

FIRE RESCUE

Read It Today, Use It Tomorrow

SUCK IT UP!

**Vacuum Trucks Aid Trench
Rescue Operations, p. 60**

PLANE FACTS

**Aircraft Rescue Firefighting
Training & Tactics, p. 54**



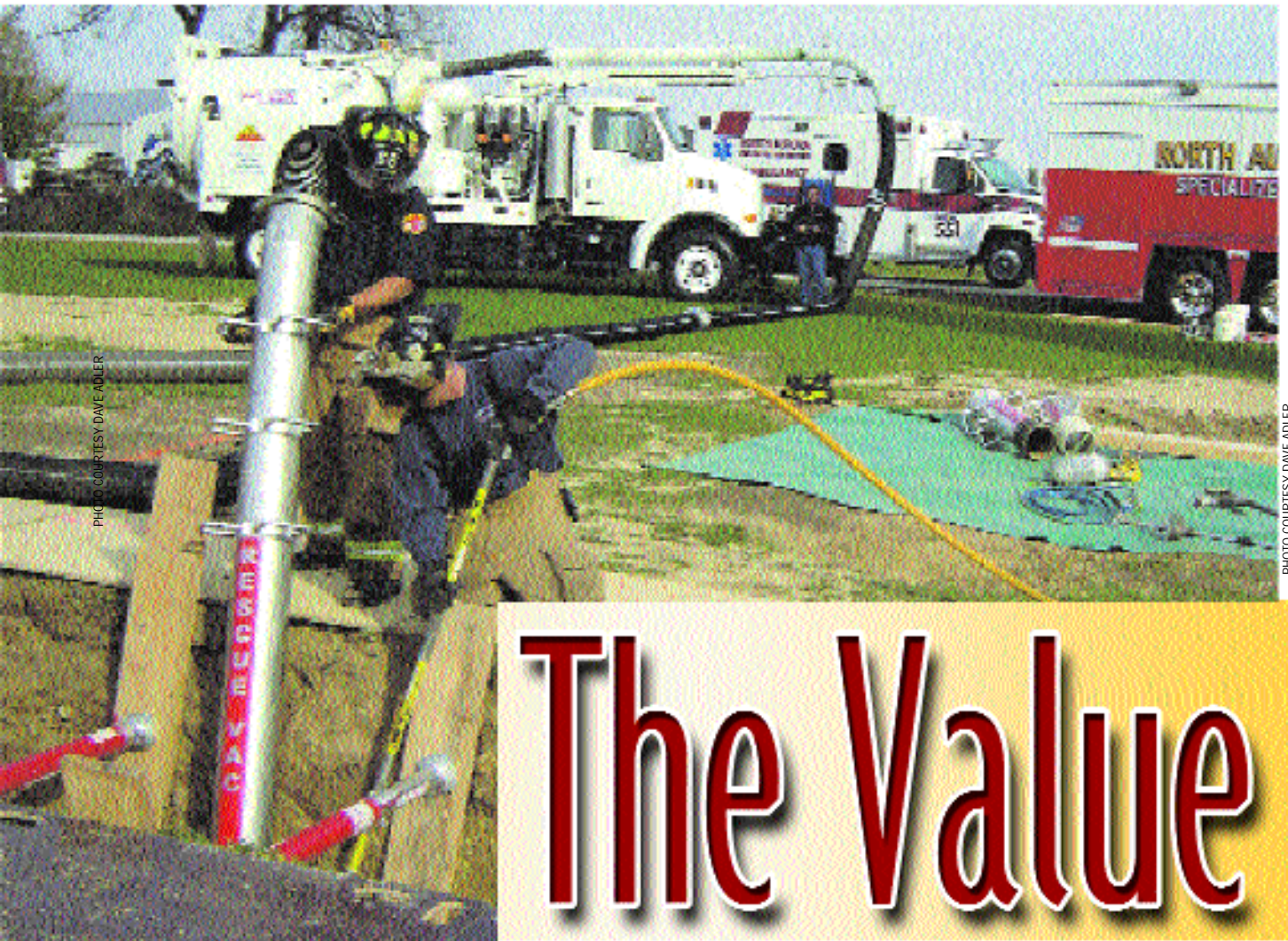


PHOTO COURTESY DAVE ADLER

PHOTO COURTESY DAVE ADLER

The Value

Using vacuum trucks to perform trench rescues

The Rescue Vac system uses 20' sections of hose, a manual relief valve and custom nozzles with a safety tip, allowing the truck to set up well outside the trench's hot zone. The system can speed up soil and water removal time by up to 80 percent.

