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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 11 Number 1

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

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

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Forest Service, Washington, D. C.

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Contents

THE HUDSON BAY HIGH AND THE SPRING FIRE SEASON IN THE LAKE STATES

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INTRODUCTION

What causes periods of critical burning conditions in the Lake States? Are these critical periods associated with any particular weather types? If so, what weather types are generally associated with critical periods in the spring? In the summer? In the fall? The answers to these questions would be of considerable help to a fire-weather forecaster in the Lake States, especially in attempting to arrive at a longer range forecast of impending critical burning conditions.

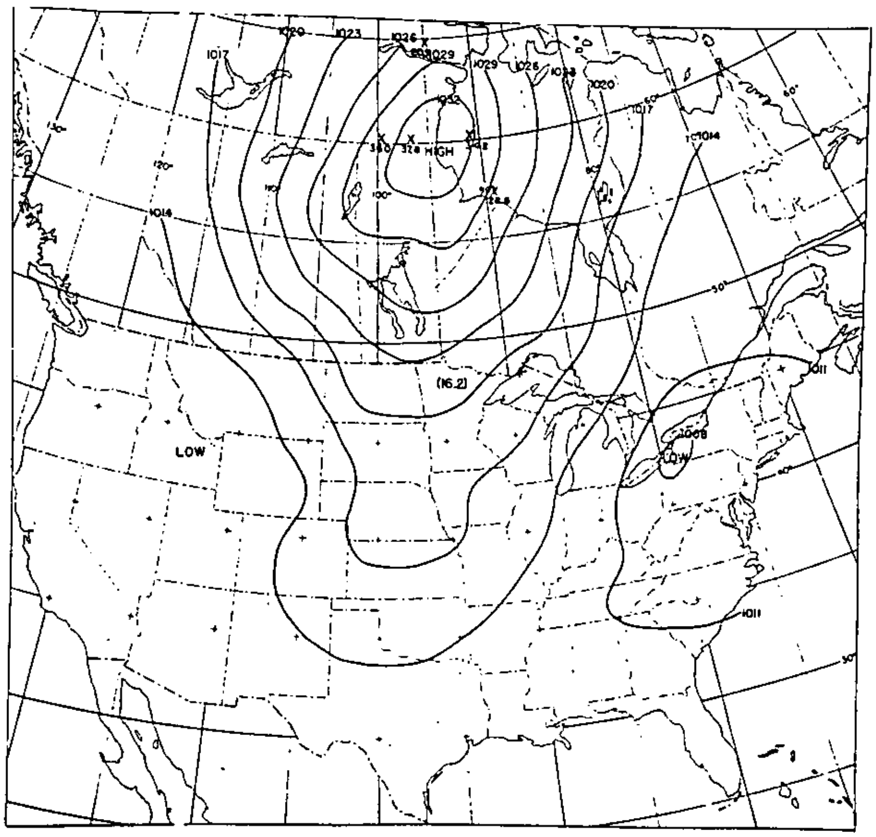

FIGURE 1.—Composite map of the Minnesota cases 2 days prior to the first day of very high burning index. The 6:30 a. m. maps for May 2 and 16, 1946, May 7, 1947, and May 7 and 22, 1948, were used. The location and central pressures of the individual highs are indicated.

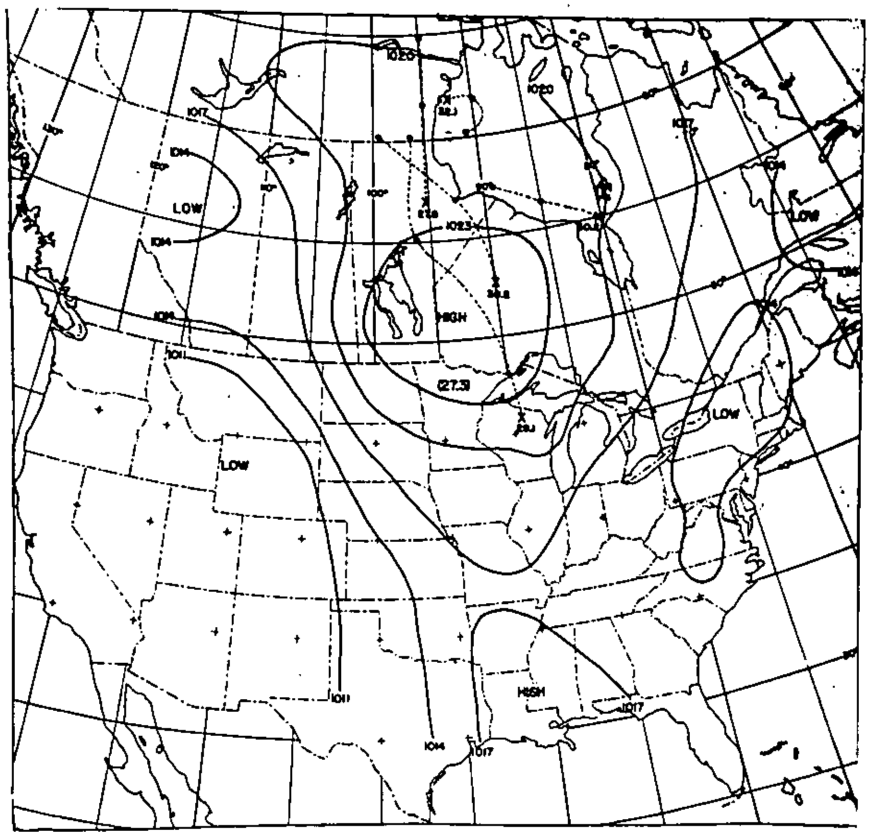

FIGURE 2.—Composite map of the Minnesota cases on the first day of very high burning index. Past daily positions of the individual highs are shown by dots and their paths by dashed lines.

Not all of the above questions are answered here. In this study an examination of the spring burning index records and associated weather was undertaken. It is expected that studies of the summer and fall seasons will be made at a later date.

METHOD

In the Lake States a 0–100 scale of burning index is used which is divided as follows:

safe	0–1
very low	2–3
low	4–6
moderate	7–12
high	13–24
very high	25–49
extreme	50–100

The periods of critical burning conditions for each State were determined by simply averaging the highest burning index reported each day by each of the fire-weather stations. This was done for the spring fire seasons of the years 1945–48. A State average of more than 24 (very high) was considered critical.

The spring fire season in the Lake States normally extends from the 1st of April through the 31st of May. Since only one period of very

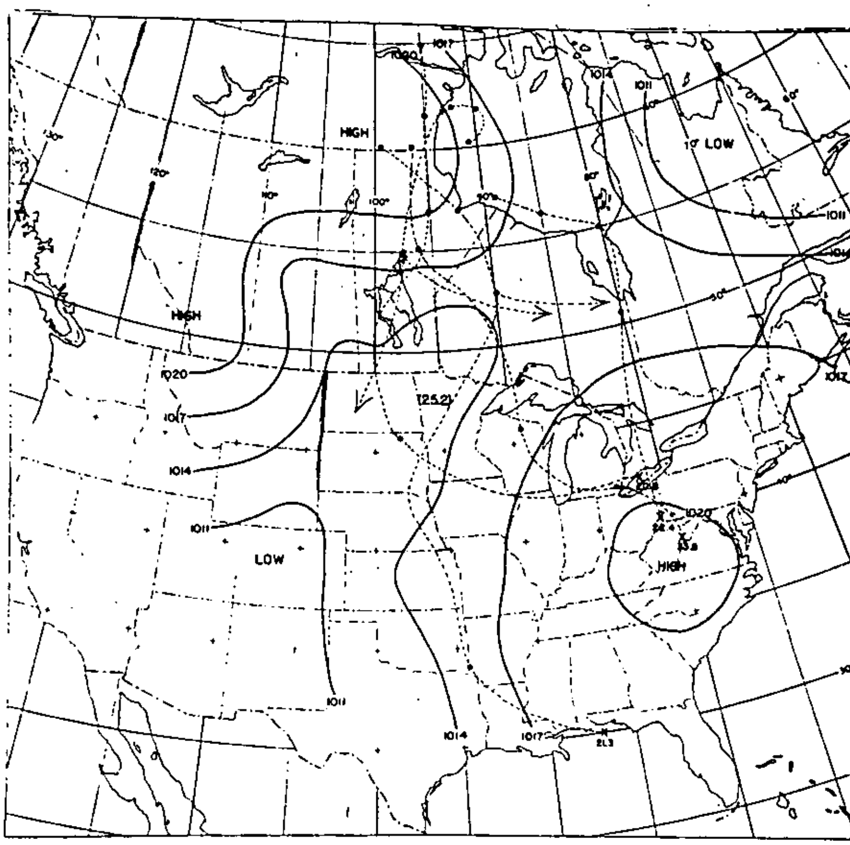

FIGURE 3.—Composite map of the Minnesota cases 2 days after the first day of very high burning index. Paths and daily positions are shown as in figure 2.

high burning index occurred during the month of April, not justifying a study of weather types, only the month of May was considered further. There were five May periods of very high burning index in Minnesota, eight in Wisconsin, six in Upper Michigan, and four in Lower Michigan.

A study of the weather maps during these critical periods showed a similarity between most of the weather situations. To bring out this similarity, composite maps of the similar cases were made by averaging the sea-level pressures at each of a large number of weather stations in the United States and Canada and drawing isobars (lines through points of equal pressure) for these average pressures.

DISCUSSION OF RESULTS

Nearly all of the critical periods were associated with an area of high pressure (hereafter called a "high") which developed near the western shore of Hudson Bay and subsequently moved either southward or southeastward. A slow-moving high that develops or intensifies in the Hudson Bay region is frequently referred to as a "Hudson Bay High." All of the periods of very high burning index in Minnesota and Upper and Lower Michigan were associated with that weather type, as were seven of the eight periods in Wisconsin.

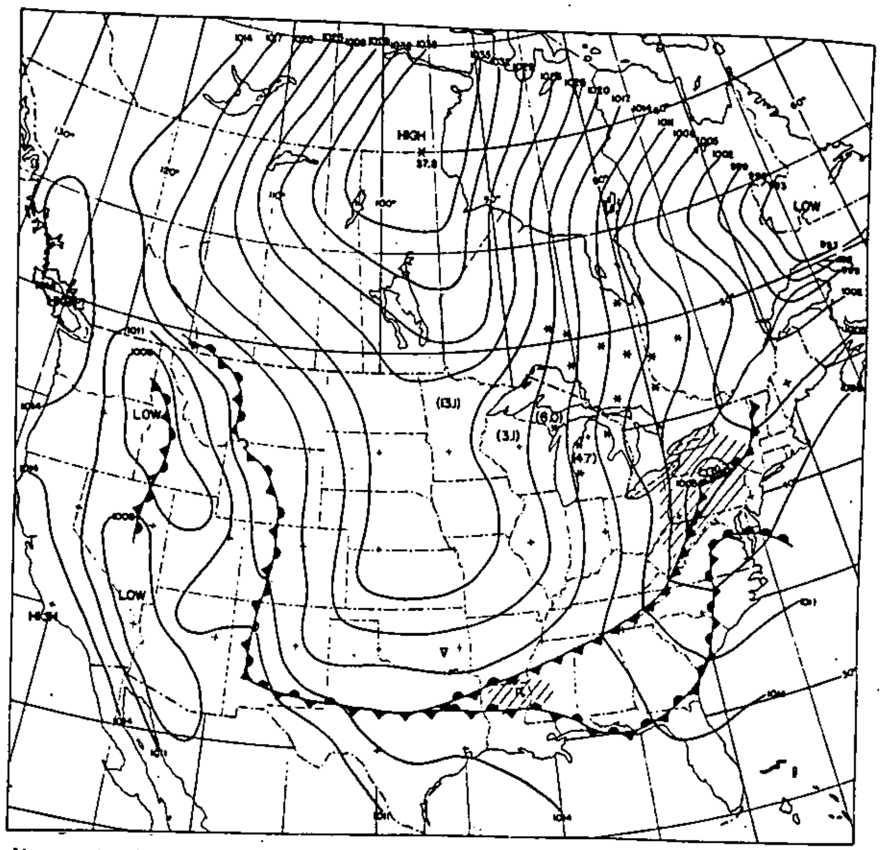

FIGURE 4.—Surface map for 6:30 a. m. May 7, 1947. The average burning index in each of the Lake States is shown by the figure in parentheses. Stars indicate snow and hatched areas are areas of more or less continuous precipitation.

The one Wisconsin period which was different, and the one April case that was found, were associated with highs that moved from western Canada through the Lake States in a southeasterly direction.

It was interesting to note that there was no case in May of the years studied in which a Hudson Bay high moved southward or south-southeastward from the Hudson Bay region, that was not associated with a period of very high burning index in Wisconsin.

