Jet Dump Capability Speeds Up Unloading Time of Tank Trucks

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A great many rural fire departments are faced with the problem of covering large areas where hydrants are few or nonexistent.

An obvious and popular solution to this problem is to obtain a tank truck dedicated to hauling water to supply the pumpers at the fire. In many instances, financial considerations have prompted the fire department to convert a fuel supply truck into a water tank truck. Often a fuel truck of 1500 or 2000 gallons capacity can be obtained at a substantial savings over a conventional piece of fire apparatus of equal tank capacity.

The greatest disadvantage to this approach is that fuel trucks rarely, if ever, are designed to supply water at rates compatible with fire department operations. In most instances, the tank truck comes equipped with a power take-off (PTO) pump capable of 300 to 350 gpm. Although this might be sufficient in most instances, it is not adequate for a major fire.

Room for improvement

Such a unit may have the capability to rapidly extinguish 90 percent of the department's fires, but if the remaining 10 percent account for 90 percent of the loss, then there is room for improvement. This fact has led many departments to seek alternate solutions to getting water off the tank truck at a rapid enough rate to control a large body of fire.

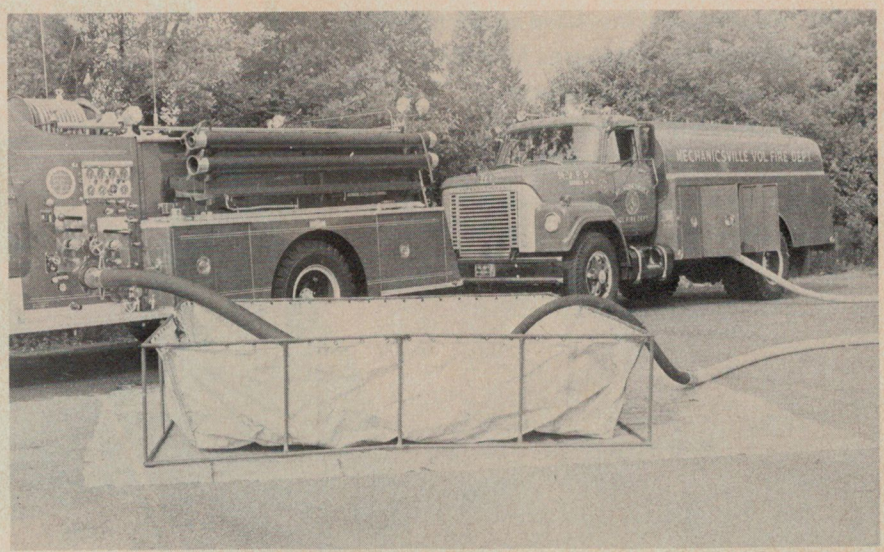
The simplest and perhaps the least expensive method of increasing the available flow rate from a tank truck is the installation of a large dump outlet. The diameter of a typical outlet is 4 to 6 inches. In most instances, this allows dumping water at a rate which exceeds the pump-off rate. Obviously to take advantage of a dump outlet, a suitable container, such as a folding tank, must be available.

At first glance, the requirement for a folding tank seems to reduce the cost advantage a dump outlet might have since the combined cost of a folding tank and the installation of a dump outlet might approach the cost of installing a high-volume (500 to 750-gpm) auxiliary fire pump.