Story, Illustrations & Photos By Tom Pendley

Fire department rescue teams all across America respond to trench cave-in emergencies on a daily basis. One grim statistic, which indicates rescuers make up about 65 percent of all deaths resulting from trench cave-ins, proves trenches are very dangerous places for both contractors and rescuers. Equally grim is the fact that many survivors who are unearthed and rescued end up dying in the hospital days later from the effects of crush syndrome or traumatic injuries.

Crush syndrome occurs, in part, because it takes time for rescuers to protect a trench and remove the soil and debris trapping the victim. The syndrome can develop within 30 minutes of sustained pressure applied to large muscle groups. Since the average cave-in involves approximately 1.5 cubic yards (or approximately 4,000 lbs.) of debris, it can take quite some time to move that amount of dirt with the traditional 5-gallon bucket and garden spade.

One available resource can speed soil removal by 80 percent: the vacuum truck. The vacuum truck is not exactly new—most cities' public works departments use one or more of these trucks on a daily basis—but few people completely understand how to safely use a vacuum truck to help dig a trapped person out of a collapsed trench. This article will explain how vacuum trucks work, the hazards associated with them and how you can safely use them in trench operations. I'll also discuss the new Rescue Vac system and how it has revolutionized trench-rescue operations.

TYPES OF VACUUM UNITS

Technically, vacuum trucks are described as pneumatic (air) conveyance equipment—in other words, they use airflow to move material. Vacuum trucks first appeared in the 1960s as equipment designed for the municipal public works market, and they were widely used with great success to clean clogged or plugged sewer lines, culverts and storm drains. But soon after the development of

Centrifugal Fan Vacuum Truck

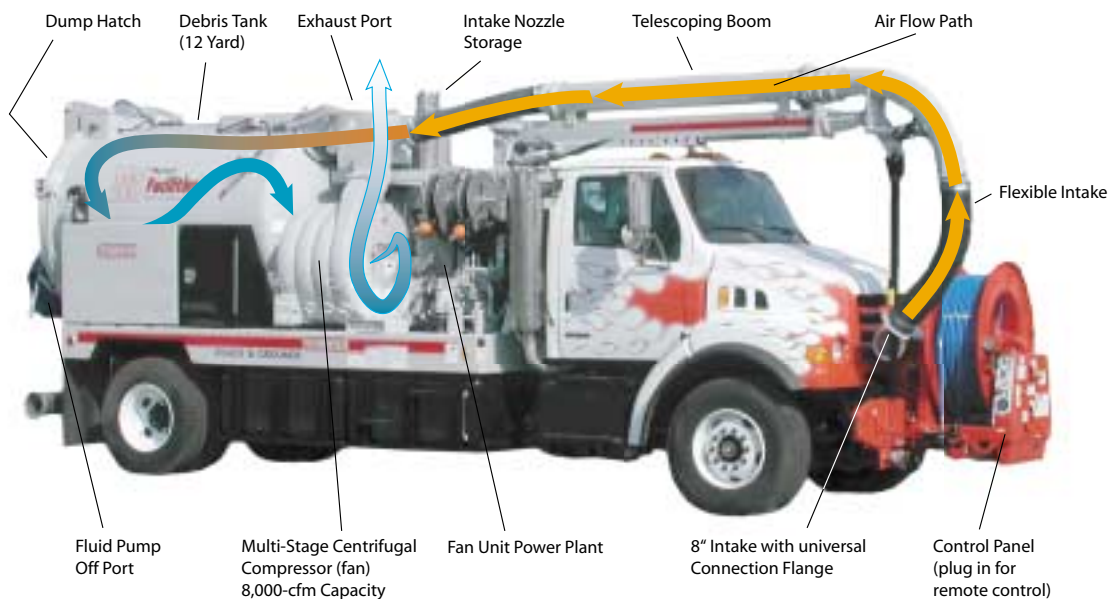


ILLUSTRATION TOM PENDLEY

of a Vacuum



RIGHT: The flanges on the standard 8" hose are universal. This clamp holds the sections together.

sewer cleaners, other large, truck-mounted vacuum technology began to appear, such as large industrial vacuum loaders that recovered valuable raw materials and performed maintenance in industrial facilities. The hydro-excavator, a more recent invention, is a vacuum truck equipped with high-pressure air and water nozzles for locating buried utilities and performing excavation work.

The most common municipal vacuum truck, a centrifugal fan unit (or fan unit for short), generates its vacuum by using a large fan (a 38" fan

diameter is typical). This system is very similar to a shop vacuum: The fan creates airflow through a pick-up hose (an 8" diameter is typical for a municipal truck), which then flows through a debris chamber and out through the fan housing exhaust chamber (see illustration above).