Composite maps shown in figures 1 through 3 show definitely that the Hudson Bay type is associated with critical burning conditions in the Lake States in May. Figure 1 is a composite sea-level map for 6:30 a. m., 2 days before the first day of very high burning index for the Minnesota cases. Figure 2 is a composite map on the morning of the first day of very high burning index, and figure 3 is one for 2 days later. The first of this series shows a rather intense high located on the west shore of Hudson Bay with a ridge of high pressure extending southward through the Plains States; a very dry situation for Minnesota and usually Wisconsin and Upper Michigan. The burning index at this time is already high over Minnesota (16.2), and at some stations very high, but the average over the State does not become very high until 2 days later. By then (fig. 2) the high center has

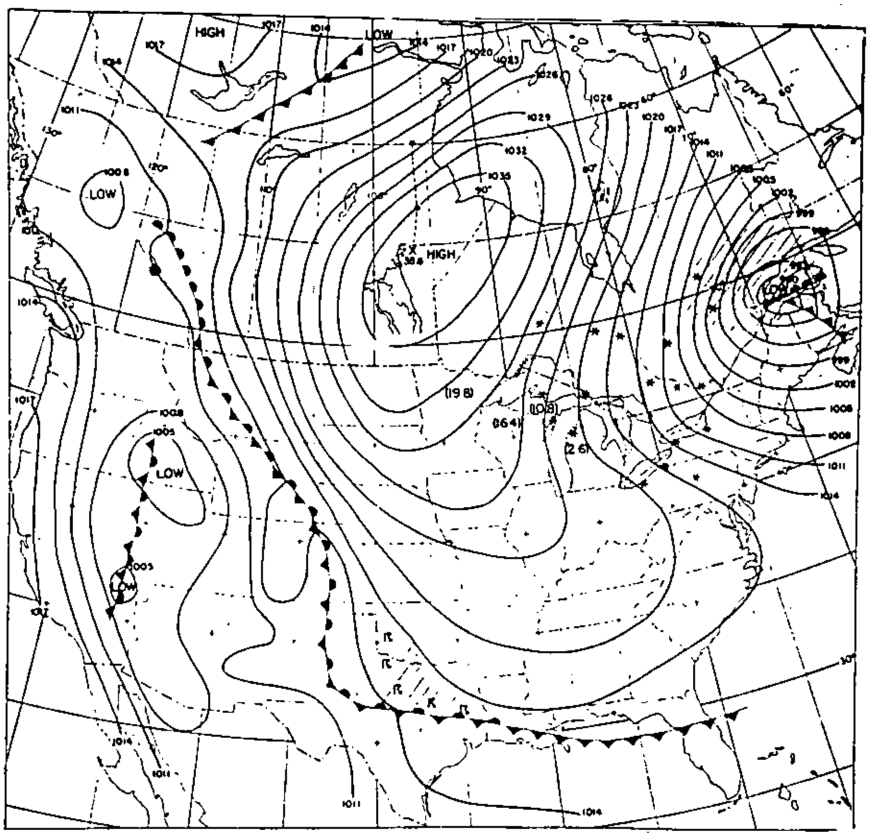

FIGURE 5.—Surface map for 6:30 a. m. May 8, 1947. Past 12-hourly positions of the Hudson Bay high are shown by dots and its path by a dashed line.

moved southward to extreme western Ontario. The high pressure ridge has moved eastward to the Mississippi Valley and has built southward to the Gulf coast. Two days later (fig. 3) the high center has moved to the middle Atlantic coast and diminished in intensity, while lower pressure has moved into the northern plains. The burning index in Minnesota is still very high, but is about to be reduced by rainfall.

Similar composite maps (not shown) for the seven Wisconsin cases of very high burning index were drawn and show generally the same pattern. No composite maps were drawn for the critical periods in Upper and Lower Michigan. Since each of these periods occurred with a weather situation that also produced a critical period in Wisconsin, there is no doubt that a similar pattern would result.

The length of the critical periods in Minnesota ranged from 1 to 6 days with an average of 3½. In Wisconsin the range was from 1 to 5 days with an average of 3, in Upper Michigan 1 to 3 days with an average of 2, and in lower Michigan 1 to 6 days with an average of 3. Usually the period of very high burning index associated with a single Hudson Bay high was 2 to 3 days. During longer periods an additional high passed through or near the Lake States. The second one was either another of the Hudson Bay type or one from northwestern Canada moving southeastward. What usually happened in these

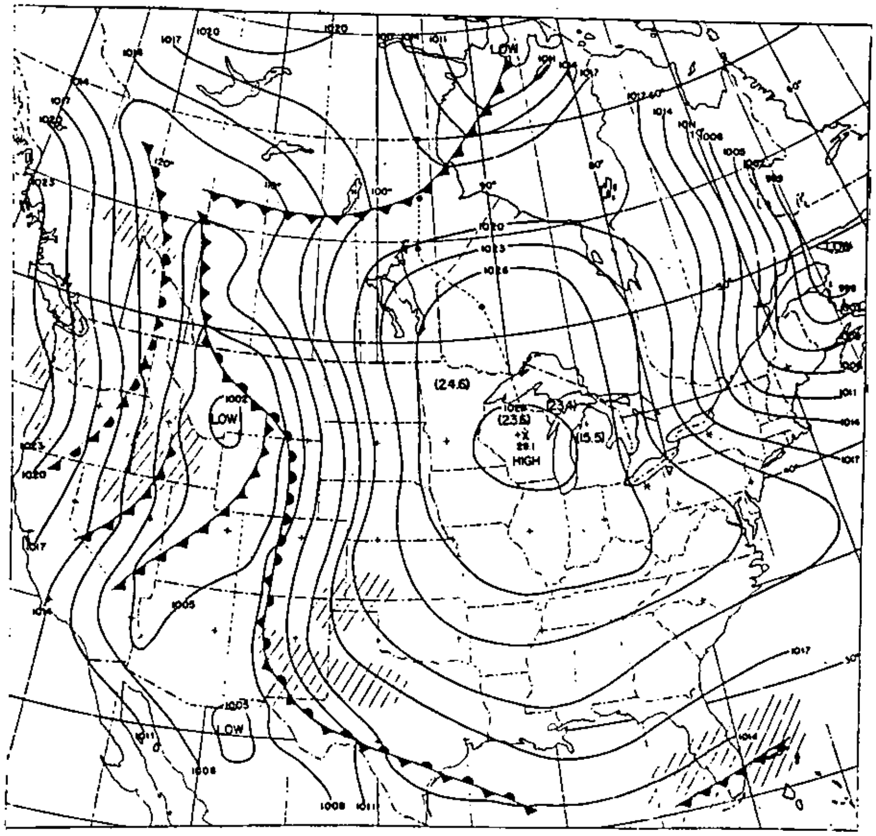

FIGURE 6.—Surface map for 6:30 a. m. May 9, 1947.

cases was that the precipitation following the Hudson Bay high did not cover all of the Lake States, and in the areas where none occurred the burning index remained very high during the passage of the next high.

Previous studies have shown that Hudson Bay highs are more frequent during the month of May than any other month; also that their mean path has a more southerly direction in May than in April. This may account for more periods of very high burning index being found in the Lake States during May than during April.

TYPICAL CASE

A typical weather sequence involving a Hudson Bay high is shown in the 6:30 a. m. sea-level maps for May 7–11, 1947, reproduced in figures 4–8. This weather sequence was chosen because it was associated with a period of very high burning index in each of the Lake States.

On the first day of this sequence the average burning index in Minnesota was already high (13.1); the fire-weather stations in that State having been without measurable precipitation for 3 to 5 days. Stations in Wisconsin and Upper Michigan had been without precipitation for 1 to 4 days, and in Lower Michigan 1 to 3 days. Measurable precipitation was reported at some stations in Lower Michigan as late as the morning of the 8th.

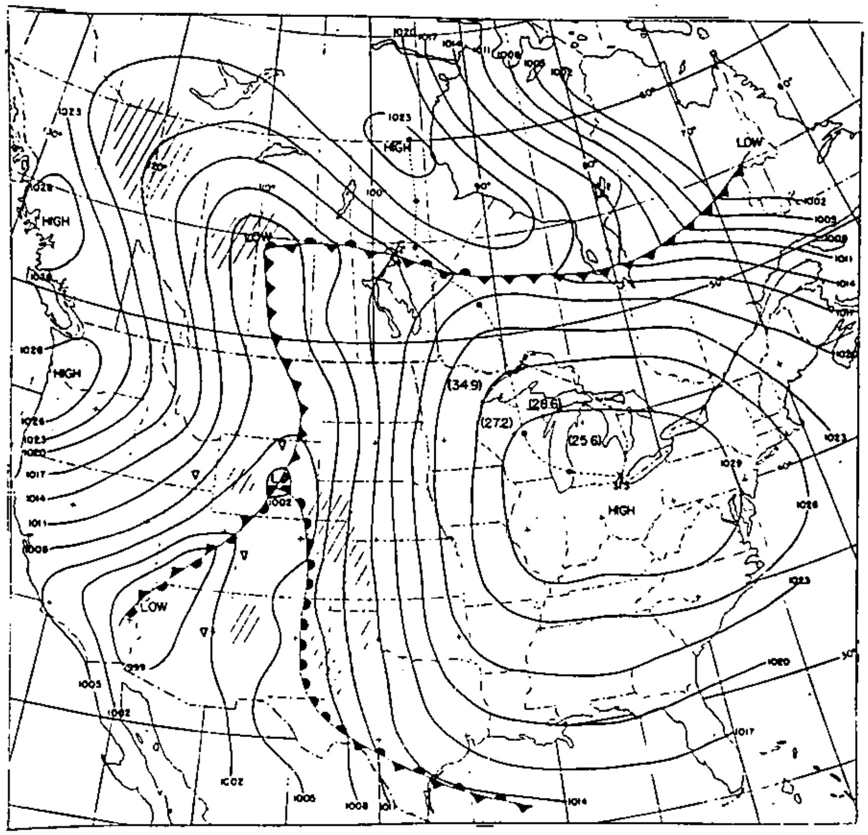

FIGURE 7.—Surface map for 6:30 a. m. May 10, 1947.

As the high moved southward on the 8th, the relative humidities in Minnesota and northwestern Wisconsin lowered; noontime readings being generally in the 20's and 30's in these areas. When the center of the high moved to Wisconsin on the 9th, humidities lowered considerably in both Upper and Lower Michigan and the rest of Wisconsin, being under 20 percent at several stations at the noon reading. The burning index increased correspondingly, reaching the very high classification in Minnesota.

The winds became predominantly southwesterly on the 10th and increased in velocity in Minnesota, Wisconsin, and Upper Michigan, while the humidities changed little or increased slightly. (Winds blow in a clockwise direction around a high with a slight cross-isobar component from high to low pressure. The wind velocity is inversely proportional to the spacing of the isobars; that is, the closer together the isobars, the stronger the wind.) The burning index then rose still more, becoming very high in all of the Lake States. It should be noted that the average burning index in Lower Michigan rose from low to very high in only 2 days.

A trough of low pressure began to move into northwestern Minnesota on the 11th as the high moved southeastward to the Virginias. Dry conditions still prevailed in Wisconsin, Lower Michigan, and portions of Minnesota, but rain at some stations in Upper Michigan and

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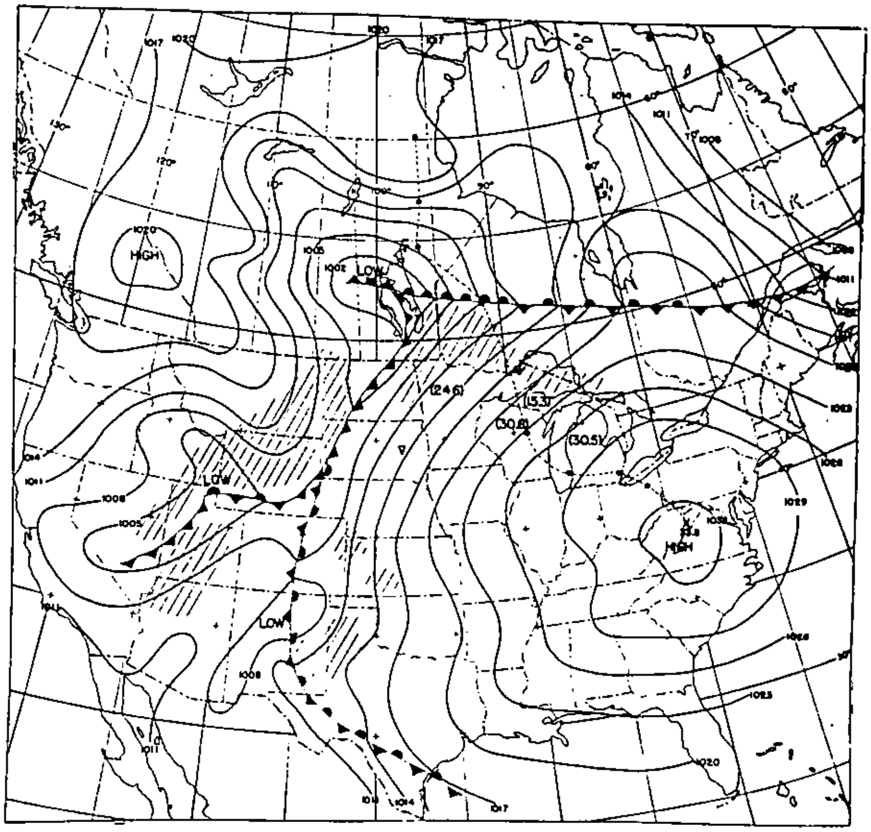

FIGURE 8.—Surface map for 6:30 a. m. May 11, 1947.

Minnesota diminished the average burning index in those two areas. Rain finally reduced the burning index to the low classification, or lower, in Minnesota and Upper Michigan on the 12th and in Wisconsin and Lower Michigan on the 13th (maps not shown).

