THE POTENTIALITIES
OF TANK TRUCK UTILIZATION
WITH FOREST FIRE SUPPRESSION
by
Mal Harris

A Thesis
Presented to the Faculty
of the
School of Forestry
Oregon State College

In Partial Fulfillment
of the Requirements for the Degree
Bachelor of Science
June, 1940

Approved:

Professor of Forestry
Acknowledgement

For the information and aid which was received in compiling this thesis, appreciation is hereby expressed to Chief Assistant J.J. Davis, of the Los Angeles County Department of Forester and Fire Warden, and to Ranger W. F. Mann of the Cleveland National Forest, United States Forest Service.
INTRODUCTION

Statement of Problem

The purpose of this paper is to review the development of tank-truck suppression and to indicate the future possibilities of its use in forest fire protection. For many years, this type of suppression has been used throughout urban districts with satisfactory results. In rural and forest areas, however, hand methods have invariably dominated, and the degree of success has been comparatively low. At the present time, our seemingly-inexhaustible supply of timber resources has been so greatly depleted, that the burning of a single tree assumes major importance. It is essential, therefore, that our forest lands be protected by the most effective methods at man's disposal.

Forest fire suppression with tank-trucks is still largely in the experimental stage, but its potentialities are becoming increasingly evident. Although at present not applicable to all types of forest land, there are indications that a proper combination of roads, tractors, and tank-trucks might be an advantageous supplement to the protective organization of any forest.

Related Studies

There have been many studies made of existing fire protection methods, both in suppression and presuppression. Man-power protection has been analyzed and organized to a high degree of perfection. Perhaps by supplementing these ever-increasing improvements with standard mechanical aids, the annual acreage burned may be even further reduced.
Procedure

The material for this paper has been based on the work of the Los Angeles County Department of Forester and Fire Warden and the U.S. Forest Service, in the forest vicinity of southern California. Some material has also been obtained from the suppression records of several other state and county forces. The data has been compiled in an attempt to describe what has been done and what may be done with tank-trucks and tank-tractors in our forests.

TANK TRUCK FUNDAMENTALS

Before attempting to consider previous developments or to predict future potentialities of mechanized suppression, it might be well to briefly review the principles of construction and operation upon which all tanker-units are based.

Definition and Description

"Tanker-unit" is an all-inclusive term which may be applied to any mechanized equipment which carries water and is capable of effectively utilizing said water in suppressing fires. The first tanker-units were developments of urban fire districts, and these crude contrivances evolved to our modern city fire engine. This large, powerful urban unit is too inflexible for forest use, but its principles have been emulated in designing the smaller types which are adaptable to that purpose.

Tank-trucks for forest use have been constructed for
power, both high and low-gear, versatility, and efficiency. The procedure has been to supplement a standard truck chassis with the added construction which is needed for tank-truck use (Figure 1). The major items of this equipment are tank, pump, valve and port system, cooling system, pressure gauges, tool boxes, hose carriers, and miscellaneous accessories such as the siren and fire lights. The size of truck chassis used for this purpose has ranged from a one-half ton pickup with a 50-gallon tank to a 10-ton heavy duty truck carrying a 2500-gallon tank.

Los Angeles County has recently persuaded several truck manufacturing establishments to produce standard tank-trucks as commercial units. Due largely to these efforts, all major fire-apparatus companies now manufacture some type of tank-truck. Although many of the old makeshift pumpers are still in use, they have been largely replaced by this new standard equipment.

Types of Pumps Used

In order to utilize the water which it carries, a tanker unit must be equipped with some means of throwing this water under pressure. This purpose is accomplished by the use of a fire pump which is operated from the truck motor by means of an auxiliary transmission gear which allows the pump to operate while the truck is in motion. Fire pumps are of two general types: positive and non-positive.

Positive Pumps

A positive pump is one which theoretically delivers a definite amount of water with every stroke or turn. Under
actual working conditions, however, the amount of water delivered will vary with water slippage, frictional resistance, and the condition of the pump.

This type of pump is the one in most general use with forest fire equipment due to the fact that it will draft water either from or into a tank without the aid of a supplementary priming system. This advantage facilitates operations in draining and refilling the tank on actual fires and offsets the somewhat higher maintenance cost of positive pumps.