Air serves as the transporting medium in fan units; therefore, airflow is key to good suction performance. A typical fan unit generates 3,000–8,000 cubic feet per minute (cfm) of airflow. Actual vacuum pressure on a fan unit is considered low because it's measured in inches of



This is about a yard of soil dumped on top of a dummy. We vacuumed it up in less than 10 minutes. The vacuum truck is impressive because it sucks up large clumps of dirt and softball-size rocks with no problem.



The standard tip can cause injury to a live patient. An air knife would speed up trench rescue operations and allow the tip to work in a sump created next to the patient.

water rather than inches of mercury (Hg). Some manufacturers offer an optional two-stage compressor that boosts suction performance by increasing airflow velocity.

The second type of vacuum truck looks identical to a fan unit, but uses a positive displacement (PD) air pump. A PD unit generates 2,000–3,000 cfm of airflow, but a much higher vacuum pressure—typically about 13 inches Hg. **Warning:** A PD vacuum truck's hard vacuum can cause severe injury.

PD units are most commonly used in industrial applications that require much higher lifting capacity. One manufacturer told me that there are about three fan unit trucks for every PD truck. You can use a PD truck to remove soil, but you must exercise extreme caution.

Contractors and municipalities use a number of smaller vacuum units, but they are less common and less powerful. The smallest vacuum unit is handheld and operated off a commercial air compressor. This lightweight, maneuverable device features a 3" diameter hose and a 265-cfm rating, but is only suitable for moving small-diameter solids, such as sand and pea gravel. The next size up is a trailer- or skid-mounted unit that features a 3–4" hose and a 500–850-cfm rating. Like the handheld unit, the trailer unit is only useful for uniform, finely divided solids.

CUTS LIKE AN AIR KNIFE

Even with an 8"-diameter hose, large fan unit trucks don't move large chunks of soil as well as they do smaller pieces of soil. An air knife is an indispensable tool that breaks the soil into small pieces for the vacuum unit. Air knives are widely used by contractors, arborists and the military for land mine and unexploded ordinance removal and do not damage cables, pipes or tree roots.

An air knife fractures and aerates the vacuumed soil, which facilitates rapid soil removal through the vacuum nozzle. A common air knife used for soil reduction in the construction industry operates at 100 psi and 150–185 cfm.

Hydro-reduction tools are everyday pressure washers that you can purchase at your local construction supply store. These tools use water pressure to break up the soil, but operate at dangerous pressures that can reach up to 5,000 psi. **Note:** Never use hydro-nozzles when there's a chance you might come in contact with or hit a victim or rescuer.

To operate an air knife, you need a typical trailer-

mounted contractor's compressor. Like the vacuum truck, most cities have air compressors in their public works fleet. If not, locate a rental source and establish an agreement.

VACUUM TRUCK HAZARDS

The first problem with using a vacuum truck for soil removal at a trench cave-in emergency is its weight—a loaded vacuum truck can weigh up to 60,000 lbs. Since the typical truck can only work in **close proximity to the trench (15 feet away)**, it increases the risk of a secondary collapse. **[Tom: This is confusing. A Vac truck can only work close to a trench, but the standards prohibit it from getting that close? Can you clarify?]**

Another problem involves the vibration generated by the truck motors. OSHA does not limit operation of equipment near trenches, **but most trench rescue standards prohibit operating equipment within 50 feet of the trench.** Ideally, you should establish a 300' vibration-free zone prior to installing protective systems.

Warning: The vacuum nozzle's high airflow can cause serious injury to the rescuer and victim. Exercise extreme caution to prevent physical contact with the nozzle. A positive displacement unit could cause severe injury with its hard vacuum.

TRENCH RESCUE WITH VACUUM SOIL REMOVAL

To perform a trench rescue using vacuum equipment, first safeguard the area by establishing a 50' hot-zone perimeter. Early in the incident, determine the viability of the person trapped. If you determine the patient is viable, proceed with the rescue ▶



ABOVE: Most vacuum trucks have some type of vacuum relief valve that you can open from the operator's remote control. Opening this valve effectively dumps vacuum pressure and is an important safety feature. **LEFT:** This is a typical remote used by the vacuum truck operator. The control for the mounted relief valve is on this remote.