It is interesting to note the similarity between this typical situation and the composite maps for the Minnesota cases by comparing figures 1, 2, and 3 with figures 4, 6, and 8.

CONCLUSION

This study suggests that the Hudson Bay high is the principal weather type associated with periods of very high burning index in the Lake States in May, although other situations may occur. It is not reasonable to conclude, however, that critical burning conditions associated with Hudson Bay highs do not occur in April.

Knowing the relationship between the Hudson Bay high and the burning index should be an aid in producing longer-range fire-weather forecasts of impending critical burning conditions in the Lake States. The accuracy of the forecasts, however, will be contingent upon the forecaster's ability to foretell the development and movement of the Hudson Bay high.

CHEMICALS FOR FIRE PREVENTION

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California Forest and Range Experiment Station

Propaganda alone will not prevent man-caused fires. Active prevention aimed at fireproofing rights-of-way and other areas of concentrated use is often a greater need.

Annual grasses and weeds are commonly the fuels most susceptible to fire on such areas in many forest regions. Their removal is frequently the only practical way to prevent fires. Hand grubbing, power scraping, burning, cultivating, and spraying with petroleum oils are among the methods used to get rid of fuels. Too often the effects are not what they should be. High costs and the need for annual retreatment result in sporadic and incomplete results. In the search for a cheaper and more permanent method, chemical treatment has been tried and found to be the answer in many cases.

Annual fireproofing is necessary when a regrowth of plant cover must be encouraged each year to hold the soil in place during periods of heavy rains. The objective of chemical treatment is to reduce the yearly cost. Sodium chlorate and polybor-chlorate are used for annual treatment. Long-time sterilization may be used where soil can safely be maintained bare of vegetation. Arsenic trioxide, R. C. A., and Borascu will prevent growth of plant cover for several years and are therefore economical to use.

Sodium chlorate.—Sodium chlorate in water solution is an effective spray for killing annual grasses and weeds. It is quick-acting and comparatively low in cost. It should be applied after heavy rains are over and the need for plant cover is no longer critical. The fireproofing job should be complete, however, before the dry season in order to meet the prevention need. Its sterilizing effects are temporary because it will leach from the soil during the rains preceding the following growing season.

One-half to one pound of sodium chlorate per gallon of water will give complete kill of most weeds and grasses. Heavier dosages saturating lower stems and the ground may be used to kill shrubs and perennial weeds. Some easy to kill species may call for a weaker mixture. Enough solution should be sprayed with enough force on the foliage to thoroughly wet the leaves and stems. Power spray equipment is generally used. The cost of sodium chlorate in California is $107.50 per ton or approximately $5.37 per hundred pounds. Prices may differ in other areas.

Because sodium chlorate is highly combustible when applied to organic material, it should never be used immediately preceding or during periods of high fire danger. Risk to men and equipment through the use of chlorate can be almost wholly overcome by observing strict rules for storing, handling, and applying. The following points from Purdue University Extension mimeograph No. 1 should be kept in mind:

Precautions (when in contact with organic matter sodium chlorate creates a fire hazard):

1. Store sodium chlorate in tightly closed metal containers.
2. Do not spill sodium chlorate in automobiles, trucks, or in buildings.
3. Avoid using sodium chlorate near buildings. On such areas, remove all vegetation and apply material on the soil to reduce fire hazard.
4. Do not allow clothing to become saturated with sodium chlorate solution.
5. Wear rubber boots when applying sodium chlorate.
6. Keep sodium chlorate out of reach of livestock. Do not pasture treated areas until the plants have dried or the material has been washed into the soil by heavy rains.

Hundreds of tons of sodium chlorate are used each year on hundreds of miles of roadside strips and for large scale noxious weed control in California. This demonstrates that it can be used successfully. There have been cases of improper use in dry periods following very light fall rains. A few years ago several fires in southern California apparently were started when passing cars rubbed against roadside weeds sprayed with sodium chlorate. Fortunately, these are rare and can be avoided if good judgment is used in choosing time of application.

Polybor-chlorate.—Polybor-chlorate was developed to eliminate the fire hazard associated with chlorate for use in places where rainfall is very low, dry seasons are long, and fire danger continuously high. Its manufacturers claim a killing strength equal to chlorate when sprayed on foliage in a mixture of 1½ pounds per gallon of water. Although its sterilizing effect on the soil has not been observed past the first year, it is not expected to differ from chlorate. Possible disadvantages include a slightly higher cost ($140 per ton in California) and a poisoning effect on citrus trees because of the addition of boron.

Arsenic trioxide.—Arsenic trioxide (usually called white arsenic) is known to have caused soils to remain sterile for periods of 10 years or longer. Wherever erosion is not a problem and the soil can remain undisturbed after treatment, effects are long-lasting. Treatment should be limited on most soils to slopes under 25 percent. Steeper slopes may be treated if the soil is very stable. White arsenic is usually applied after all annual growth has been cleaned from the area to be treated. The chemical is easily applied in dry powder form by hand or with spreaders at the rate of 4 pounds per square rod on most soils. Coarse sand and heavy red clays require more. It should be put on during the rainy season or set down afterward to prevent wind loss.

The cost in California is 6 to 8 cents per pound. Labor and transportation costs are low owing to the small quantities needed to produce long-lasting effects. Even though white arsenic is a poison, it is not hazardous if reasonable care is used in handling and storing. It does not attract game or wildlife and is therefore not a hazard to them.

A good example of the use of white arsenic is to be seen on the Shasta National Forest. It was applied in April 1940 to bulldozed and hand-cleared fire lines. Forest officers cooperated with the Southern Pacific Company on a project to fireproof their railroad right-of-way. In 1948, 100-percent sterilization was still in effect (fig. 1).

R. C. A. (*razorite concentrate anhydrous*).—R. C. A., or razorite, is a boron ore in granular form which is often used when white arsenic is not available or for some reason cannot be used. Applied by hand or spreaders at the rate of 25 pounds per square rod, it is equal to arsenic trioxide as a soil sterilant. Because R. C. A. is somewhat water-soluble, however, its effects are less permanent; depending on the amount of annual rainfall, it will leach from the soil in 3 to 5 years. Because of its granular form R. C. A. may have some disadvantage where wind loss is a problem.

The cost of $60 per ton, large volume of material to be handled, and the less permanent results make it a more expensive material to use.

Borascu.—Borascu, an unrefined boron ore in granular form, similar to R. C. A., is also widely used. The cost is $35 per ton, but its soil sterilizing strength is only half that of R. C. A., and therefore twice as much material must be applied to do the same job. It may be more readily available than R. C. A. or white arsenic in some areas.

FIGURE 1.—Fire line along railroad right-of-way 8 years after treatment with arsenic trioxide.

FIRE PUMPER TESTING AND DEVELOPMENT

ARCADIA FIRE CONTROL EQUIPMENT DEVELOPMENT CENTER
Region 5, U. S. Forest Service

A continuing project at the equipment development center is pumper testing. Not only are pumps tested as to compliance with specifications, but also any new developments and designs in pumper units that give promise of possible use to the Forest Service are given short test runs. The purpose of the program is to insure that pumpers offered as meeting specifications are adequate for Service needs and that new developments in equipment are immediately available.

Pumpers purchased under existing Forest Service specifications are required to have passed an approval test including a 100-hour operating test. The 100 hours in actual practice represents the approximate operating time that many units are used during a fire season. In effect, it insures that a pumper put into service can be expected to at least perform at rated output and pressure during a season without need of repairs.

Another Forest Service specification requirement tested is that pumps under normal operating conditions should require only 80 percent of the horsepower output of the driving engine when operating at sea level. This requirement is important since the average gasoline engine decreases in horsepower output approximately 3 percent for each 1,000 feet above sea level. We are thus assured that pumpers will operate at rated output up to elevations of 7,000 feet without overloading the engine. Under operating conditions below this elevation, the engine not being operated at peak output can be expected to have a longer service life.

The main equipment used in the tests are recording flow meters, pressure meters, and vacuum meters, which are operated in parallel with indicating gages of the same types. All equipment is calibrated preceding each test run and the purpose of dual instrumentation is to insure that any failure in meters will be immediately apparent and corrected. The complete description of testing equipment and procedure of the tests has been covered in a Pumper Test Procedure Report, which is available at the Development Center.[1] A general view of the test stand is shown in figure 1. The equipment is used, not only to check pumpers, but also to test hose, strainers, nozzles, and any other equipment through which water flows.

Before starting the 100-hour pumper test, a series of runs are made to give data regarding the output of the unit under pressure ranges from free discharge to the maximum pressure obtainable. Runs under varying suction lifts are also made to show the ability of the unit when

[1] Arcadia Fire Control Equipment Development Center, U. S. Forest Service, 701 Santa Anita Ave., Arcadia, Calif.

drafting. This same series of tests is performed at the conclusion of the 100-hour run and the comparison of values before and after are an indication of wear and decrease in efficiency. Units are checked before and afterward for clearances and, if efficiency drops to any great extent, are completely dismantled and checked against manufacturer's specified tolerances.

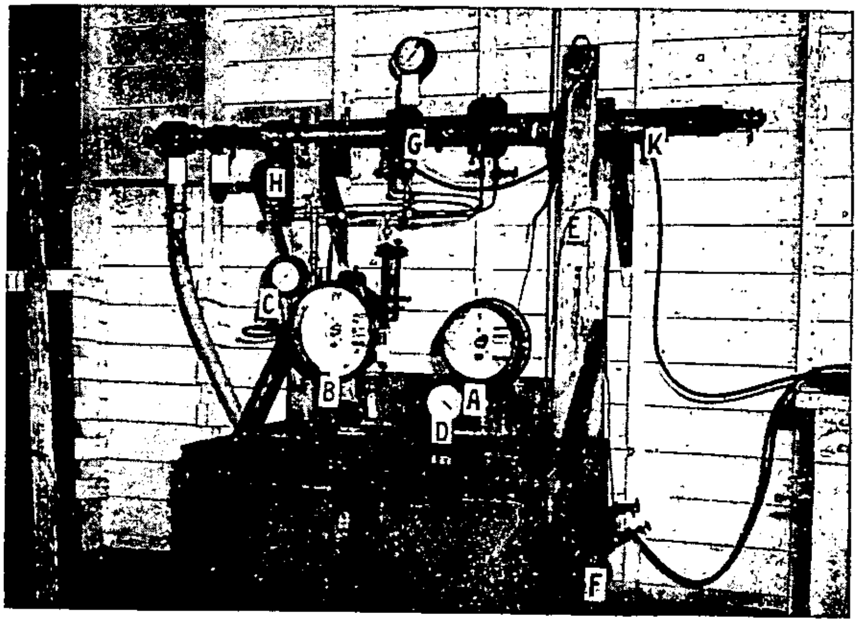

FIGURE 1.—Pumper testing equipment: *A*, Draft (vacuum) recorder; *B*, discharge pressure and rate recorder; *C*, discharge pressure gage; *D*, draft (vacuum) gage; *E*, draft gage (mercury manometer); *F*, hand-operated priming or vacuum pump; *G*, orifice meter piping; *H*, discharge pressure (back pressure) regulator; *K*, intake connection to orifice meter piping.

In performing the 100-hour test, units are run intermittently for the first 50 hours and continuously for the final 50 hours. During intermittent operation, items such as ease of starting, and procedure of starting are noted. The final period is used as an indication of the unit's ability to perform over long periods.

Other pertinent details, such as adequacy of design, fuel consumption, and general suitability for the varying needs of the Service are checked.

In checking new pump designs only the tests that are normally run as preliminary to the 100-hour test are performed. This is usually sufficient to provide proper data that indicates whether or not the unit warrants further investigation.

Many interesting facts have been brought to light as the result of the pumper tests. Of two units submitted by different manufacturers, the volume of water pumped by both was in excess of that which could be efficiently handled by the factory recommended suction and discharge hoses. An increase to the next larger hose size on the suction side increased the volume of water pumped by approximately 10 percent. On the discharge side, an increase to the next larger hose size reduced pressure drop by approximately 90 percent. One unit was redesigned for a lower volume and higher pressure, and on subsequent tests, performed adequately. A change was made in the inlet and outlet fittings of the second unit, which allowed for the use of the next larger size of hose.

Of two other units tested for the same manufacturer, the first by actual weight was 60 percent lighter than the second one and had an output at the same rated pressure approximately 35 percent less. However, the efficiency of the pump and engine was such that when compared with all accessories and with sufficient fuel for 24 hours of operation, the units had approximately the same over-all weight. This indicates that over-all weight for a given operating period, and not weight of the pumper only, should be considered when deciding on what type of equipment is to be used.

To date three units have been 100-hour tested. Two more units are scheduled and will be completed in the near future. The pressure volume rating for the three units mentioned above are as follows:

Pressure (pounds per square inch)	*Volume discharge in gallons per minute*		
	Pump A	*Pump B*	*Pump C*
0 (free discharge)	24	42	18
100	22	39	17
250	18	30	10
310	16	25	--

Complete specifications have been written, under which approximately 85 pumps of the above sizes have been purchased and placed in field operation.

Approximately 10 additional units have been spot-checked. Of these, two merit further study and, after redesign, will again be submitted by the manufacturers.