Non-positive Pumps

A non-positive pump is one which may operate without delivering water. The principal disadvantage of this type of pump is its inability to draft water without the aid of a supplementary priming system. That is, an auxiliary pump is needed to bring water to the main pump before any delivery or draft may be effected. This process is time-consuming and therefore somewhat reduces the desirability of the non-positive pump, in spite of the fact that it is resistant to wear when pumping water which carries abrasive materials.

The stated capacity of either type pump is that amount of water which may be delivered at the optimum operating conditions. For example, a Viking positive pump with a 2" discharge will deliver 80 gallons per minute at 1800 revolutions, without any outside pressure interference or retardence. It's stated capacity is therefore 80 gallons, and the manufacturer so advertises.
Valve and Port System

When a fire pump is engaged and begins to pump water, it becomes necessary to direct the flow to whatever outlet is desired. This action is best accomplished through the use of a system of 2" pipes and a three-way valve. This valve utilizes the three-port principle, which allows the movement of air or liquid to be regulated so that it can be directed through any combination therein offered by the ports involved. It is through this principle and action that numerous pipes and valves have been eliminated, and a more efficient operation has thus been established. The details of this principle are illustrated in Figure 2.

Cooling systems

When conditions necessitate tank-truck operation from a stationary position, some method of cooling is required to overcome the tendency of the engine to overheat. To accomplish this purpose, many trucks have a small water-line running from the pressure side of the pump to the radiator. This simple apparatus assures a steady flow of cool water to the radiator while the pump is in operation, but the radiator cap must be removed to allow for the consequent overflow.

Another type of cooling system consists of a small fuel pump which draws water from the water-tank through a control valve and thence to the motor-head. With the control valve open, water is thus circulated through the radiator and back to the water-tank by means of a copper tubing which connects the radiator over-flow line to the top of the tank. This
system offers a constant circulation, and it also precludes the necessity of removing the radiator cap.

Loose Equipment

In order to be independently capable of performing any required task within its capacity, each tank truck carries whatever equipment is needed for maximum efficiency. An assortment of hoses, nozzles, fittings, and various miscellaneous items constitutes this equipment, the most important parts of which are described in the following paragraphs.

Fire Hose

The three types of fire hose used with forest-fire tanker units are: hard-rubber, cotton-jacket, and linen. The first-named type is usually carried on a live reel which is attached to the tank truck chassis, whereas the cotton-jacket and linen hose may be either on reels or in loose rolls. All hose coupling arrangements are usually of the slot-type, as these have been found most practicable for use in rugged topography.

Hard rubber hose

This hose is usually 3/4" in diameter and is carried in two to three-hundred foot lengths on live reels. It's construction is of hard rubber with cord or canvas-like material built into it for added strength. This allows the hose to be flexible without sacrificing the ability to withstand high pressures.

Suction hose is similarly constructed but is supplemented by coiled wire to insure strength against collapse. This hose is used to draft water from outside
supplies into the truck tank, and this added strength is therefore essential. Suction hose is usually 2" in diameter, but it's size may vary with the size of equipment on which it is used.

Cotton-jacket hose

This hose may be either 1" or 1½" in diameter for use on tanker-units. It's construction is of a rubber hose encased in a woven cotton jacket. This jacket is usually one layer in thickness on small hose, and two layers in thickness on the larger hose. Although this added thickness is an aid in withstanding high pressures, it is much more difficult on hose lays because of the greater elongation and twist which results. Nevertheless, the double-jacket hose is usually preferred due to the compensating advantage of its added strength.

Linen hose

The usual diameter of this hose is 1", and its use is largely restricted to emergency duty of local origin. It's chief advantages are its lightness, flexibility, and ability to withstand considerable heat. Before it can withstand high pressures, however, it has to be thoroughly moistened in order to swell the fibers and seal the small openings of the weave. Furthermore, there is always a certain amount of water lost through sweating of the hose, the friction loss is about 2½ times that of the cotton-jacket type, and its strength is less. Obviously, then, this type of hose is not used to any great extent on forest fire suppression activities.
Hose fittings

Aside from its hose, each tanker unit also carries a varied supply of accessories which are essential to efficient hose operation. This assortment consists mainly of nozzle tips, shutoff valves, siamese units, suction strainers, and various types of couplings, reducers, bushings, and nipples. Most of this equipment is usually fitted with the Iron Pipe Thread type, as this type has the most universal use. It is also necessary, however, to carry enough fittings to be able to make connections to outside water fittings of different type threads.