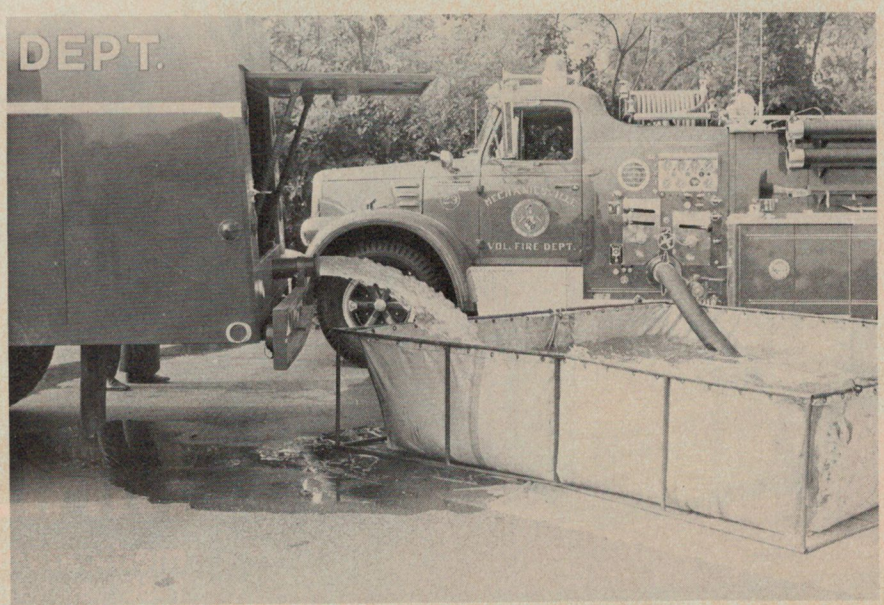
Significant drawback

However, a significant drawback of operating a tank truck without a folding tank is that it must remain at the scene until its water supply is depleted before it can move on to transport another load. This has the effect of reducing the average amount of water (over an extended period of time) that any one tank truck can supply.

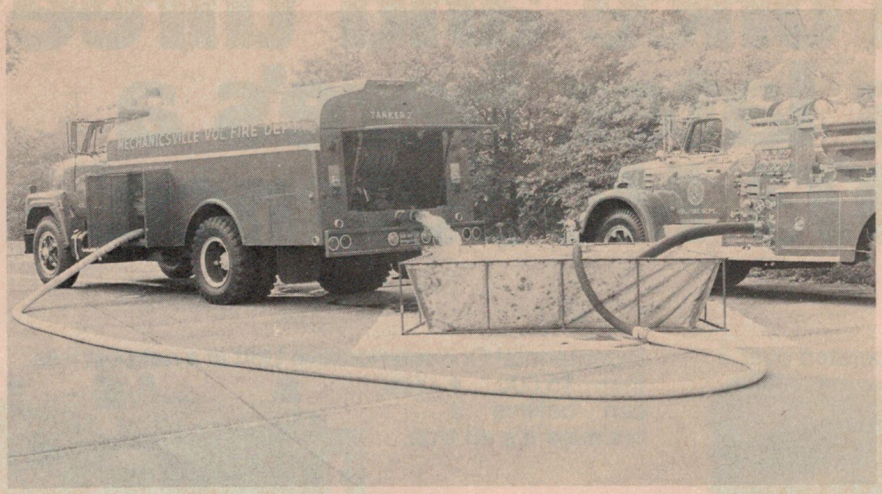
The most efficient use of a tank truck



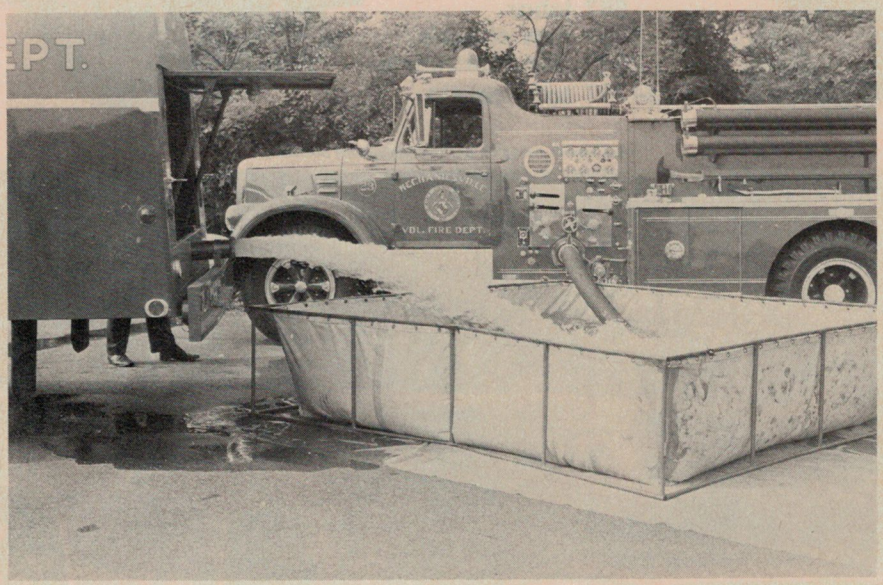
Tank truck is pumping through a length of 3-inch hose into folding tank. Note use of hard sleeve to hold hose in place— *all photos by the author.*



Conventional dumping operation, unassisted by pump, has a discharge stream with little reach.