Fire Guard Improvises Antenna for Handi-Talkie on Project Fire.—The following story is quoted from a letter by Supervisor Kooch of the Salmon Forest, regarding use of Handi-talkie by Ranger Alternate J. G. Denny.

"Our first chance to try out the new Handi-talkie, Forest Service type FS sets, on this district was on the Dutch Oven Fire, with three of the sets in strategic positions on the fire and one on an observation point. They certainly worked beautifully.

"While on mop up on this fire we had two Handi-talkies for communication on the fire and also for communication with the dispatcher in Salmon via Long Tom Lookout.

"We had moved our camp to a more suitable location and somewhere in the shuffle we lost the antenna for one of our Handi-talkies. I experimented with a length of No. 9 telephone wire inserted in the antenna socket. I could send and receive all right but the wire was so loose in the socket that it caused a great amount of static.

"Through inquiry at camp I discovered a short length of antenna from an automobile radio, and a stove bolt of the desired size. By fastening the stove bolt to the antenna with a gob of solder, I had an improvised antenna that would transmit and receive at a distance of more than 10 miles.

"The little Handi-talkie is the answer to a fire fighter's prayer."—FRANCIS W. WOODS, *Communications Engineer, Region 4, U. S. Forest Service.*

Beds 3 feet wide, 30 feet long, and 3 inches deep were prepared for each kind of litter. A fuel-moisture stick was exposed 10 inches above each bed on wire supports (fig. 1). The sticks were weighed to the nearest 0.1 gram on a torsion balance at 4 p. m. daily.

After the sticks were tested over different litters, all of them were exposed over the ponderosa pine needle bed and weighed regularly to measure the variation in individual sticks. Curves were drawn showing the relation of the observed moisture content of each stick to that of the stick over ponderosa pine needles. These curves were then used to correct the observed stick moistures for stick differences.

The data for the stick over ponderosa pine needles were grouped into two broad moisture content classes. Then the average corrected moisture content was computed for the other sticks in each of these two classes. The indicated moisture content at 4 p. m. of these fuel-moisture sticks exposed over 8 kinds of litter was as follows:

Litter type:	*Moisture content (percent)* 3.5–5.9 percent class [1]	6.0–8.4 percent class [2]	Average [3]
Ponderosa pine needles	5.1	6.6	5.7
Oak leaves	5.1	6.2	5.6
Snowbrush leaves	4.9	6.2	5.4
Manzanita leaves	5.1	6.2	5.5
White fir needles	5.2	6.0	5.5
Bitterbrush leaves	5.3	6.1	5.6
Mixed conifer needles	4.7	6.1	5.2
Cured grass	5.0	6.0	5.4

[1] Basis: 13 days. [2] Basis: 9 days. [3] Basis: 22 days.

None of the fuel-moisture sticks exposed over the different litter types used in this study showed any significant difference in indicated moisture content. Morris [2] found that there is no difference in the moisture content of sticks exposed 9 inches and 12 inches above Douglas-fir litter, bare ground, and gravel. It is thus probable that the type of ground cover immediately under fuel-moisture sticks is relatively unimportant when the sticks are exposed 9 inches or more above the surface. Ground cover of some type of dry litter is advisable, however, to keep the sticks from being splashed with mud during heavy rain.

[2] MORRIS, WILLIAM G., EFFECT OF GROUND SURFACE AND HEIGHT OF EXPOSURE UPON FUEL MOISTURE INDICATOR STICK VALUES. Pacific Northwest Forest Expt. Sta. Forest Research Note 30, pp. 5–6. 1940. [Processed.]

CONVERSION OF A MILITARY CARGO CARRIER INTO A TANKER TRAILER

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Among the many vehicles declared surplus by the armed forces is a small trailer, known officially as "Trailer, dump, 2-wheel, ½-ton, air-borne." It was designed for use as a general cargo trailer, and was matched in size, capacity, and tread with the jeep. Most of the repair parts are interchangeable with those of the jeep, especially the running gear. The vehicle is fully covered in Technical Manual TM5-9084. Many of these trailers were sold as surplus items, and fire control agencies will find in them a useful vehicle for conversion to flat-tank water carriers.

During 1947 the Michigan Forest Fire Experiment Station carried out a rather extensive research project dealing with tanker design, in conjunction with the military jeep, the Dodge power wagon, and a number of tanker trailers to accompany them as accessory water carriers. One phase of this work was concerned with the trailer described above, and from it was developed a pilot model that might be of interest to other fire control agencies.

Reference is suggested to TM5-9084, but in case a copy is not available, a brief description and the accompanying photographs might clarify this report. The trailer is manufactured as a dump trailer and the bed is a sturdy metal box manufactured as a single piece. A heavy tail gate is provided to permit use as a dump box. There are no springs on the unit. Full electrical equipment is installed for taillights.

Examination of the box suggests the removal of the tail gate and the substitution of a rear bulkhead welded all around and made watertight. With additional baffle plates, angles, and cross members, the original dump box can be converted into a splendid water tank, with valuable features of design that cannot be found usually in commercial tanks (fig. 1).

For sake of completeness in describing conversions, the following details may be left unchanged:

1. The dumping feature need not be changed, although convenience in the installation of plumbing and intake hoses might determine otherwise.
2. The pintle hook for towing may be retained, if the towing vehicles are equipped with the corresponding hook. Otherwise, some sturdy type of ball hitch is required and the standard ball in the 2-inch size is recommended.
3. Tail lighting fixtures may be retained. The plug will fit into the standard socket supplied on the military jeep. Otherwise, some suitable set of plugs and sockets may be selected as standard between all towing vehicles.
4. The leg pedestal should be left intact.
5. The lack of springs under the bed is no particular disadvantage and need not be corrected.

Possible changes are as follows:

1. If the dumping feature is discarded, remove all mechanism associated with tripping and locking. These are the tail-gate catch, dump release assembly, trip handle assembly.
2. Tail gate must be replaced with a solid steel rear bulkhead, preferably not heavier than ⅛-inch. Fitting the new piece must be accurate to conform to the size and shape of the box, and to permit a watertight weld along all sides.
3. It might be found desirable to replace the pintle eye (lunette eye) with a longer tongue to permit closer turning, or to guarantee necessary clearance if the vehicle is used behind tractors.
4. Install supporting angles for attaching baffle plates. The accompanying photographs show the box divided into six compartments. The location of the angles at top of baffles and along the floor are shown; to these angles the baffle plates are welded, leaving spaces at corners for passage of water from one compartment into the adjoining ones.
5. A flat cover plate must be attached to the top of the tank. The surface angles are tapped, and the cover plate drilled to conform. Attachment is by means of brass machine screws.
6. The rear corners of the tank are outfitted with filler ports; these are equipped with long strainers reaching to the bottom of the tank and are removable for cleaning.
7. To the bottom of the tank, proper flanges must be attached for plumbing the suction lines to pumps.

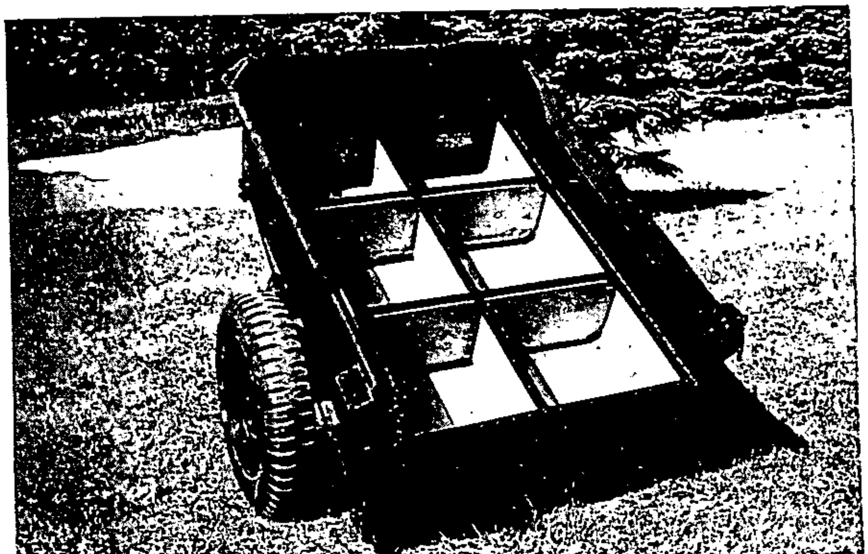

FIGURE 1.—The original trailer box is easily converted. The baffle plates contribute to improved travel characteristics, especially in the absence of springs. The tapped holes for attaching the cover plate are all located in the top surface of the angles. By removing the top plate the interior is easily accessible for repair, refinishing, or cleaning.

The removable top has proved very useful in providing access to the interior for refinishing, repair or seasonal cleaning. Figures 2 and 3 illustrate the fact that deck space is left for items which might have to be carried on top of the trailer.

The flat deck also provides a position for a power pump if desired (fig. 2). If this feature is incorporated in the outfit the unit becomes

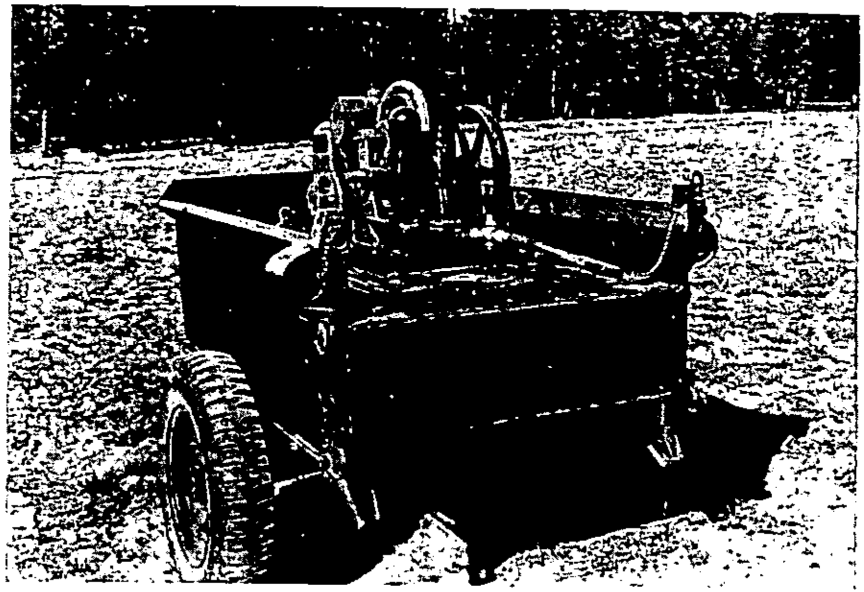

FIGURE 2.—The trailer may be mounted with a power pump on the top deck, in which case it becomes a self-contained tanker. Two filler ports equipped with strainers are provided.

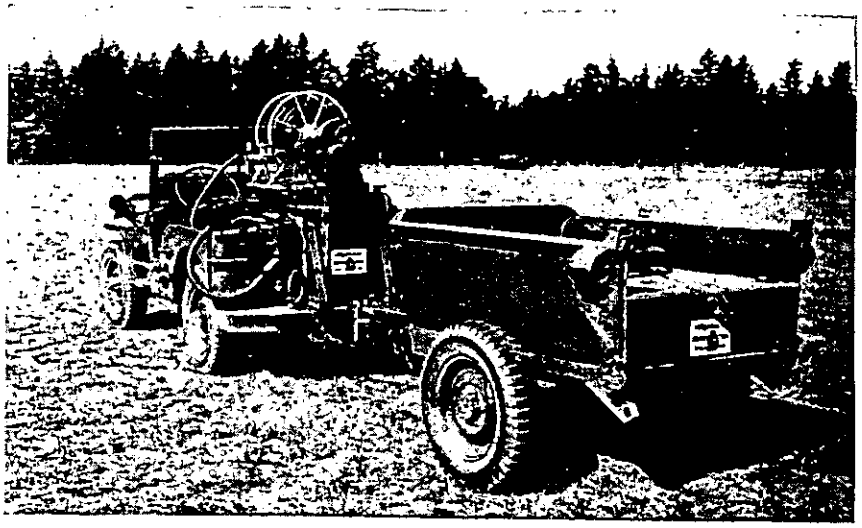

FIGURE 3.—Towed by a jeep the trailer provides 110 gallons of water in addition to that carried in the truck. If conditions of terrain become too difficult to haul the trailer in actual fire fighting, it may be dropped off at will and the water used as tank refill on the jeep truck.

a self-contained tanker, able to work behind any towing vehicle including tractors. The pump illustrated is a Bean Little Giant No. 66, capable of 400 pounds pressure and 7 gallons per minute. Used with a modern spray gun the water is employed most effectively, since the high pressure of the stream produces a strong sweeping action in burning fuel.

If the outfit is used as a water carrier only, a wide variety of combinations is possible. One of these is illustrated with the trailer transported by a jeep (fig. 3). In this case the pump becomes part of the truck and is driven by a power take-off. The jeep is also equipped with a built-in tank of 60 gallons. If the trailer becomes awkward to transport behind a towing vehicle, it may be dropped and its water content employed as tank refills for the truck. This becomes the case in about 50 percent of the fire runs.

It will be found desirable to equip either the trailer or truck unit with a live reel and the usual tool equipment necessary to operate power pumps. One experimental assembly is illustrated; in this instance the entire reel is mounted on a cabinet containing a tool drawer (fig. 4). The entire assembly constitutes a complete unit which may be handled or mounted as one piece, either on the trailer or truck.