Shutoff valves

These are handy valves for shutting off the water at the end of the fire hose. Because it is quick-acting, care must be exercised in operating one of these valves against high pressures, since the resultant surge may be damaging to both hose and equipment.

Nozzle tips

These fasten to the shutoff valves to govern the stream of water. They are usually of the regular taper type, ranging in size from the 1/8" to the 3/4 inch diameters, but the 3/16 inch tip has proved to be the most efficient water-conserving taper tip. Although these standard tips are always carried, the most effective tips have been those which develop a fog effect, as illustrated in Figures 9 and 11. The common Boston Garden Nozzle has been widely used for this purpose, especially by the U.S. Forest Service, and it has ably proved to be both convenient and effective on grass and
chaparral fires. The Los Angeles County Department of Forester and Fire Warden, however, has gone one step farther and utilized the recently-developed Griswold Fognozol. This product delivers a powerful, wide-spraying spray which is the most efficient small-fire combatant in use today (Figure 11). Los Angeles County is thus far the only forest agency to utilize this development, however, other organizations still relying on the taper and Boston Garden tips.

Siamese unit

This is a device which allows the connection of two hose lines from one water line. Either or both of these hoses may be shut off by means of a valve built into the three-port construction of the siamese feature. This unit is widely used on construction fires, and also where it is desired to attack two sides of a forest fire simultaneously.

Suction strainer foot-valve combination

This unit is for the purpose of straining out debris from the water flow before it enters the suction hose on drafting operations. It is merely a rectangular-shaped container of screen and metal which fits onto the end of the suction hose. The foot-valve feature, of course, holds the water in the hose when the pump is stopped, so that the prime is not lost. This device allows tanker units to obtain refills from any water supply, no matter how contaminated or filled with foreign matter.
THE PRINCIPLES OF TANK-TRUCK OPERATION

Tanker functions

Except on lowland grass fires, the tank-truck is not considered to be an extinguishing agent. It's chief value lies in the ability to cool down a hot fire so that really effective manual methods may be employed to accomplish the actual control. Moreover, since a fire takes advantage of every natural condition to increase it's rate of spread in advance of the usual hand methods, it is the tankers duty to retard this spread and thus enable the final control to keep abreast of the flames.

In addition to these two main functions, the tank-truck is also a great aid in mop-up work. At this function, which is often the most disliked phase of fire-fighting, the application of water from a tanker will greatly improve the fire-fighters' morale and effect a substantial saving in both time and cost. Furthermore, on back-fire work, the tanker unit has proved extremely valuable in preventing spot fires and in keeping the backfire from getting too hot for the firing crew. Still another use has been in automobile fires, when by using a fog nozzle and directing the spray through the radiator core with the hood down, a very effective suppression has been attained. Finally, on construction fires, it has been proven that tanker suppression is faster and more effective than the former hydrant methods, especially in isolated mountain districts.

Each tank truck carries sufficient tools for line construction and direct hand attack. These tools are still
considered to be the main control equipment, but their use is greatly facilitated by the above-described tank-truck accomplishments.

Crew Organization (15)

A four-man crew is usually sufficient to operate a tank truck unit. The members of this crew are the tank-truck driver, nozzleman, reel man, and hoseman.

Tank-truck driver

This man is in charge of the truck and its equipment, and he is responsible for operating all of its appliances, from the water supply to the beginning of the hose line.

Nozzleman

The crew foreman usually assumes this position. It is his duty to plan the method of attack, organize the crew, and direct the placement of water on the fire.

Reelman

This man handles the reels to control amount of hose which is delivered to the hoseman.

Hoseman

It is this man's duty to help the nozzleman handle the hose. If two lines are used, this man directs the spray of the second nozzle.

The size and organization of this typical crew is, of course, varied according to the conditions of the fire.

Crew Procedure (15)

The general rules which a tanker crew follows are:

1. Attack the fire at the point of origin, working
fast from this point to the head of the fire, and leaving behind a line which will not escape before hand methods are applied.

2. Keep the fire truck behind the nozzleman so that it is adjacent to a safe piece of line and will not be in danger of getting burned.