Separate outlets on tanker are used to discharge water by both gravity dumping and pumping.



Jet dump method uses power of pump to speed dumping operation. Note increased reach of discharge stream.

is to unload at its maximum rate and begin a water shuttle operation as quickly as possible. Thus, even if a tank truck has a large-volume pump, it may still be more efficient to unload the water into a holding tank at the scene. Unless there are enough tank trucks available to permit using one as a stationary nurse tanker, a portable tank is a must.

Obviously, a tank truck with a rated pump is much more flexible and can be used in many situations where its pump is absolutely essential, such as drafting and filling itself rapidly when no pumper is available. However, in those departments where financial considerations rule out the expense of installing a large-volume pump, the dump outlet and folding tank combination is a very cost effective alternative.

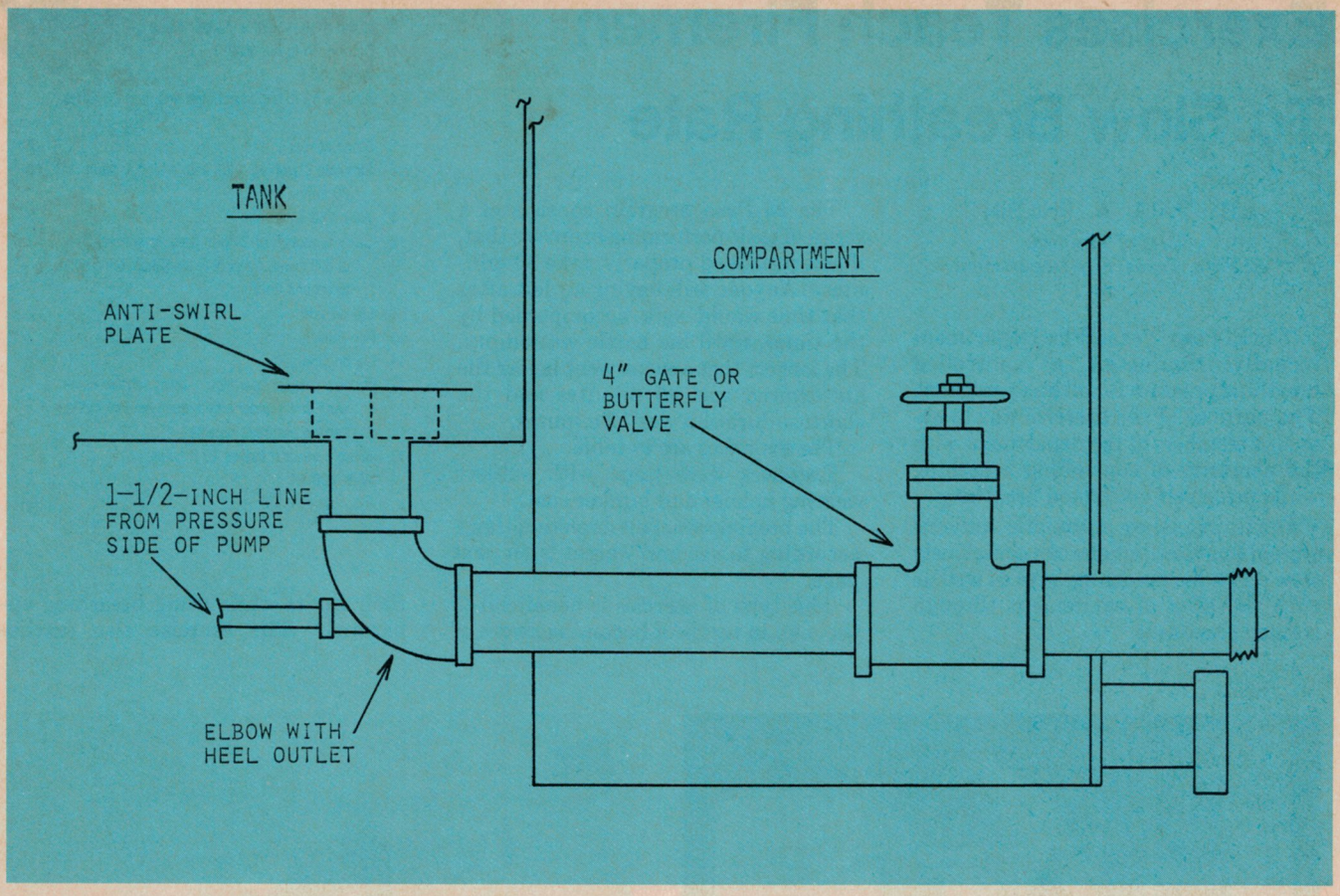
There are several considerations which affect the efficiency and usefulness of any dump outlet. The most important is, of course, the size of the outlet. The smallest practical size is usually 4 inches, but the larger the better. The size of the piping used on any installation should be based on the space available for the valves, elbows, etc., and should never be made smaller simply to make the installation easier or cheaper. The cost difference between 4-inch and 6-inch pipe is relatively small when compared to the 225 percent larger area of 6-inch pipe.