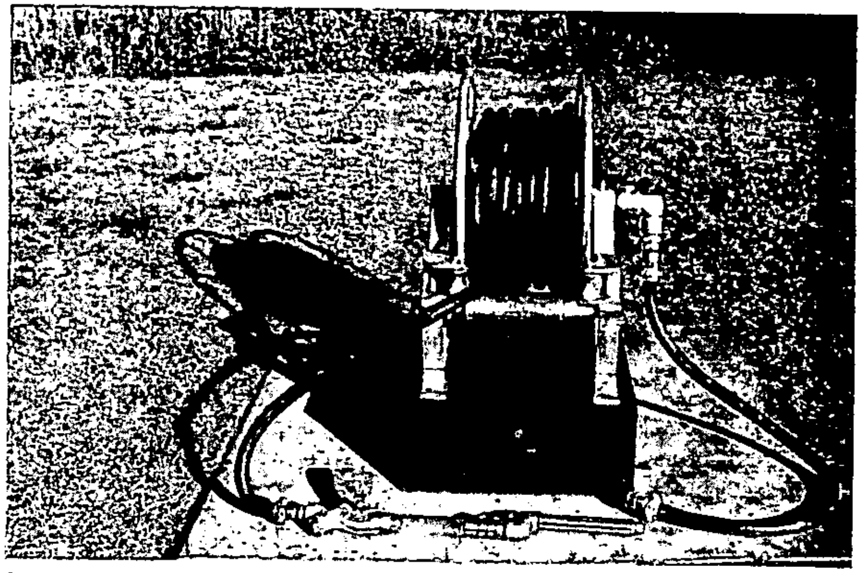

FIGURE 4.—A live reel and tool box unit developed to accompany trailers or tankers of this kind. It may be mounted as a complete assembly, either on the trailer or the truck. The tool equipment includes a complete issue of wrenches, pliers, screw driver, gaskets, hose fittings, and a variety of items required to operate and maintain power pumps.

In trailer tankers of this kind, total water capacity must be decided by the design. Capacity also depends on proposed use and assignment. In the trailer illustrated, it is limited to 110 gallons, although the original box is large enough to provide for a tank of 175 gallons without difficulty and still leave enclosed deck space for other cargo.

Total gross weight with water cargo will approximate 1,500 pounds which permits road use in Michigan without brakes.

Specifications of the original trailer are as follows:

Weight	636 pounds	Length	93½ inches
Height	45½ inches	Width	56 inches

To date, the best use of this outfit, transported by a jeep, is in fast initial attack. The use of high water pressure has been found effective and efficient in the application of small quantities of water. It has also been found that even though the trailer might not be transported behind a truck while fire is being fought, the prompt refill of tanks from the trailer tank insures immediate return of the truck to fire fighting.

In all tanker equipment the problem of refilling at water sources must be solved. In this case an ejector type of tank filler is used. It is operated by the Bean pump at a pressure of 400 pounds. Suction lift is most efficient at 15 feet or less and capacities are as follows:

Suction lift:	*Gallons per minute*
15-foot	20
10-foot	24
5-foot	28

These refill capacities are secured with an input of 6 gallons per minute at 400 pounds pressure.

Three Projects in Process at Arcadia.—The following are three of the projects in process at the Arcadia Fire Control Equipment Development Center.

Ejectors . . . Known also as eductors, injectors, tank fillers, and jet pumps. For use as quick tank fillers they indicate a possibility of filling tanks at from two to three times regular pump capacity. They can also be used for drafting from ponds with tanker up to 200 feet from water source or for drafting on lifts up to 100 feet. Eventual development may eliminate suction hose and reduce danger of pump damage when pumping dirty water.

Small hose . . . With the field trend definitely toward smaller nozzle tips and reduce flow, the use of 1-inch and 1½-inch hose for single streams becomes less necessary. Present study is in friction loss and other properties of hoses from ⅜ inch to 1 inch in linen, high-pressure, and cotton-jacketed rubber-lined. Advantages of small hose are higher allowable operating pressures, lighter weight, less storage space, longer length can be handled by a single man and hose can be had in single continuous lengths.

Back pack . . . A back-pack pump outfit of 4-gallon capacity and having a pump with 8 less parts than present units is being investigated. Advantages noted from preliminary tests include light weight, improved pump, a cost 25 percent less than present commercial models, convenient right- or left-handed use of pump without removing unit from back.—ARCADIA FIRE CONTROL EQUIPMENT DEVELOPMENT CENTER, *Region 5, U. S. Forest Service.*

55-GALLON SLIP-ON PUMPER-TANKER

ARCADIA FIRE CONTROL EQUIPMENT DEVELOPMENT CENTER

Region 5, U. S. Forest Service

The Arcadia Fire Control Equipment Development Center was assigned a project to construct a light slip-on tanker suitable for jeep and pickup installation, for use principally by patrolmen.

The use of small surplus spray rigs (reported in April and July 1948 issue of FIRE CONTROL NOTES), when other equipment was not available, indicated such a unit to be desirable. The basic specifications indicated that it be a complete self-contained unit, as light as possible, high water-weight ratio, and be equipped with a pumper unit with an output of at least 18 gallons per minute at 250 pounds per square inch.

A slip-on tanker meeting these specifications was designed and constructed, using a pumper unit which has met requirements for a light, portable outfit under specification "Portable Pumpers, U. S. F. S. R-5, Model 47, revised October, 1947."

The unit, consisting of a pump and engine and one large box mounted on a water tank (fig. 1), weighs 373 pounds without equipment, and with tank empty. Fully equipped for pumping on a fire, it weighs 950 pounds.

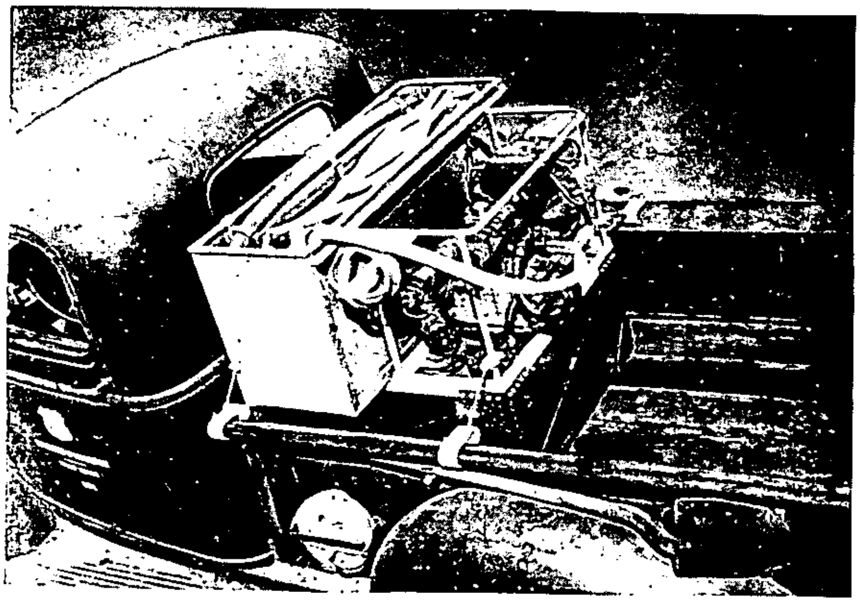

FIGURE 1.—55-gallon slip-on unit mounted in pickup.

The small positive displacement pump is powered by an air-cooled gasoline engine which is rated at 6 horsepower and 2,700 revolutions per minute. The pump and engine make a unit 24 inches long, 16¼ inches wide, and 20 inches high, weighing 96 pounds. The unit is equipped with a rope starter. Following is a table showing pump performance in gallons per minute at various discharge pressures and with 3 feet of water suction lift:

Pressure (pounds per square inch)	*Discharge rate (U. S. gallons per minute)*
0 (free discharge)	25
100	22½
250	18
310	16

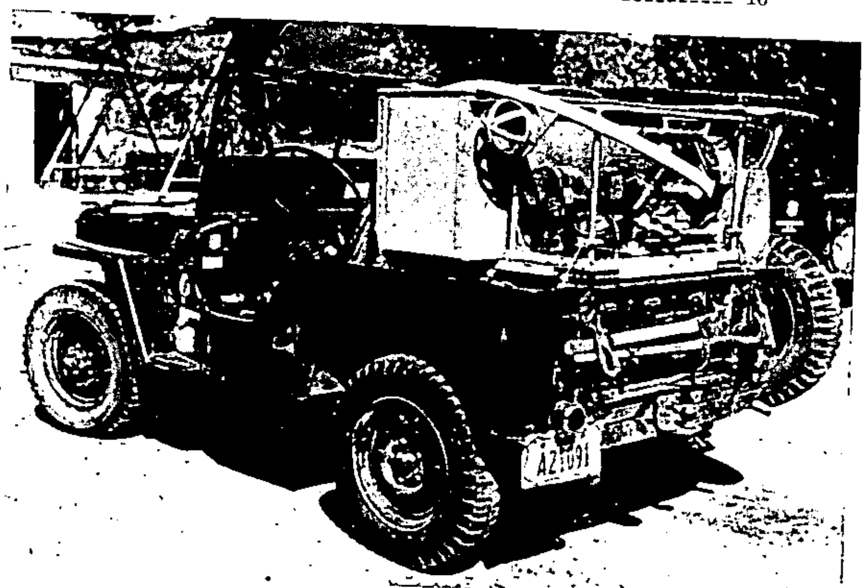

FIGURE 2.—Slip-on unit mounted in jeep.

The 55-gallon water tank is made of 14-gage aluminum alloy. It is 28½ inches wide, 32 inches long, and 14½ inches high. An aluminum box provides space for the 5-gallon gasoline tank, a tool kit, four 4-foot lengths of 1½-inch suction hose, and 200 feet of 1-inch cotton-jacketed, rubber-lined hose. Four clamps and turnbuckles provide a means for rapidly securing the unit to a jeep, weasel, or pickup bed (fig. 2).

The pumper is equipped with four folding handles for use in carrying as a portable pumper. It is mounted on two angle irons at the base, to which the pipe frame is attached. By removing four bolts and disconnecting suction and bypass lines, the pumper can be removed for portable use.

Observations and conclusions.—Based on field use for one season, a combination jeep and pickup unit is not recommended as practical. Because of the dual purpose, design compromises reduce efficiency for the pickup installation. It appears more practical to design separately for the jeep and for the pickup.

Aluminum construction used in both pumps and tank has given trouble due to electrolytic action between aluminum and chemicals in water available in certain areas. Baffles have pulled loose at spotwelds, causing holes in tank. Hard starting and difficulty with pumps freezing can also be attributed to this cause.

When installed in a jeep bed, the aluminum tool and hose box gives the appearance of top-heavy design. Basically, the center of gravity of the loaded vehicle is sufficiently low to insure safe operation. The psychological effect on field men, however, is adverse.

The concensus of field men in several regions indicates that hose baskets, as such, are not satisfactory for general tanker use. A hose reel, preferably live, is more desirable.

Further work is scheduled for this fiscal year on the the design of a unit for the ½-ton pickup only. Additional work on a jeep installation is being carried on by Region 9. For details of the unit described, refer to Specification "Slip-on Pumper-Tanker, U. S. F. S. R-5, Model 48," and Drawing F-2-03 on file at the Equipment Development Center, U. S. Forest Service, 701 North Santa Anita Avenue, Arcadia, Calif.

Use of Firefinder to Measure Fires.—William T. Stephenson, lookout man on Ranger Peak, San Bernardino National Forest, uses his firefinder and a table to determine the diameter of fires.

Table 1 gives for each minute reading on the azimuth circle the diameter in feet of a fire 1 mile away. The table also gives diameters for each degree reading on the azimuth circle.

Example: To determine the diameter of a fire 8 miles away. A sight on one side of fire reads 31°20′. The sight on opposite side of fire is 32°33′. The difference between the two readings is 1°13′; this is the width of fire in degrees and minutes. From the table, 1° gives 92.40 feet, and 13′, 20.02 feet, a total of 112.42 feet, the diameter at 1 mile. The diameter of the fire 8 miles away is 8 times 112.42 or 899.36 feet.

TABLE 1.—*Predetermined diameters of fires 1 mile away by minutes and degrees of angle*

Minutes	Feet	Minutes	Feet	Minutes	Feet	Minutes	Feet	Degrees	Feet
1	1. 54	16	24. 64	31	47. 74	46	70. 84	1	92. 40
2	3. 08	17	26. 18	32	49. 28	47	72. 38	2	184. 80
3	4. 62	18	27. 72	33	50. 80	48	73. 92	3	277. 20
4	6. 16	19	29. 26	34	52. 36	49	75. 46	4	369. 60
5	7. 70	20	30. 80	35	53. 90	50	76. 90	5	462. 00
6	9. 24	21	32. 34	36	55. 44	51	78. 44	6	544. 40
7	10. 78	22	33. 88	37	56. 98	52	79. 98	7	646. 80
8	12. 32	23	35. 42	38	58. 52	53	81. 52	8	739. 20
9	13. 86	24	36. 96	39	60. 06	54	83. 06	9	831. 60
10	15. 40	25	38. 50	40	61. 60	55	84. 60	10	924. 00
11	16. 94	26	40. 04	41	63. 14	56	86. 14		
12	18. 48	27	41. 58	42	64. 68	57	87. 68		
13	20. 02	28	43. 12	43	66. 22	58	89. 22		
14	21. 56	29	44. 66	44	67. 76	59	90. 76		
15	23. 10	30	46. 20	45	69. 30	60	92. 40		

THE TABER BRUSH CUTTER

W. S. Taber
State Forester, Delaware Forestry Department

Two brush cutters suitable for Coastal Plain terrain or similar soil and vegetative conditions have been constructed, specifically for the Clarkaire tractor, by the Delaware Forestry Department. One of the brush cutters is permanently attached to the pusher arms or A-frame (fig. 1), the second is bolted on at three points (fig. 2).

