

How Fire Engines Work

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Introduction to How Fire Engines Work

We see fire engines all the time, but have you ever stopped to think about all of the things that these machines do? Fire engines are amazing pieces of equipment that allow firefighters to perform their jobs and get to fire scenes quickly. The important thing to know about a fire engine is that it is a combination of a **personnel carrier**, **tool box** and **water tanker**. All three components are essential to fighting [fires](#).



Fire engines serve as a water tanker and toolbox.

With different fire departments having varying needs, fire engines come in all shapes, sizes and colors. In this article, we will take a close look at an Emergency One (E-One) pumper/tanker engine and a Pierce ladder truck. We'll also open up all the doors and compartments on these trucks and see what's inside!

Pump It Up

The primary function of any pumper/tanker fire engine is to carry water in a water tank or suck water in from an outside source, such as a fire hydrant, drop tank, swimming pool or lake.

On this pumper/tanker fire engine, the **primary water tank** is inside the vehicle, it holds **1,000 gallons** (3,785 liters) of water and it runs down the center in the rear of the truck. A **drop tank** is like a big aboveground pool that can hold about **2,000 gallons** of water. A 6-inch diameter, hard suction line is used to suck water out of the drop tank or other exterior water source.

Water stored in the engine's tank or sucked through an outside source is then discharged through water lines, or hoses. These lines are connected at points around the truck. We'll look at all the different lines later.

Priming

Before water can be sucked in from exterior sources, the line has to be **primed**. Priming the hard suction line involves pumping all of the air out of it. To prime the pump, the operator flips an electronic switch on the pump panel.



The large black pipes on the side of the engine are the hard suction lines. The walls of these pipes are rigid so that the suction of the pump does not collapse them.

The heart of the pump/tanker is the **impeller water pump**. On this particular fire engine, the pump is located just behind the jumpseat area, where the firefighters sit. An impeller is a rotor-like device that has curved blades. Driven by its own [diesel engine](#), the impeller spins inside the pump at a high rate. When water comes into the pump, it hits the inner

part of the impeller and is slung outward. **Water pressure** is created by centrifugal force from the spinning action of the impeller. A valve opens to allow water to hit the center of the rotating impeller. This action is described as entering the eye of the impeller, according to Capt. David Price of the Bayleaf Volunteer Fire Department in North Carolina.



The pump panel is used to control which hoses have water flowing through them at any given time.

You control the hoses using the truck's **pump panel** on top of the fire engine. The pump panel is a series of levers and switches that controls how much water is flowing and which lines are being discharged. When arriving at a fire scene, the driver will jump out and climb to the top of the truck to begin pump operation. An indicator -- a series of red lights on the pump panel -- lets the operator know how much water is left in the tank.

The first thing the pump operator is going to do is make sure that the **valve** between the tank and pump is open. An electric switch on the right side of the pump will open that valve, and ensure that water is flowing into the pump. Next, the operator will check to see which lines have been pulled off the fire engine by the firefighters, and the operator will discharge those lines. "Discharge" means that water is allowed to flow out of the pump and into the hose. The lines are color-coded to make it easy for the operator to know which lines to discharge. The color of the line corresponds to a plate below each lever on the pump panel.

Most of the discharging is controlled by a built-in electronic device, called a **mastermind**. It automatically controls the pump, and runs the pressure up or down. It also has a built-in relief valve, so that if one person suddenly cuts off a line, the pressure from that line doesn't automatically get fed into another line.

This truck also has a **foam system**, and carries about 20 gallons (76 L) of foam. The foam tank is embedded in the main water tank. Pumper/tankers carry different types of foam. This particular truck carries **Class A foam**, which can be used to saturate materials inside a structure to keep those materials from re-igniting. Class B foam is used to fight car fires and other fires where flammable liquids might be present.

In the next section, you'll learn more about the various hoses on the fire engine.

Hose It Down

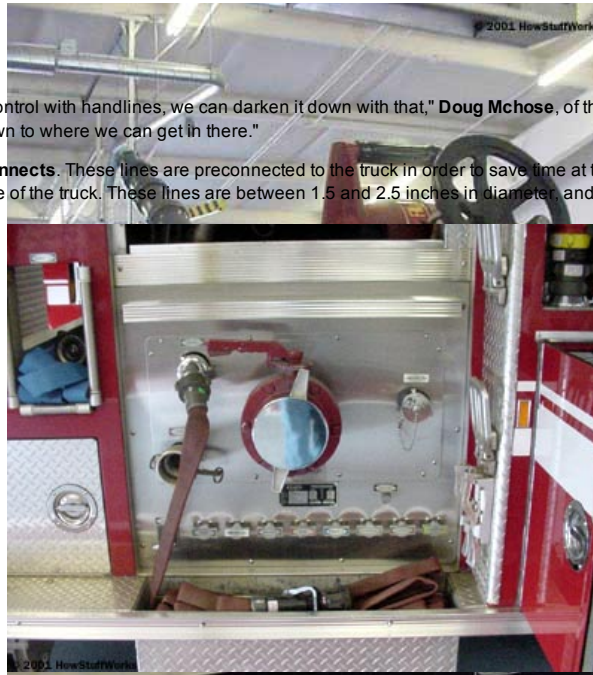
There are many types of hoses on the fire engine, and each has its own specific role in putting out a blaze. Hoses, also called **lines**, will put out different amounts of water depending on the hose length, diameter and the amount of pressure in the pump.