The second consideration in making a dump outlet installation is the actual location of the outlet in the tank. The primary influence on the rate at which water flows from the outlet is the pressure head available and, all other factors being equal, the lower the outlet the greater the flow rate.

Attaching the outlet to the end of the tank may not be the most efficient arrangement if the piping can be routed to drop below the tank bottom and still maintain enough ground clearance to conveniently dump into a folding tank. Every inch of head pressure should be utilized if the arrangement of bumpers, running boards, fenders, etc., permits. The drawing shows a typical dump outlet arrangement which drops below the tank bottom to increase head pressure.

Baffle holes and air vent

A third and often overlooked effect on the efficiency of a dump outlet is the size of the internal baffle holes and tank air vent. Inadequate baffle hole size can reduce the effective head pressure and lengthen the dumping time. The air vent size in fuel supply trucks is deliberately kept small to avoid excess fuel vapors or fuel spills. Large baffle holes and air vents are necessary. Ideally, the



Piping arrangement for jet dump system on tank truck.

baffle holes should be twice as large as the dump outlet, and the air vent should be equal to the dump outlet area.

In any dumping operation, water swirling around the outlet can be a problem. Some means of reducing the amount of swirling is usually required and apparatus manufacturers have developed many ingenious ways of combating this problem. The simplest method usually involves mounting a horizontal plate several times the size of the outlet directly over the opening. Care must be taken not to reduce the flow by constricting the path the water must follow to enter the opening.

Swirling is almost always present to some degree and reducing or eliminating it can significantly increase the dump-off rate.

Another method of increasing the flow rate is to arrange a pump discharge so that it accelerates the flow from the dump outlet. In many cases, this can be accomplished by routing the pump-to-tank fill line in such a manner that it discharges into the tank in front of or via the dump outlet piping. The drawing shows an arrangement to accomplish this.

An increase in flow results because the high pressure water from the pump imparts kinetic energy to the water flowing through the dump outlet. To appreciate the principle involved, imagine discharging a 1½-inch straight tip nozzle into a bucket of water. More water goes out than goes in. To the aerodynamic engineer, the effect is known as "mass flow augmentation." It is usually called a jet pump and utilizes the principle of conservation of momentum (Newton's second law). Whatever the name, it does work and it can substantially improve the speed of a tanker dumping operation.

The photos show various methods of unloading water from a 2000-gallon tank truck with a small PTO pump and a 4-inch dump outlet. Table I provides a comparison of these four methods. An examination of the results in the table reveals that the jet dump procedure (method 4) provides a 50 percent reduction in dump time over a conventional dumping operation (method 2) and a 25 percent reduction in the pump and dump operation (method 3) time.

TABLE I

Method	Operation	Time Required (Min)	Av. Flow Rate (GPM)
1	Pump	6	330
2	Dump	6	330
3	Pump & Dump	4	500
4	Jet Dump	3	660

Why it works

The question of how the jet dump operation can be superior to the separate pump and dump operation naturally arises. In the pump and dump operation, the water pumped off does not contribute to the dump outlet's head pressure and thus reduces the average flow rate. Unfortunately, the pump does not fully compensate for this even though it maintains a constant flow rate throughout the operation.

On the other hand, the jet dump operation uses the power of the pump to assist the dumping operation without substantially affecting the pumping rate. This situation is a function of the pump size and the efficiency of the jet dump, but the results shown are valid for a converted fuel tank truck equipped with a PTO pump and a dump outlet.

Installing a well-designed dump outlet requires consideration of many factors but it can make a substantial improvement in the efficiency and flexibility of any tank truck operation. In addition, the cost and complexity of the installation is usually well within the capability of most departments without their having to seek help from outside the local community. □ □