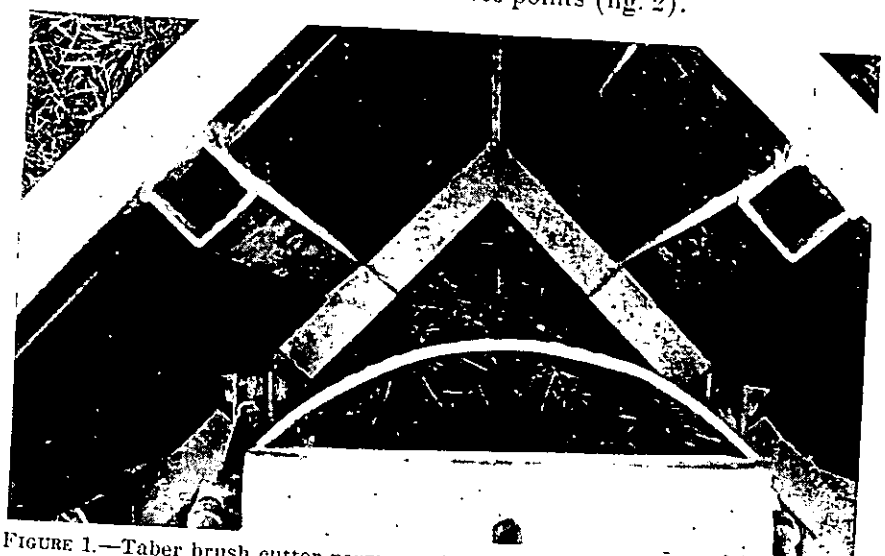

Figure 1.—Taber brush cutter permanently attached to A-frame. (Photographs by Delaware State Forestry Department.)

The Clarkaire tractor has sufficient power to cut off live trees up to the protruding width of the blade which in our case is 3½ inches. By making a pass on either side of a larger tree, trees up to 7 inches butt diameter may be severed.

The brush cutter uses hard steel-backed paper knives ⅞ inch thick and 5½ inches wide. The knives are welded to a framework of 3- by 3- by $\frac{3}{16}$-inch cold-drawn seamless tubing and 16-gage sheet iron. This framework is welded to the A-frame or provision is made for bolting. The vertical nose is also made from a paper knife and serves to cut briers (fig. 3). Angle irons, 3 by 3 by ¼ inches, are welded to the posts, knives, and sheet iron for further strengthening. A 3-inch skid shoe at the point of the bottom knife keeps it from digging. Cost of construction per brush cutter is $20 for paper knives, $35 for square tubing for posts and top rail, $15 for 16-gage sheet iron and other odds and ends, and $70 for welding.

The radiator guard illustrated in figure 1 is made by splitting a perforated hammer mill screen in half, welding the halves in the center, and skip-welding the guard to the outer radiator shell. Screen material is $\frac{3}{16}$ or ¼-inch thick and is reinforced with ½-inch iron round rods at top and bottom. Cost is $10.

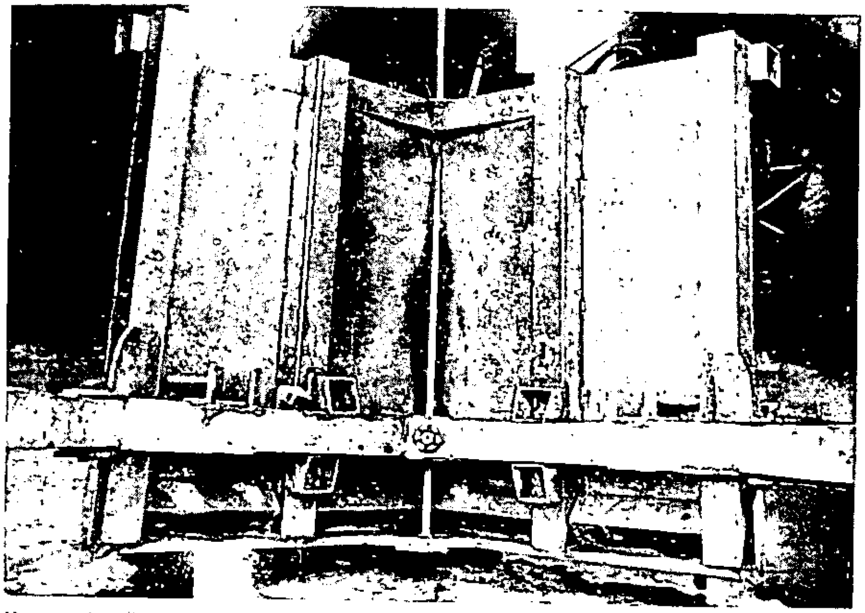

FIGURE 2.—Slip-on brush cutter with A-frame in place; bolt in center is a 1-inch clevis bolt which straddles vertical knife.

FIGURE 3.—Taber brush cutter depends on sliding action of knives. Note slant of vertical knife.

250-GALLON SLIP-ON PUMPER-TANKER

ARCADIA FIRE CONTROL EQUIPMENT DEVELOPMENT CENTER

Region 5, U. S. Forest Service

Recent trends in the Forest Service have been toward the use of slip-on and demountable tankers to replace conventional fire trucks. In general, fire trucks, whether in use by the Forest Service, State, county, or city fire departments, become obsolete even though actual vehicle mileage is low. The solution of this problem, particularly for those areas not having a year-round fire season, appears to be slip-on pumper-tankers. These can be readily transferred to any truck and, as a result, maximum utilization of vehicles is obtained. A slip-on unit of this type, built in 1948 for stakeside trucks in the 13,500 gross-vehicular-weight class, is shown in figure 1. The improved unit shown in figure 2 was built in the spring of 1949.

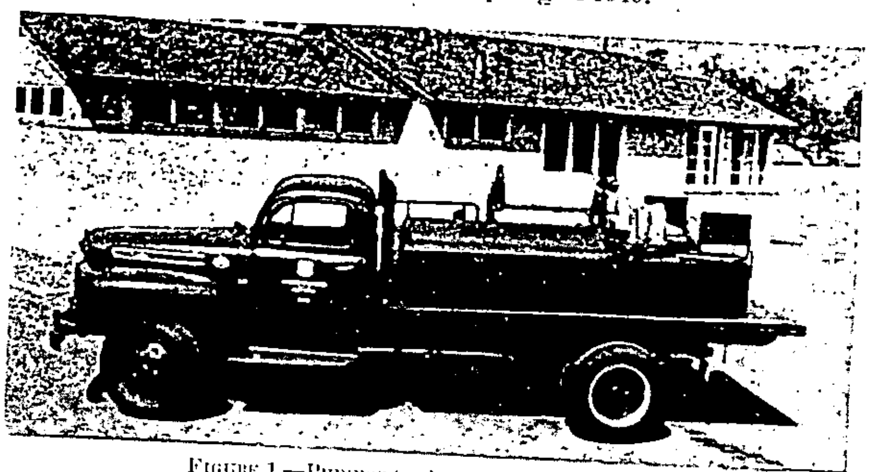

FIGURE 1.—Pumper-tanker unit built in 1948.

The 1949 unit consists of a tank; pumper; live hose reel; tool, hose, radio, and equipment boxes; and hose basket mounted on a skid frame. The unit can be made self-contained, having as extras its own batteries, lighting system, siren, spotlight, and red light. It is fastened to the chassis frame of the vehicle with four J-bolts. Seating accommodations for two crew men are provided.

The over-all dimensions of the unit are 10 feet 11 inches long, 6 feet 7 inches wide, 2 feet 5 inches high, to top of fill spout. The empty weight, without water, hose or fire tools, is 2,095 pounds. Filled, equipped with all fire-fighting equipment listed further in this article, and including two crew men in the seats, the unit weighs 5,290 pounds.

The pumper unit used has a rated capacity of 30 gallons per minute at 250 pounds per square inch, 45 gallons per minute at free discharge, and 23 gallons per minute at a maximum pressure of 340 pounds per square inch. It is a positive displacement gear type, driven by a 10-

horsepower, opposed twin cylinder, air-cooled, four-stroke cycle engine. The unit is electrically started, being equipped with a 12-volt starter generator system. Provision is made for emergency rope start. The pumper unit is also available with rope start only. The space allotted for the pumper is sufficient to allow for the installation of other types of pumpers, such as higher or lower pressure gear, piston, or centrifugal type units in the comparative weight class. The pumper unit used weighs 192 pounds.

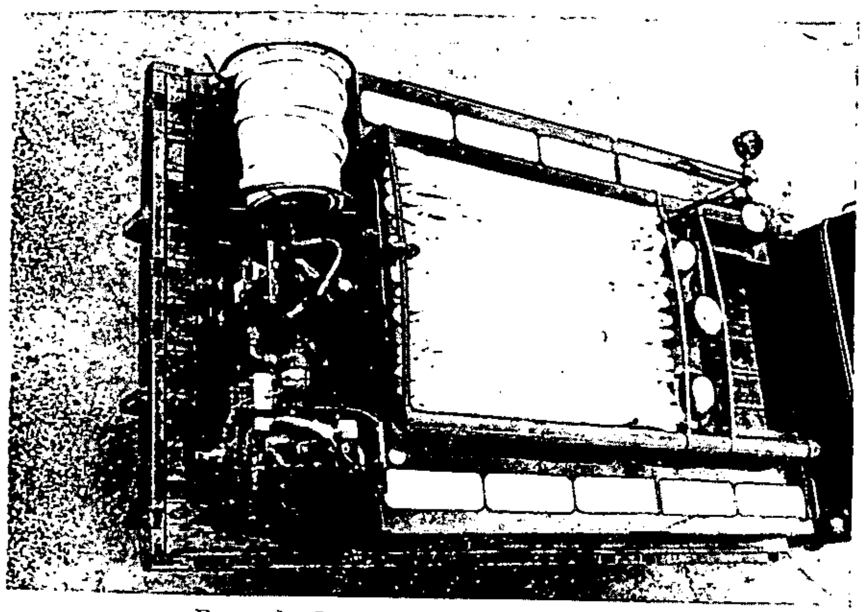

FIGURE 2.—Pumper-tanker unit built in 1949.

The 250-gallon tank, constructed of 14-gage black iron, is divided into three compartments by two transverse baffles. For ease in fabrication, cleaning, and painting, the entire top cover is removable. The tank is 6 feet long, 3 feet wide, and 22 inches high. The hinge-capped fill spout has a 16-mesh strainer. Other tank openings are 1½-inch for suction and fill, and 1-inch for drain, vent, and relief valve return. After fabrication and testing, the interior of the tank is sandblasted and given three coats of a sanitary rust preventive paint. Gage cocks, with plastic tubing, are provided at the rear end of the tank to show the water level.

All operating valves and piping are mounted as a single assembly adjacent to the pump. Valve handles, pressure regulator and pressure gage are mounted on a panel board. Suction connection from pump and tank to pipe assembly is by means of 1½-inch hose. A 16-mesh strainer is provided in the overboard draft line. A combination panel and red light is mounted on top of panel.

The high-pressure hose reel will accommodate 250 feet of 1-inch cotton-jacketed rubber-lined or ¾-inch high-pressure hose. Hose reel is constructed to withstand an operating pressure of 800 pounds per square inch. The reel is equipped with an eccentric type quick-throw friction drag brake, and a geared crank for winding in the hose. Figure 3 is a closeup of the rear, showing pumper, control panel, and reel.

There are four equipment boxes, two mounted on each side of the tank. They are mounted on T-iron outriggers fastened to the main frame. If desired, either or both of the forward boxes could be replaced with hose reels. On the right side (fig. 4) the forward box has been left empty for use in carying crew's duffel, additional hose, or equipment. The rear box is used to carry fire tools, flashlights, fuses, etc. The fuel tank for the pumper is installed in this box.

On the left side (fig. 5) the forward box is used to house the storage batteries and for the installation of radio equipment. The rear box is used to store nozzles, strainers, adapters, and additional hose.

At the forward end of the unit, between the boxes, two crew seats are installed. In this position the men are fully protected by the vehicle cab in front and the boxes on the side. In most vehicles a small amount of forward vision is available through the rear window of the cab. As shown in figure 6, the seats are low and, in this position, it is unnecesary to provide safety straps for the crew. Space is available between the back of the seats and the front of the tank to accommodate four 1-gallon canteens. Design revision scheduled for this fiscal year will provide alternate design to accommodate three men.

Four 8-foot tubes, two to the side, are mounted on the tops of the equipment boxes. These are for storage of the suction hose. The 1½-inch suction hose is easily removed from the forward end of the unit. These tubes also form the sides of the hose basket on the top of the tank.