3. Concentrate the major part of the effort on the side of the fire which will be liable to cause the greatest damage.

4. Always provide for getting the tank-truck and crew out along a safe line of retreat in case the fire becomes too hot.

In the actual application of water, there are also several general rules, as follows:

1. Use the smallest tip which will do the work.
2. Direct the entire stream at the base of the fire.
3. Shut off the water when it is not doing effective work.
4. Cool down the fire rather than drown it.
5. Use water on that part of the fire where spread may be stopped quickest.

Methods of Attack

Direct attack with reel hose

This is the most common method of tank-truck attack, especially on lowland grass fires where the truck may drive along the edge of the fire. The nozzleman walks in front of the truck and directs the spray along the fire edge while the crew follows behind. The reelman and hoseman perform, as usual,
their respective duties or begin building a follow-up line whenever the opportunity arises. If it becomes necessary for the truck to remain stationary, the reel hose may still be sufficient on small fires. If needed, other lengths of cotton-jacket hose may be connected to the end of the reel hose or to the overboards on the truck.

Straight Lay

At the side of each tank truck, there are usually attached two or more outlets known as overboards. By using the proper fittings, any size hose may be fitted to these outlets. The consequent stream may be used singly or in combination with the reel hookup, as in Figure 8.

Siamese Lay

A length of 1½" hose is connected to any outlet, and two lengths of 1" hose are fastened to the end by means of siamese unit. This system affords two nozzle lines from one outlet and is especially valuable on structural fires, or where it is desired to play a large stream of water around both sides of a fire at once.

Methods of Refill

Each tanker unit carries specially-constructed suction hose which fits 2" inlets on the side of the truck. Whenever water is needed, this hose may be placed into a stream or other water source to draft water into the tank through the pump.

Whenever reservoirs are located on side-hills above the truck, this hose may also be utilized in creating siphon for rapid refill. Naturally, if water hydrants are available
the aforementioned refill methods need not be employed, but instead, water may be conveyed into the tank through regular hose.

Any of the described methods of attack or refill may be combined to fit the particular situation at hand. By proper valve control, the pump will force water out, draft water in, or do both of these operations simultaneously. Obviously, then, under a properly-trained crew, a tank truck may become a versatile, highly-efficient fire suppressing unit with unlimited potentialities.

HISTORY AND DEVELOPMENT OF TANK TRUCKS

City fire departments have always had the best modern equipment available, whereas forest fires have usually been fought with primitive hand methods. A movement to overcome this procedure originated in California in 1923 (11) when the first tank-truck pumper was developed. This was rather a crude attempt and not very successful, inasmuch as the result was top-heavy, underpowered, not adaptable to rural conditions, and demanded too large a pump capacity for the available water supply. This experiment did prove to be beneficial, however, in revealing the possibilities of tanker operation; as a result, in 1929, a California state committee was organized to study tank-truck potentialities. At the conclusion of their analysis, it was determined to attempt a practical experiment. Consequently, state funds were appropriated, tanker specifications were compiled, and rural fire law amendments were passed.
The First Rural Tankers

During the 1929 fire season, the State Department of Forestry in California decided to take action on the recommendations of the recently-organized state tank-truck committee. Consequently, four tankers were built, each consisting of a gasoline-auto fire apparatus equipped with water tank, pump, hand tools, and hand extinguishers. The minimum high and low gear speeds were forty and one miles per hour, respectively. The pump clutch was constructed independently of the motor clutch, and there was no provision made for drafting refills.

These four tankers were successfully utilized during the fire season of 1929, and they unquestionably proved the value of properly constructed and well-equipped motor trucks for combatting rural and forest fires. Subsequent experiments were conducted throughout the state, until many counties were soon equipped for fire suppression with tankers.

Development of Tankers in Los Angeles County

Undoubtedly the most progressive pioneer in the application of tank trucks to forest protection has been the Los Angeles County Department of Forester and Fire Warden. This agency has a unique fire problem, inasmuch as it must protect the so-called "invisible" or "treeless" forests of southern California. Here the proximity of residential, industrial, agricultural, and mountainous areas necessitates an intensive fire control and watershed management program.

As early as 1928, this Los Angeles County Department realized the necessity for developing and maintaining an
intensive, efficient protective organization. Consequently, attempts were made to construct tank-truck fire apparatus from standard truck chasses, similar to the previously-described units which were built by the California Department of Forestry.

