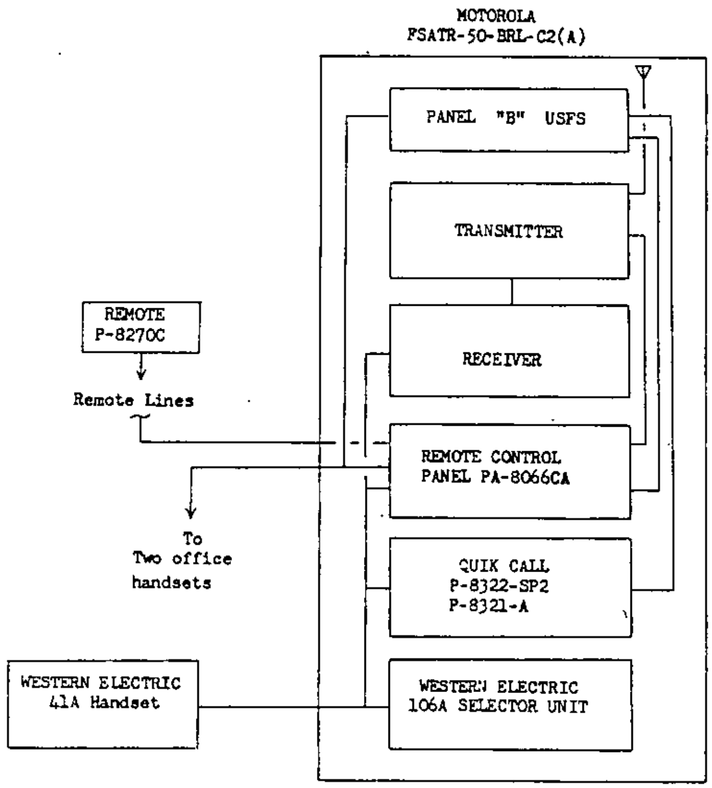

FIGURE 4.—Ranger Stations. Remote lines, 3 pair run from equipment in office to 3 residences, 1 pair for remote unit, 1 for selector signal buzzer, and 1 for control key of Quik-Call.

to the first and so on through the 5 numbers of the call. The total must be 23 to make the signal bell ring. If a number misses a hold pin, the code wheel returns to zero.

All dialing numbers for the stations have been assigned by the telephone company and are unlisted. After dialing, the operator releases the dialing key, and when the station answers it is informed of the phone call and the phone is plugged into our system. When the phone party hangs up, the operator disconnects the line, releasing control for normal operation. Because of losses in the hybrid filters and telephone cable of incoming speech, a small speech amplifier is added at the transmitter input to raise the volume.

A district making a phone call turns the transmitter on in the normal manner, pushes the call button for 3 seconds, then releases both. Two tone pulses are transmitted, which actuate the signal at the telephone office switchboard. These tone pulses are from the Quik-Call sender unit that has four tone generators called Vibrasenders, a timer chassis, and power supply. Pushing the call button closes a relay on the timer, releasing 2 tone pulses of

1 second each. Two tones are transmitted on each pulse, their frequency being the same as the four Vibrasponders in the Quik-Call receiver at the Supervisor's office. Only by these four pulsed tones is it possible to energize the signal relay in the receiver.

Throughout its 2 years of operation, this system has worked very well. It has proved to be a very satisfactory solution to the problem of providing 24-hour service between the Six Rivers ranger stations and their Eureka Supervisor's headquarters. It was particularly adaptable to the telephone company exchange at Eureka, where a coastal ship-to-shore radio telephone marine operator is available.

☆ ☆ ☆

Repellents For The Protection Of Fabric In Fire Hose

From time to time inquiries are received by the Fish and Wildlife Service for information concerning repellent materials applicable to fabric as protection against rodent depredations. Frequently, these inquiries have had to do with damage to the covering on fire hose that is stored.

In an effort to find the answer, studies were carried out with fire hose, the outer fabric of which was impregnated with candidate repellent compounds.

For the tests, 8-inch sections of 2-inch fire hose were used. The treated sections, along with untreated hose, were exposed to wild Norway rats held under simulated warehouse and field conditions. Food and water were supplied the animals during the tests but no nesting material was provided. The animals had access to sawdust, however, which was spread on the floor for sanitary purposes. Exposure of the hose was made by suspending test lengths between 1- by 4-inch boards so that each section was equally available to the animals for 7 months, October to May.

Of the six deterrent compounds tested, Z.A.C. (zinc dimethyl-dithiocarbamate-cyclohexylamine complex), sodium pentachlorophenate (Dowicide G), copper napthanate, ammonium sulfate, Teramine, and creosote, only the first two showed marked repellent properties. During the course of the tests, hose treated with these two compounds were only slightly damaged by the rats, while the average percent of fabric removed in all other tests was from 12½ to 87½ percent.

Hose treated with Z.A.C. were sprayed with a 10-percent solution in which P.e.p.s., a synthetic rubberlike adhesive, was used as a sticker, with Dreft added as a wetting agent. Hose treated with sodium pentachlorophenate were impregnated with a 10-percent solution in water, with Dreft added.

The results of these tests should not be interpreted as being applicable to the protection of foodstuffs kept in burlap and cloth bags. Repellency in barrier control deals with factors quite different.—JACK F. WELCH, *Biologist, Fish and Wildlife 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 reproduction. Please therefore submit well-drawn tracings instead of prints.


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-CRUSH YOUR SMOKES
-DROWN YOUR CAMPFIRES
-BE CAREFUL WITH ANY FIRE!
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