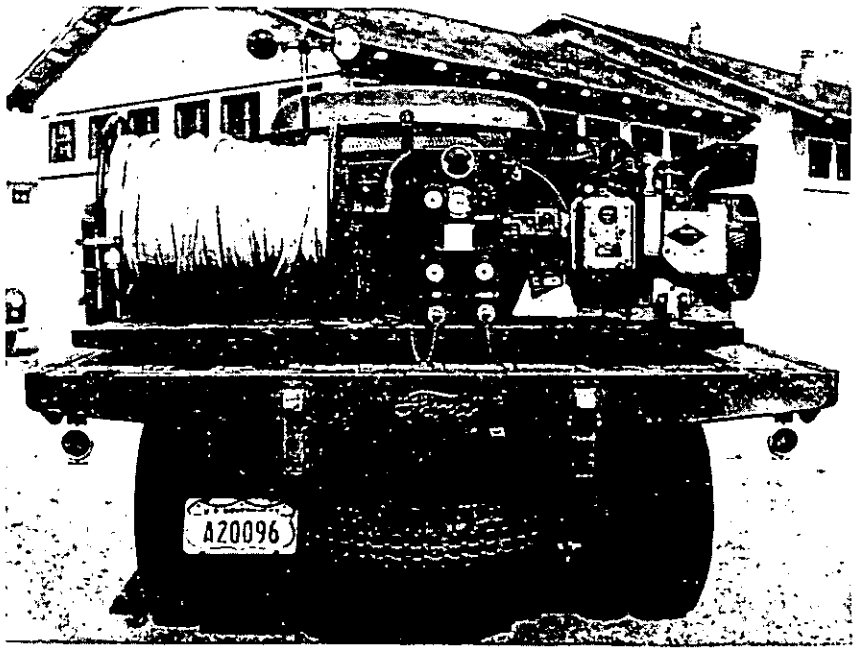

FIGURE 3.—Slip-on unit showing live reel, control panel, and pumper.

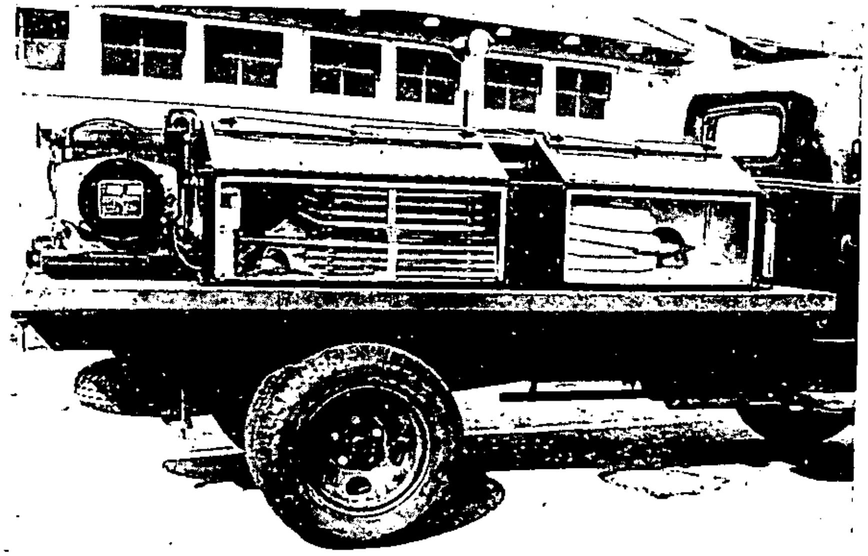

FIGURE 4.—Equipment boxes on right side of unit.

The top hose basket (fig. 2) accommodates 250 feet of 1½-inch cotton-jacketed, rubber-lined (CJRL) hose, laid in accordion fashion. Expanded metal on angle-iron frames is used to form the ends of the basket. Oak slats are installed over the tank to serve as the basket bottom and to allow for air circulation under the hose.

For maximum safety, adequate guards have been installed over engine flywheel and the muffler. Nonskid surfacing has been applied to the tops of the equipment boxes. Grab handle has been installed on top of box to facilitate boarding and leaving vehicle. A red spotlight and a white spotlight have been mounted on an extension pole at the front of the tank. These lights swing through 360° independently and can be used for warning, as well as locating items in the vicinity of the vehicle. By means of the extension pole, the lights can be raised sufficiently to shine forward over the cab of the vehicle. The siren is operated by means of remote cable and push button controls mounted in the truck cab.

To facilitate engine maintenance and operation, brass plates containing necessary instructions are mounted on pumper and valve panel. Valves are further identified by numbering, to tie them in to the operating instructions. All parts of the unit used in normal operation that cannot be reached from the ground are accessible from the space in front of the crew seats.

This unit is intended for use as a primary first attack tanker operated by a crew of four men. It carries sufficient hand tools to outfit a crew of at least eight men.

In April 1949 bids were let by Region 5 for construction of 12 of these units. The low bids were approximately $1,350 for the unit, less pumper, and $575 for the pumper unit. Hose, fire tools, backpack pump, and other equipment cost approximately $750.

The list of equipment furnished for the unit is as follows:

1 Set of tools for engine and pump.
1 Back-pack pump, complete.
4 Lengths of suction hose, 1½-inch (8-foot lengths).
1 Strainer for suction hose.
1 First aid kit.
4 Hats, protective.
1 Siamese valve, 1½-inch.
11 Lengths hose, CJRL, 1-inch (50-foot lengths).
10 Lengths hose, CJRL, 1½-inch (50-foot lengths).
3 Shovels, size 0.
2 Axes, double-bitted.
2 Brush hooks.
1 Fire extinguisher, 1½-quart.
1 Wrecking bar.
1 Bolt cutter.
2 Garden hose nozzles.
4 Spanner wrenches.
2 McLeod tools.
2 Pulaskis.
4 1-gallon canteens.
1 Automatic check and bleeder valve.
2 Nozzles, shutoff, twin tip, with fog and solid stream tips.
3 1½-inch to 1-inch adapters.

This unit (fig. 2), being the second model of this class, shows considerable improvement over the original unit (fig. 1). With the experience gained in two seasons' use of this equipment, we are preparing final plans and specifications which will be but slightly improved over this 1949 model. Alternate pumper and piping layouts are being prepared. A new live hose reel is being planned, to facilitate paying out of the hose to the sides of the vehicle. Crew seats are being redesigned to accommodate three men. We are also working on the design of a larger tank for use in those areas where mountain

FIGURE 5.—Equipment boxes on left side of unit.

FIGURE 6.—Front end of unit showing seats for two men, space behind seats for canteens, and the four 8-foot tubes for storing suction hose.

grades and off-road terrain are not as severe as they are in the western regions, and loading to the maximum gross vehicle rating can be made without sacrificing speed and maneuverability.

The construction of this 250-gallon slip-on pumper-tanker is covered under Arcadia Fire Control Equipment Development Center Drawings Nos. F-17-01, F-17-02, F-17-03, F-17-04, F-17-05, and F-1-10; and Specifications "1½-ton Slip-on Tanker, U. S. F. S. R-5, Model 49," and "Live Hose Reel, U. S. F. S. R-5, Model 48, revised March 4, 1949, Size 3." The pumper unit is covered by Specification "Portable Pumper, U. S. F. S. R-5, Model 49 (30 gpm at 250 psi, 4-stroke cycle gasoline engine, battery ignition, electric start)." Plans and specifications are available at the Arcadia Fire Control Equipment Development Center, U. S. Forest Service, 701 North Santa Anita Avenue, Arcadia, Calif.

MECHANIZED FIRE FIGHTING ON A GULF COAST RANGER DISTRICT

Russell E. Rea

Assistant Chief of Fire Control, Region 8, U. S. Forest Service

The advantages from applying mechanized fire equipment to the fire suppression job are becoming more and more evident. It has reached a high stage of development in the coastal flatwoods belt stretching from North Carolina to Florida and around the Gulf Coast to Texas. Some of the results can best be shown by analysis of its use on a typical coastal ranger district. Developments on the Biloxi Ranger District of the Mississippi National Forests offer a measurable example.

One hundred fires occurred on this District during the period January 1 through September 15, 1949. Total acreage burned was 1,019 acres, an average of about 10 acres per fire. Total length of line constructed to control the 100 fires was 4,357 chains; 3,826 chains, or about 88 percent of this line, were constructed with mechanized equipment.

The Biloxi Ranger District has a protection area of about 200,000 acres. It is predominantly flatwoods type with longleaf-slash pine and a fast burning ground cover of grass and underbrush. Fire occurrence and area burned during the period January 1 through September 15 are as follows for 1945–49:

Year:	*Fires (number)*	*Total acreage burned (acres)*	*Average size of fires (acres)*
1945	90	4,800	53
1946	288	6,107	21
1947	295	6,594	22
1948	158	3,747	24
1949	100	1,019	10

Decreasing acreage subsequent to 1947 directly reflects the development of mechanized equipment. This ranger district has six Ranger Pal plows, one Mathis plow, and one Dodge power wagon tanker. Ranger Pal plows are transported on 1½-ton stake trucks. The Mathis plow is transported by semitrailer.

Both the Ranger Pal and Mathis tractor-plow outfits are described in detail in the U. S. Forest Service Fire Control Equipment Handbook. The Dodge power wagon is equipped with a 180-gallon water tank and package unit power pump. All transport equipment is equipped with 2-way mobile FM radio.

Mechanized equipment has largely displaced manpower on this ranger district. Individual fire records for the 100 fires in 1949 show that the maximum number of men used on any one fire was 15. Thirty-eight fires were handled with only 3-man crews and the average number of men per fire was 5. Ninety-eight of the 100 fires were of incendiary origin, varying in the number of sets from 1 to 18. The average number of sets per fire was 3. Forty-one fires were recorded as having only one set.

Tractor-plow outfits are strategically distributed over the protection area to facilitate quick attack. Small fires are handled with one outfit; large fires or ones with multiple sets are handled with two or more outfits. Actual use of equipment on the 100 fires is as follows:

Equipment used:	*Number of fires*
1 plow	53
2 plows	26
3 plows	3
4 plows	1
1 power wagon tanker	3
1 plow and tanker	5
2 plows and tanker	3
Hand tools only	6
	100

Occurrence of fires by fire danger classes is shown below. The longleaf-slash pine danger meter, used on this area, rates fire danger in five classes: Class 1 is practically no fire danger, Class 2 low, Class 3 moderate, Class 4 high, and Class 5 extreme.

Class fire day:	*Fire occurrence*
1	0
2	8
3	43
4	37
5	12
	100

The 6 fires suppressed by hand tools were handled when conditions did not necessitate mechanized equipment. Total area burned by these 6 fires was 4 acres. Ninety-one fires were suppressed at less than 25 acres each. Of the 9 fires exceeding 25 acres in area, only one exceeded 100 acres in size, having a total area of 126 acres.

These figures tell their own story of reducing the average size of fire from 53 acres to 10 acres in a 5-year period. It should also be added that mechanized equipment is only as effective as the skill of the operators and crews who use it. Experienced and well-trained crews and an alert and well-trained fire dispatcher are necessary in order to handle equipment in the manner required to produce this excellent fire suppression record.

PNEUMATIC BACK-PACK FLAME THROWER

ARCADIA FIRE CONTROL EQUIPMENT DEVELOPMENT CENTER

Region 5, U. S. Forest Service

A pneumatic back-pack flame thrower, using Diesel oil, has recently been designed and submitted for tests to the Arcadia Fire Control Equipment Development Center. It is a result of service requirements suggested to manufacturers for the construction of a flame thrower using straight Diesel oil, that would operate satisfactorily at pressures between 40 to 100 pounds per square inch.

In the past, the difficulty encountered with Diesel flame throwers has been in hand pumping the tank to high working pressure and in maintaining pressures required to produce the desired flame. Previous units would not operate satisfactorily at pressures under 70 pounds per square inch when using straight Diesel oil. In order to overcome the need for high pressures a mixed fuel containing part Diesel oil and part kerosene was used. This allowed for operation at from 40 to 60 pounds per square inch. However, the length of flame projection with the mixed fuel was approximately 50 percent of that obtained with straight Diesel oil. Variations in the mixture of oil and kerosene and the possibility of a dangerous oil gasoline mixture made the units undesirable. The further requirement of a separate fuel and containers further complicated the use of this type of equipment. Also the firing gun became too hot when in continuous operation and its use was restricted to intermittent firing only.

The new back-pack flame thrower consists of a tank, air pump, firing gun, shoulder straps, hose and hose connections, filler cap and pressure gage (fig. 1).

The unit fits into a space 10 inches square and 25 inches high. It weighs 18¼ pounds empty and 47¼ pounds with the 4-gallon tank full of Diesel oil.

The tank, which is 9 inches in diameter and 24 inches high, is made of 61 ST aluminum alloy sheet welded to sand cast aluminum head and base, and is tested to 250 pounds per square inch. The top head of the tank is constructed so as to prevent complete filling of the tank with oil, thus maintaining a safe minimum air chamber.

The firing gun which is 24¼ inches long, consists of an aluminum alloy tube having a pistol grip type of handle with a trigger-operated nozzle valve on one end an a flame igniter cap with asbestos wicking secured in the base on the other.

The hose connecting the firing gun to the fuel tank is provided with a coupling of the quick-disconnect instant shut-off type.