By 1933, Los Angeles County exemplified the most efficient, existing rural fire organization. Here the tankers were constructed for versatility and were of a capacity ranging from 150 to 600 gallons. Each tanker carried hand-tools, emergency rations, fire extinguishers, first aid kits, flashlights, and various other supplementary aids to fire fighters. Centrifugal, non-positive pumps were used due to their low maintenance cost, though this meant a slight time loss due to priming. A valve system was installed which facilitated either an output or input of water through the pump. This meant that available water sources could be directly utilized as the tanker supply was exhausted. A variety of nozzles was carried to fit the $\frac{3}{4}$", 1", and 1½" hose which was conveniently carried on live reels or storage rolls. Through continued use, it was soon discovered that a fog type nozzle was the most efficient and least damaging tip. Several other important discoveries were made as well, and a plan for future tanker construction was compiled. The desirable qualities herein included were as follows: (3)

1. Sufficient horsepower for high speed on level, as well as for low speed on steep gradients.
2. Overloading provisions in spring assembly
3. Best type of frame for insured stability
4. Tire size suitable to carry load without danger of blowouts.
5. Capacity of tank to be determined by protection needs and water facilities.
6. Selection of pump to be based on (a) capacity necessary for a sufficient stream, (b) practicability of mounting under driver’s seat, and (c) low initial and maintenance costs.
7. Standard location of all equipment.
8. Equipment complete for any emergency.

Under these specifications, new tankers were soon constructed. Water tanks were installed along fire control roads to provide for rapid refills, and tanker suppression became permanently installed in southern California.

Tanker Development by the U.S. Forest Service (15)

In 1934, the United States Forest Service became impressed by the success of the fire control system being developed in Los Angeles County. Consequently, as an experiment, several tankers were constructed from 1½ ton trucks and placed throughout the Cleveland National Forest in Southern California. During the subsequent fire season, these tankers proved their worth by greatly reducing the usual acreage burned. Since that time, Forest Service units have been placed throughout the national forests in southern California, as well as in many other districts.
THE PRESENT AND FUTURE OF TANKER SUPPRESSION

Recent Tank-Truck Developments

Within the past few years, numerous states and agencies have adopted tankers as supplemental fire-fighting additions. Although the original tankers were palpably most effective on grass and shrub lowlands in California, several successful adaptations have also been made in timbered areas elsewhere.

Oregon's Tanker

In 1937, the Oregon State Forestry Department constructed a 525-gallon tanker from a GMC 3-ton chassis with a 160" wheelbase. This unit was constructed to carry a large quantity of supplies and equipment, as well as men, and it was to be chiefly used in the timbered coast region adjacent to population centers. The entire unit has been especially adapted to the use of ocean water by utilizing salt-resistant metals in its construction. This very compact and complete assembly includes a dual transmission, hydraulic brakes, and dual tires. The power take-off pump is made to withstand salt water and has a capacity of 140 gallons per minute. There are also carried two additional Pacific Marine portable pumps with capacities of 70 gallons, as well as a 50-man tool outfit.

Due to the crown nature of many Oregon fires, together with the rough topography and undeveloped road system, this tanker unit has found little use outside of occasional fires in grass and shrub types. With other tankers placed at strategic points, and with properly-developed road systems, it
seems reasonable to believe that this method of suppression might well be utilized, however, to reduce Oregon's annual area burned.

Recent Los Angeles County Activities

The territory of the Los Angeles County Department of Forester and Fire Warden is now divided into four divisions, each of which includes an intricate system of lookout towers and patrol stations. Each of these divisions has a one-ton squad truck equipped with a pump and a 140-gallon water tank. This unit (Figure 3) is useful in suppressing small fires and in speedily transporting men and equipment. In addition to this squad truck, each division also equips outlying patrol stations with a pick-up truck equipped with pump, 70-gallons of water, and a reel of one-inch hose. This lighter and faster truck offers an ideal means of speedily suppressing grass fires, as well as a means of patrolling more remote and less hazardous areas. (Figure 4)

To follow up these small speed jobs, each divisional headquarters is also equipped with a larger, more complete unit of 600-gallon capacity. This tanker carries 1000 feet of 1" and 1000 feet of 1½" cotton jacket hose, as well as shovels, axes, and Pulaski tools. In addition, each tanker is equipped with an extension ladder, fog nozzles, and hand extinguishers for use on structural and vehicular fires. These pumpers (Figures 5 & 6) are thus adapted for the dual purpose of protecting either watersheds or structures within the area.