When responding to a house fire, the firefighters will immediately pull off the **crosslay hoses**. These lines are located directly below the pump panel. They lay out in the open and are light, so they are easy to get off the fire engine for attacking a fire. Crosslays are 200 feet (61 m) long, have a diameter of 1.5 inches and can gush water at 95 gallons (360 L) per minute. For smaller fires, such as small wood fires or chimney fires, the small booster line is adequate. A **booster line** is the smallest hose on the truck and has a diameter of about 1 inch.

Located directly above the pump panel is the **deluge gun**, also called a deck gun or master stream. Just by looking at it, you know why this water cannon carries those names. The deluge gun is used to put a lot of water on large fires. It can put out in excess of 1,000 gallons per minute.

"If we get a big fire, like a house fire that we can't control with handlines, we can darken it down with that," Doug Mchose, of the Bayleaf Volunteer Fire Department, said. "We can use that on it for a couple of minutes to knock it down to where we can get in there."

The truck also has at least three lines called **preconnects**. These lines are preconnected to the truck in order to save time at the fire scene. There's one preconnect on the driver's side, one on the back and one on the captain's side of the truck. These lines are between 1.5 and 2.5 inches in diameter, and can put out 250 gallons (946 liters) per minute.



A 5-inch-diameter hose is stored on top of the truck. This is the line that the firefighters will hook up to fire hydrants. There's also another 2.5-inch-diameter hose stored in 100-foot sections. This is the line that the firefighters will



The wide yellow hose in back carries water from the hydrant to the fire engine.

In one of the compartments on the captain's side of the truck, there are extra sections of hose. There are two extra sections of the 5-inch hose: a 25-foot and a 50-foot section. These two sections are called **curb jumpers**, because they typically lay on the curb. These sections give firefighters just a little bit more line to connect to a fire hydrant without having to get another 100-foot section down.



Curb jumpers and hose packs

Also stored in this compartment is a **hose pack**. A hose pack is a small, bundled hose that can be taken to the higher levels of a building. It is banded to make it easier to carry up a ladder. A firefighter can just throw it over his or her shoulder and take it up and through a window. Usually, a hose pack is used if the other lines can't reach inside. This hoseline will connect to the hose that runs up the ladder of the ladder truck, which you will learn more about in the next section.

Going Up!

When a fire breaks out in a [multi-story building](#), a **ladder truck** is used to get firefighters to the higher floors.



The ladder on the truck is raised and lowered using a **hydraulic piston rod**. As hydraulic fluid enters this piston rod through one of two hoses, the pressure of the fluid will either cause the rod to extend or retract. If the piston rod extends, the ladder will go up. If it retracts, the ladder will come down.

Another set of hydraulic hoses allow the sections of the ladder to telescope up and down. A hydraulic motor is used to rotate the [gear](#) that moves the ladder from left to right. While the ladder is in use, four outriggers are extended to stabilize the truck.



One of the outriggers

On this 105-foot (32-m) ladder truck built by [Pierce](#), the ladder also has a 3-inch pipe that runs the length of the ladder. This is an extra water line that is sometimes used to spray water on fires that are in a high spot, or to spray water down on a fire. This pipe can spray out 1,000 gallons per minute.



The ladder is controlled by a series of joysticks at the base of the ladder. The outriggers are controlled in the back of the truck. Each outrigger has four control levers: two for extending the beam out and two for lowering the leg to the ground. Metal pads are placed under the legs to absorb the force of the truck from cracking asphalt surfaces.

The Ultimate Mobile Toolbox

For large fires, or fires in high locations, the ladder truck has a line that can be raised 150 feet to attack a fire from above.

Firefighters have to take dozens of tools and other equipment when responding to a fire or medical call. All of this equipment is stored in several compartments that line the sides and back of the fire engine.

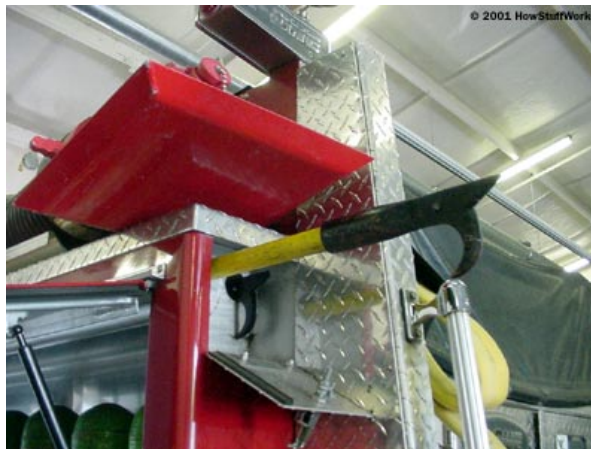


A fire engine carries dozens of tools and supplies in its compartments, including forceful-entry tools, nozzles and hydrant connection adapters.