To provide a rapid and easy means of pumping up the fuel tank, a pneumatic tire type pump, with a 20½-inch stroke and 1⅜-inch diameter, is attached on the outside of tank by means of metal bands.

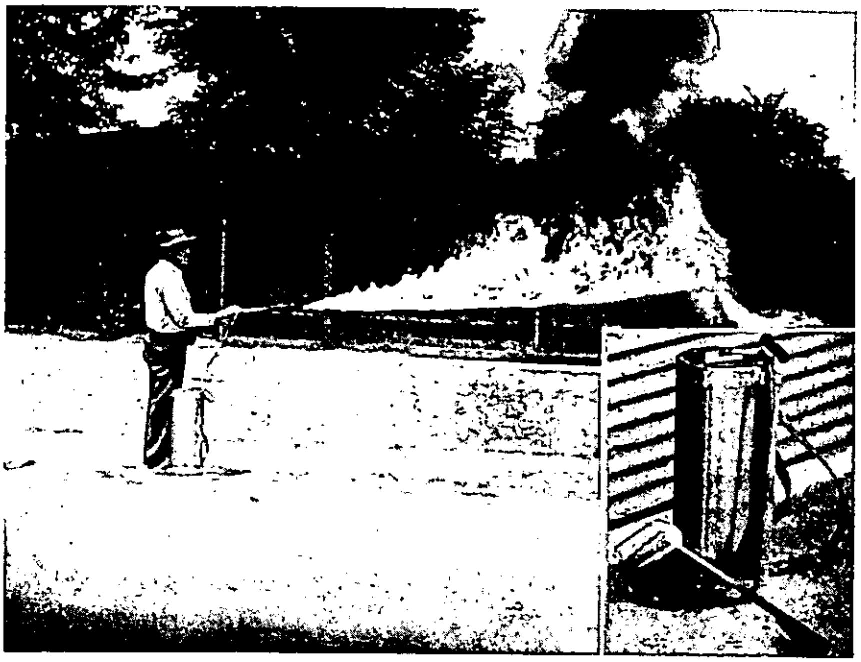

FIGURE 1.—Pneumatic back-pack flame thrower.

D-rings to which back-pack straps can be attached, are welded onto these bands.

Tests were conducted to determine: (1) Length of time and the effort required in pumping the tank up to working pressures; (2) rate of pressure drop when operating; (3) rate of fuel consumption; (4) amount of unburned fuel deposited on the forest fuel to sustain fire; and (5) length of flame projection at various pressures.

Test results were as follows:

(1) After the tank had been filled with Diesel oil to the prescribed level (4 gallons), 57 strokes of the pump were required to produce 50 pounds per square inch pressure. One hundred pounds per square inch pressure was obtained by 122 strokes in 1 minute and 50 seconds, without undue effort.

(2) After a pressure of 100 pounds per square inch was obtained in the tank, the flame thrower was operated for 4 minutes before the pressure decreased to 40 pounds. At this point 2 gallons of oil had been discharged.

(3) Fuel was consumed at the rate of 0.6 gallon per minute at pressures of 80 to 100 pounds per square inch, 0.53 gallon at 60 to 80 pounds, and 0.45 gallon at 40 to 60 pounds.

(4) One advantage of a Diesel flame thrower is that all the fuel oil is not consumed in flight and sufficient is deposited on the surface to maintain the flame. At 100 pounds per square inch pressure, practically all of the Diesel oil is consumed in flight if flame is allowed to travel its maximum distance. If directed on objects 12 to 14 feet distant, however, some Diesel oil is deposited, which, coupled with a hot

flame, produces good ignition. At 80 pounds per square inch a noticeable amount is deposited, and at 40 pounds sufficient oil remains on the forest cover to maintain the flame even under adverse burning conditions. Flame can be maintained by the torch down to a pressure of 20 pounds per square inch.

(5) Length of flame projection for various pressures is as follows:

Pressure (pounds per square inch)	*Approximate distance (feet)*
100	12–20
80	10–14
60	8–10
50	6–8
40	6–8
20	2–4

The following conclusions were made:

This flame thrower can be used for continuous firing, completely discharging a tank of fuel, without the firing gun becoming excessively hot.

An adequate air pump provides a rapid and easy means of supplying sufficient working pressures.

Diesel oil alone can be used to project a flame 6 to 20 feet at pressures from 40 to 100 pounds per square inch, respectively.

The 4-gallon tank of Diesel fuel will provide constant firing for 6 or 7 minutes at 80 to 100 pounds pressure or for 9 to 10 minutes at 40 to 60 pounds pressure.

When burning conditions are such that a deposit of oil to aid burning is not required this torch can be used as a drip or orchard torch. Under this condition only enough oil is discharged to maintain flame on the asbestos igniter pad of the flame tip. This requires a short blast every minute to maintain flame on wick, and under this condition of operation, the unit has sufficient capacity for from 2 to 4 hours of operation on a single filling.

From test operations it appears that the most desirable operating range is from 40 to 60 pounds pressure. At this pressure range flame projection is adequate, flame characteristics are good, and sufficient fuel is deposited to help sustain fire.

The unit as a whole is lightweight, sturdy, and safe.

Of the pneumatic flame throwers tested to date this unit most nearly approaches the desired operating characteristics for this type of equipment. The present cost of the unit f.o.b. Arcadia is approximately $45. Further information on this unit may be obtained from the Arcadia Fire Control Equipment Development Center, U. S. Forest Service, 701 North Santa Anita Avenue, Arcadia, Calif.

THE ACTUARIAL METHOD OF FIRE SUPPRESSION PLANNING AS APPLIED TO TANKER DISTRIBUTION

RALPH L. HAND

Division of Fire Control, Region 1, U. S. Forest Service

The Region 1 fire suppression plan is somewhat of a new departure in that it is based primarily on actuarial principles. The object is to determine the probable load in terms of the expected use of manpower, overhead, power equipment, transportation, warehousing, and all other elements that are necessary to do a satisfactory, economical job of fire suppression. The use of mass statistics has been eliminated in favor of the individual fire analysis and the calculation of mathematical betting odds has been selected in preference to the time-honored employment of averages which has long since proved meaningless in dealing with the various combinations of unpredictable conditions that make up the fire problem.

Three years ago, at the beginning of the planning project, it was decided that a cross-section sampling of 6 representative years of the previous 16 would be used in the individual fire analysis; the reason being that a long continuous run would be too costly and require too much time. This idea proved erroneous and the following year saw the conclusion of a 16-year run involving some 23,000 individual fires with no more than a couple of weeks required for the analysis on each individual forest. In this analysis, a post mortem was conducted on every fire—not to discover errors in the action as taken—but to reconstruct each particular fire in the light of the present day as regards physical conditions, policies, and a realistic view of the human element. Each fire was considered as to the practicability of using bulldozers, tankers, chain saws, trenchers, pumpers, smoke jumpers, or any other special equipment or techniques of suppression. In each instance where a fire was placed in a special category, certain information was calculated and recorded. This included time from the nearest logical base; percentage of line that could be machine built; and reduction in manpower, perimeter, and time of control by reason of the application of special equipment or methods.

The value of the analysis increases in direct proportion to the knowledge and practicability of those making the decisions and to maintain consistently high standards it is necessary to insist that top fire control men from each forest be given a leading part in the planning for their unit. To insure uniformity, a fire planning specialist from the regional office likewise participates on every unit. Obviously, it is necessary to eliminate from the record those fires in which the specific cause no longer exists in that particular area.

The application of the findings, as determined from the analysis, requires separate treatment for each of the various categories and each has its peculiar problems. The Region 1 Tanker Plan is used to illustrate the planning principles, mainly because the practical application of this plan has progressed somewhat farther in this than in planning other elements. The tanker fire problem is largely localized, and the assignment of this type of equipment relatively cheap. There are no serious problems of interforest assignment or costly transport considerations as with bulldozers, for example.

THE TANKER PLAN

The tanker plan is one of the major sections of the Region 1 Fire Suppression Plan. It was designed for the purpose of determining the extent to which tankers and all types of water-carrying equipment are needed in the region, their proper distribution, and the economy of their use compared to other fire control methods. It evaluates the problem by localized areas and determines priorities of the many prospective bases from such factors as probable occurrence of fires on which tankers should be used; volume and dispersion of fast-spreading fuels; degree of vulnerability of the area to damaging fires; accessibility to water-carrying equipment; recent occurrence trends and probable future increase or reduction in hazards.

The plan is to be used in the transfer and assignment of tankers and water carriers and as a guide in directing new developments and purchases. It provides a method by which tanker production records can be kept and used to determine the amount that we can afford to invest in this type of firefighting equipment.

THE ANALYSIS

The expectancy in rate of occurrence and seasonal duration and the hour-control data from the various bases was determined by means of the analysis of individual fires which resulted in the classification of 3,088 tanker chances out of a total of more than 23,000 fires.

It is realized that occurrence, even when adjusted to meet changed conditions, and with full consideration for recent trends, is but a single factor. The fuels that exist within those areas that are accessible to tanker equipment—the potential hazards introduced by either dense concentrations or widespread areas of fast-spreading types are at least equal if not more important, according to the degree in which they add to the possibility of costly and damaging fires. Maps were prepared by those forests that had considerable areas of slash, outlining them in as much detail as possible, and this data was supplemented by specific information gained from those individuals who had intimate knowledge of actual conditions on the ground. Smelter-fume, bug, disease, blow-down, and frost-kill were treated the same way, to the extent that they affected the situation regarding tanker use. Extensive grass areas, particularly cheatgrass slopes, were given full consideration with the greatest emphasis on potential damage rather than probable burned area.

Accessibility was determined mainly by the study of "tanker road tracings" which outline the usable roads within those areas of appreciable man-caused fire occurrence and indicate the amount of operable area. Also, time estimates were made for each individual tanker fire in relation to specified bases.

PROSPECTIVE TANKER BASE RATING SYSTEM

Add the numerical ratings from each category below to determine the final combined rating.

Occurrence.—Rate: Normal expectancy in number of fires per year.

Trend: Pronounced up or downward recent trends expressed as plus or minus; add or subtract 1, 2, or 3 to or from base rate according to degree.

Heavy Fuels.—Rate: Expressed as 1, 2, 4, and 8, for low, medium, high, and extreme, in conformity with the progression used in Region 1 in all phases of fire planning. Emphasis placed on probability of costly and damaging fires that might occur from delayed action, rather than danger of fires starting in such areas, although both factors are considered.

Trend: Best judgment available as to prospects of the immediate future expressed as plus or minus; add or subtract 1, 2, or 3 to or from base rate.

Grass fuels.—Expressed directly as 1, 2, 3, or 4, to represent low, medium, high, and extreme. In this case, too, potential cost and damage is given the edge over prospect of fires starting in such fuels.

Accessibility.—Road: Rating of 1 or 2 given according to degree of accessibility as indicated by extensiveness of the road network to cover the danger areas.

Nonroad: Rated 1 or 2 additional to show value of the base where four-wheel-drive equipment can cover areas beyond the road system.

Hour control.—Thirty-minute and one-hour control given a rating of 1 each, if 50 percent of the tanker fires allocated to the base can be reached in 30 minutes; 90 percent in 1 hour.

CLASSIFICATION OF TANKER BASES

Prospective tanker bases are grouped in four major categories as follows:

Class A or primary base.—Must be of sufficient importance that the combined occurrence, hazard, and risk warrants assignment of a high-grade, standby unit, designed as a single-purpose fire truck. Numerical rating 15+.

Class B or secondary base.—Of lesser importance than class A as determined by rating of occurrence, fuels, potential cost and damage, and other pertinent factors, but still justifies assignment of second-rate standby or first-class demountable equipment. Numerical rating 11 to 14.

Class C or utility base.—Rates below class B but still justified for tanker equipment that can be developed at moderate cost and used in combination with other activities in the out-of-fire season. Numerical rating 7 to 10.

Class D or provisional base.—Lowest rated base. Must justify assignment of water-carrying equipment in combination with need for regular transportation of fire-goers. Numerical rating 5 and 6.

The above classifications are for the purpose of grouping bases according to relative importance. Mechanical standards for tankers regarding speed, power, water capacity, etc., are another matter and should not be confused with the base categories. While most primary or class A bases will justify assignment of a prime, standby tanker, it does not necessarily follow that all grades of equipment will fall in line with the base assignments. A few relatively low rated class C bases may require heavy-duty equipment because of the nature of fuels, while other higher rated bases may warrant low-capacity, dual-use units. Four-wheel versus conventional drive is also a matter of efficiency according to the nature of the area covered by the particular base and is in no way connected with the importance as determined from the numerical rating.

On the above basis, Region 1 analyzed 105 prospective tanker bases of which 65 were given ratings of 5 or over. Fourteen made the primary, 17 the secondary, 24 the utility, and 10 the provisional grade. Seventeen tankers have been assigned since the initial rating was completed and it is expected that 9 more will be placed next spring.

A continuation of the analysis to cover three more years (1947, 1948, and 1949) will be completed this winter at a cost of approximately 3 man-days per forest and all bases will be rerated according to the latest findings. Thereafter, it is expected that the recalculation and rating will be done annually in order to keep abreast of changes in conditions and be assured of the best possible distribution of power equipment and specialized services.

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 on a strip of paper attached to illustrations with rubber cement. 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. Do not submit copyrighted pictures, or photographs from commercial photographers on which a credit line is required.

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