The latest Los Angeles County innovation has been a
2500-gallon capacity tank truck (Figure 7) which will be assigned to areas comprising agricultural, residential, and oil-field districts. Although this equipment is not applicable to mountainous areas, its construction is being emulated in designing tankers for that purpose. Specifications are now being compiled for a new tank-truck which will be a combination of the 2500 and 600-gallon tankers. The equipment will be identical to the 2500-gallon job, and the design will be similar to the 600-gallon size. This tanker hybrid will carry a 1000-gallon tank and will be used on heavily built-up areas for the suppression of structural fires.

As previously stated, these new developments are not designed for forest-fire suppression. They are, however, interesting examples of the way in which pioneering Los Angeles County is fabricating new tanker designs and ideas which are considered to be radical by other fire-suppression agencies. The efficacy of these new developments, however, has been well-demonstrated by the fact, that in structural protection on the average fire, lines can be laid and the fire controlled more quickly than with the standard, triple-combination pumping equipment which other agencies operate from a hydrant.

Water supply has always been a major, limiting factor to tank truck development in southern California forests. At the present, however, there are 300 miles of motorways penetrating the formerly-inaccessible watershed areas. Water tanks of 2500 to 10000-gallon capacities
are located at strategic points along these routes. The extension of this system is enabling the Los Angeles County Department to dispatch pumper units to distant fires without the former fear of water shortage preventing their full utilization.

Having thus superseded traditional urban fire-fighting equipment, perhaps tank trucks may subsequently be developed to likewise solve the problems of forest fire suppression. When the Los Angeles County Department gains the full cooperation of state and federal agencies in this objective, the valuable watersheds of southern California should represent the most intensive and efficient forest-protection development in the United States.

Dry-ice tanker

In 1937, A.B. Everts, of the Cleveland National Forest in southern California, experimented with the use of dry-ice confined in heavy steel cylinders as a pressure medium for expelling water from a tank. In this experiment, a crude dry-ice tanker was evolved, consisting of a 50-gallon steel, pressure tank, two dry-ice convertors, and a live reel for carrying hose. These parts were mounted on angle irons to facilitate insertion into the body of a one-half ton pick-up truck.

In the operation of this unit, dry-ice is inserted into an opening in the top of the convertor and the lid closed. The pressure which is thus created seals the convertor lid, and the dry-ice sublimes into a gas and then condenses into
a liquid. The average pressure in the convertor at this point is 933 pounds per square inch at 77 degrees F. This pressure is then stepped down by means of a reduction valve, and water is forced from the adjoining tank through the hose line.

The portability, low cost, and simple one-man operation of this unit, together with the fact that the water flow is independent of truck power are advantages which cannot be overlooked. Consequently, the inventor has recently improved his idea and mounted a perfected dry-icer on a small trailer body. Under actual tests, this new improvement has expelled 300 gallons of water before exhausting the dry-ice contained in the convertors. A $\frac{1}{2}$" nozzle was used under 100 lbs. pressure, and the water was discharged at the rate of 10 gallons per minute to an average distance of fifty feet (6).

This ingenious invention is particularly adapted to estate and grain-field protection, and for spraying various chemicals and liquids. Although it cannot be expected to replace regular tank truck units in forest protection, it might well be adapted to logging or woods operations. By mounting on a speeder or trailer, such a unit would be ready for instant call without tying up motorized equipment. As the cost of mass production would be about 350 dollars, the dry-icer indeed offers a low-cost, highly-versatile unit of great potential value.

Tractor tankers

As previously stated, standard tank trucks are not at
present applicable to timbered areas. In an attempt to overcome this deficiency, there have been several attempts to construct tractor tankers for this purpose. Chief among these experiments have been those conducted by the U. S. Forest Service on the Shasta National Forest in California and the Desoto National Forest in southern Mississippi.

During the 1938 fire season, Shasta National Forest experimented with a "35" Cletrac bulldozer-tractor which was equipped with a 140-gallon water tank and a high-pressure Pacific Y pump. Also attached was a live reel containing 200 feet of 1" cotton-jacket hose for discharge. Four 32 foot lengths of draft hose were carried separately for refill purposes. In actual tests, this entire unit traversed a 76 per cent, smooth, grass-covered slope and effectively discharged water. This test proved the potential value of the unit, and it was used to great advantage in timber types during the 1938 and 1939 fire seasons.