Let's open up each compartment and see what's inside.

Here is a list of some of the tools found on a fire engine:

- **Barrel strainer** - This is an attachment put on a hard suction hose when sucking water out of a lake or pond. This tool keeps debris out of the water supply.
- **Nozzles** - Different nozzles are needed for different situations. Fog nozzles put out more of a strong mist of water. Other nozzles direct water in a solid stream. There's also a **piercing nozzle** that can be used to punch through walls and spray areas that can't be reached otherwise.
- **Foam inductor** - This is a special nozzle used to mix water and foam.
- **Haligan tool** - This tool looks similar to a crowbar.
- **Sheet rock puller** - This tool is used to peel back the sheet rock on walls so that water can be sprayed inside the wall.
- **Pike poles** - These spear-like tools are about 10 to 12 feet long and are thrust into the ceiling to pull sheet rock down.



A pike pole is one of the forceful-entry tools used by firefighters.

- **EMS equipment** - Most fire engines carry a [defibrillator](#), an emergency oxygen tank and a **trauma jump kit**, which includes all of the first aid equipment needed for emergencies.
- **Gated Y** - This special hose adapter can be attached to a line to allow two smaller lines to run off of the same water source.
- **Spanner wrenches** - These unique tools are used to tighten the lines to the fire engine or to a hydrant.



Here you can see spanner wrenches and a hydrant wrench.

- **Hydrant wrench** - This is the wrench used to turn the hydrant on.
- **Jaws of Life** - This extrication equipment is used to free victims from car or building accidents. Read [How the 'Jaws of Life' Work](#) to learn more about these hydraulic machines.
- **Exhaust fan** - This fan is placed in the doorway to suck smoke out of the house. Fire engines may also carry a **positive-pressure exhaust fan**, which blows air through the house and out the other side.
- **Salvage covers** - These are used for covering furniture on a lower floor while firefighters attack a fire on a floor above.

In addition, fire engines also carry bolt cutters, a sledge hammer, a [fire extinguisher](#), a water cooler, a 24-foot (7-m) extension ladder and a 16-foot (5-m) roof ladder. Some trucks may also carry [chain saws](#), rappelling rope and backboards, which are used to transport injured people.



Fire engines used for rescue will often have the "Jaws of Life" onboard.

As you can see, there are a lot of tools and devices stored on a fire engine, and the design of the fire engine maximizes all possible storage space.

Grab a Seat

The unique design of a fire engine allows it to carry a lot of crew to the fire scene. Up to eight firefighters, including the driver and the captain, can fit onto this E-One fire engine. The cabin of the fire engine is divided into two sections: the front seat, where the driver and captain sit, and the jumpseat area, where the firefighters sit.



As mentioned before, the driver is responsible for controlling the pump panel. For this reason, there are some basic controls on the driver's dashboard that are related to that task. Two red switches near his left hand operate a generator and jet dump. A jet dump essentially discharges all of the water in the tank into a drop tank through a large discharge outlet in the back.

The driver has another switch within reach that activates the **automatic tire chains**, which are sometimes needed to drive through ice and snow. Automatic tire chains save the time and hassle of jacking the truck up and putting tire chains on manually. [Click here](#) to learn more about automatic tire chains.

The captain sits in the passenger seat next to the driver in the front section of the cab. The front section of the cab has a **firecom**, which are [radio](#) headsets that allow the captain and driver to communicate with the firefighters sitting in the jumpseat area. The captain will often give instructions to the firefighters on the way to the fire scene.

The **jumpseat** area is like the backseat of your car. This is the area where four to six firefighters sit on the way to the fire. There is one row of four seats that sit back-to-back with the captain and driver. There are also two fold-down seats directly across from the row of four seats. In between the fold-down seats, there several yellow pouches that contain the firefighters' masks.

Air packs are located in the back of the four main seats. By already having the air packs on the truck, all the firefighters have to do is put them on their shoulders. Each air pack has 30 minutes of air.

For more information on fire engines, firefighters and related topics, check out the links on the next page.

Lots More Information

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- [How Fire Works](#)
- [How Wildfires Work](#)
- [How Smoke Detectors Work](#)
- [How Water Towers Work](#)
- [How the 'Jaws of Life' Work](#)
- [How do smoke detectors intercommunicate?](#)
- [Why does smoke come from a fire?](#)
- [How do multi-class dry chemical fire extinguishers work?](#)
- [What do the big diamond-shaped signs with red, yellow and blue diamonds mean?](#)

More Great Links

- [Fire Engine Tour](#) City of Davis, CA Fire Department
- [American LaFrance](#) (manufacturer)
- [E-One](#) (manufacturer)
- [Pierce Manufacturing](#)
- [National Fire and Rescue Magazine](#)
- [Boulder Rural Fire Department](#) (includes photos)
- [National Fire Protection Association](#)
- [FireHydrant.org](#)