The chief uses of this Shasta tractor-tanker have been found to be:

1. The application of water on active fire-fronts or in mop-up.
2. As a supplement to backfiring, in cooling down the flame, catching slop-overs, and wetting down the outside of the line.
3. Building fire line and cooling a fire at the same time.

The above-described unit, which cost $1000.00 to equip,
is still being used on the Shasta National Forest, and specifications are now being drawn for more, improved units of this type. Subsequent tractor tankers should be much cheaper and even more applicable to rugged, timber country.

Another recent tractor tanker is that of the Desoto National Forest in southern Mississippi. In this experiment (7), a Cletrac A.G. "20" was equipped with two 100-gallon water tanks, and a power-driven hydraulic pump taken from an old dump truck. For discharge purposes, two semi-circular lengths of pipe, equipped with sprayers, were mounted at the top of the radiator and beneath the bumper, respectively. In addition, 25 feet of hose was attached at the rear. Any of these three discharge methods may be operated independently, or they may be operated in unison, as occasion demands. This entire unit is carried on a two-ton truck and may be quickly loaded or unloaded with oak skids.

This tractor tanker has proved to be highly effective in the young-growth stands on the gently rolling topography of southern Mississippi. A well-developed road system places the tractor within easy accessibility of any fire within this district, where it can perform the triple duties of direct attack, line building, and mop-up.

The Future of Tank Trucks

The pioneering stage of tank-truck development is over, and the potential value of these units has been proved. Although most of this development was accomplished in southern California, it has become increasingly evident that other regions can also profit by the inclusion of
tankers in their protection plans. With this objective in view, the Fire Control Equipment Committee of the United States Forest Service has recently compiled a list of recommendations for standard tank trucks to be used on national forest lands. These recommendations are as follows: (14)

1. Use \( \frac{5}{4} \) and \( \frac{3}{2} \)-ton trucks with four-speed transmissions and build up to one-ton and two-ton classes, respectively.
2. Standardize tankers and equipment for each region.
3. Construct auxiliary tanks which may be quickly loaded on any truck.
4. Use permanent, built-up pumpers as much as possible.

These suggestions would seem to indicate that the U.S. Forest Service has been impressed by the work of the Los Angeles County Department of Forester and Fire Warden, since they are in accordance with current specifications used by the latter agency. Perhaps then, in the near future, a scheme of cooperation may be devised whereby these two organizations will contract the production of identical equipment from standard fire apparatus companies. Such an agreement would greatly augment the progress of tank-truck utilization, since the benefits of standardization and mass production might then be realized. Under such an economical plan of purchase, perhaps many other agencies might be able to supplement their fire protection plans with tank trucks.

Since a large majority of our forest fires are man-caused, and usually start near roads or in areas which are accessible to small pickups, the efficacy of tanker suppression
seems palpable on a large portion of our forested lands. On other forested areas which are not so accessible, tractor-tankers should be constructed and road systems should be developed. In this way, our fire problem may be greatly overcome through rapid initial attack to catch all fires while still small. It is indubitable that such a practice would tend to prevent a great deal of the rapid spread and consequent destruction which now occurs on many of our forested lands.

*******

OLD BELL TELEPHONE

[unreadable]
Appendix
Figure 1

1 ½-ton Built-up Chevrolet Tank Truck

Equipment of this type has been in use on the Cleveland National Forest in southern California since 1934. It was developed by the U.S. Forest Service and has become the major type of fire suppression unit in that locality. The construction consists of a standard 1 ½ ton Chevrolet truck which has been built up with a 150-gallon tank, a Viking pump and piping system, a live reel for rubber hose, and various compartment for carrying fire-fighting equipment. It normally carries 200 feet of 1" hard-rubber hose on the live reel, 300 feet of 1" and 200 feet of 1 ½" cotton-jacket hose, and 30 feet of 2" suction hose. In addition, a four-man hand outfit is carried, as well as the usual assortment of fire-fighting accessories.
outside water supply

In the above diagram, the three-way valve is shown as a "tee" with the inside milled to allow a circular-shaped part to rotate at the junction of the three ports. This circular portion has openings as shown in the unshaded portions and can be rotated to the following positions in order to accomplish the function indicated by each:

- draft
- tank to
- to tank
- prime
- or
- draft to hose
- hose
- hose

Figure 2

Principle of the Three-Way Valve
Figure 3

One-ton Squad Truck

This is a standard one ton pick-up body which has been developed by the Los Angeles County Department of Forester and Fire Warden. Directly behind the cab is mounted a 140-gallon water tank, and a 75-gallon positive pump with a 1\frac{1}{2}" discharge is mounted under the body. Except for cotton-jacket hose, the balance of the equipment is identical with that of the \frac{3}{4}-ton patrol car, as described in Figure 4.

The above type of squad truck has been found to be very satisfactory in moving men and equipment to any fire area as, in addition to the water-tank and pump, it is also able to carry a large number of tools and personnel.
Figure 4
½-ton Pick-up Patrol Car

The above illustration is a standard ½-ton pick-up equipped with a 70-gallon water tank and a hose reel carrying 250 feet of ½" high-pressure hose. Behind this hose reel is mounted a tool box which carries the adapters, spare nozzles, fittings, and wrenches. In the bed of the truck are fastened one backpack pump, three shovels, one axe, one Kortick tool, and fifteen feet of 1" suction hose. The transmission has four speeds forward with power take-off provisions for a 38-gallon Viking pump. By means of a by-pass and relief valve, this pump can discharge either directly to the hose from suction or from the tank, as desired. The chief use of this unit is in rapidly extinguishing roadside fires in vegetative types.
Figure 5

600-Gallon Seagraves Tanker

This unit was constructed by the Seagraves Company according to specifications compiled by the Los Angeles County Department of Forester and Fire Warden. It has a 12 cylinder V-type motor, 600-gallon capacity pump, 50-gallon capacity auxiliary pump, and two 300-foot live reels. Fifteen hundred feet of hose are carried, as well as a 24-foot truss extension ladder and the usual miscellaneous equipment. When fully-loaded, the high-gear speed of this unit is 60 m.p.h., and grades up to 35% have been successfully negotiated in first gear. It has proved to be very satisfactory both for mountain and structural use.
Figure 6

600-Gallon Mack Tanker

This unit was constructed by the Mack International Company at a slightly lower cost and lighter weight than the similar Seagraves tanker shown in Figure 5. The equipment carried by the above unit is practically identical with that of the Seagraves except that no ladder is included. This unit has also proved highly satisfactory, especially in heavily-built-up areas.
Figure 7

2500-Gallon Seagraves Tanker

This unit was designed to serve as a combination protection unit to cover residential, business, oil field, and small farm areas. Although not particularly well-adapted for use in mountainous areas on bush or forest fires, this tanker still offers an interesting example of how versatile tank-truck units may be constructed. It is practically a mobile fire department, and it has proven to be much more efficient than the usual hydrant method of attack used in most urban centers.
In the method shown above, discharge is effected through both the live reel and one overboard. By using the overboard on the other side of the truck, three lines might be utilized. If a progressive, direct attack were desired, however, only a short length of the live reel hose would be out, and the nozzleman would walk in front of the moving truck, meanwhile spraying the fire line from origin to head.
By using an adjustable-spray fog nozzle, a wide range of delivery may be accomplished. In the above photograph, both lines are equipped with this type of nozzle and are adjusted for a wide-spreading fog effect. This type of spray is particularly effective in preventing the spread of fast-moving fires in light vegetative types.
Four lines are put into effect in the above illustration. Although demonstrating the potential delivery of this unit, such an attack is seldom used due to the rapid exhaustion of the water supply. The usual procedure would be to utilize the live reel hose from a moving truck in light vegetative types, or to lay out one or more lines from a stationary position on heavier types and on structural fires.
Figure 11

Fog-effect from 600-gallon Tanker

The above demonstration of fog-nozzle utilization would be highly effective on a fast-burning chaparral fire. The high pressure and wide-spreading spray of this nozzle adjustment offers efficient water conservation while smothering the flames. The delivery may be directed from a static straight lay, as illustrated above, or from a moving truck with a progressive direct attack.
REFERENCES CITED


2. Conservation Association of Los Angeles County. Conservation activities 8:5 May, 1939 and 8:8 August, 1939


5. Everts, A.B. Dry ice and forest fires. Fire Control Notes December, 1937

6. Everts, A.B. The dry-ice tanker takes to wheels. Fire Control Notes January, 1940


9. Mace, J.K. The use of small tanks in fire control. Fire Control Notes January, 1940

10. McNaughton, V.B. Mississippi fire-tanks. Fire Control Notes January, 1939