The Air Knife & Air Spade

Pneumatic soil reduction is a fast way to pulverize soil for vacuum removal and to make clean bench cuts in collapsed areas to install shores and whales. The Air Spade by Concept Engineering and the Air Knife by Angel Guard Products is sold in a kit for trench rescue for about \$1,900. The 150-cfm nozzle delivers air at Mach 2, but exerts only 10–14 lbs. of transient force. For more information, go to www.angelguardproducts.com or www.air-spade.com.

operation. (The rescue becomes a recovery operation if you determine the patient is non-viable, and you should proceed with minimal risk to rescuers.)

During your size-up of the incident, assess the need for any special resources, including a vacuum truck and an air compressor. Place ground pads around the trench lip, and remove trip hazards. Mark the locations of tools used to help pinpoint the location of a buried victim. Set up a resource area at the edge of the hot zone and begin assembling shoring

equipment. To create a safe zone, the team leader should determine the best location to install the first set of shores.

The shoring team works with the resource team to assemble shore components for installation, such as sheeting, upright timber, cross braces and hardware. Once shores are in place, rescuers should enter the safe zone and manually move dirt from around the patient's head and chest to facilitate breathing.

Establish a sump area on one side of the patient ▶



LEFT: One key safety feature of the Rescue Vac system is a manual relief valve. A rescuer stands by, much like a belayer, who can pull open the valve immediately and relieve vacuum pressure. **CENTER:** The Los Angeles County Fire Department's rescue crew uses the

Rescue Vac system on a body recovery. Rescuers can quickly remove soil without entering the dangerous trench. Note the use of an air knife in conjunction with the vacuum nozzle. **RIGHT:** The vacuum truck is designed to remove soil, sand, grain, rocks and water. Here, a Rescue Vac nozzle pulls in water. Remember, air is the transporting medium and the tip should not be immersed in the soil or water. The air knife aerates the water and speeds up the vacuum process.

The Rescue Vac System

The Rescue Vac system [Tom when was this introduced?] uses supplemental, lightweight, 8" hose that incorporates static-dissipating properties, attaches to the standard intake of municipal vacuum trucks and allows rescuers to keep the heavy truck away from the hot zone. The hoses use standard couplings that connect to any municipal vacuum truck. Additionally, you can place your vacuum truck a safe 200 feet vertically and/or 800 feet horizontally from your rescue site and still maintain good airflow. Positioning of the vacuum truck at your trench collapse site is crucial.

The Rescue Vac manual vacuum relief valve is placed in clear view of the rescue site and permits an instant release of vacuum pressure. (Remember: The rescue might be behind a building or on a hillside, outside the vacuum truck operator's field of view.) The relief valve is an important safety feature you can use if a body part becomes pinned to the nozzle, or you just need to reposition. A safety person holds the pull cord for the relief valve and stands by much like a belayer.

Finally, three specially designed nozzles

complete the Rescue Vac kit. The nozzles have several handles and range in size from 2 to 10 feet in length. This system is much safer for rescuers because they no longer have to dig on their hands and knees with buckets and garden shovels on the bottom of a trench that has already collapsed. The 5' Rescue Vac tip allows the rescuer to maintain a standing position and move soil quickly and safely.

One of the most difficult rescue scenarios is the water main break or trench collapse during a rainstorm. The trench is full of wet, flowing mud, and the water level is increasing. Trash pumps plug up and buckets aren't enough. You can utilize the Rescue Vac's 10' tip from the safety of the trench lip, and rescuers don't have to enter the trench down to the 10' level. You can also attach rope to the nozzle handles so belayers can support it during operation.

The Rescue Vac System was designed for use with an air knife that pulverizes and aerates the soil. A vacuum in and of its self only removes surface materials, and the air knife aerates and blows soil around. It's the patented combination of both, fracturing and aerating the material *under* the

Rescue Vac's specially designed vacuum tips that creates an incredible rescue system. This system has the same results with water, gravel, grain, mud and soil. The Rescue Vac can be utilized in landslides, silo and cargo ship engulfment, trench and structural collapse, and parallel vertical shaft rescues. A construction air compressor can deliver 150–185 cfm of airflow to the air knife. One or more rescuers work the nozzle while another rescuer operates the air knife under the nozzle tip. This way, you transfer the maximum amount of soil to the truck's debris collection tank.

Since fire departments can save up to \$250,000 by utilizing local vacuum truck and air compressor resources, the Rescue Vac becomes an efficient and valuable tool for our rescue arsenal. The basic Rescue Vac System costs about \$10,000 and comes with a two-day training course. For more information, call 800/301-6798, or go to www.rescuevacsystems.com.

One grim statistic, which indicates rescuers make up about 65 percent of all deaths resulting from trench cave-ins, proves trenches are very dangerous places for both the contractor & the rescuer.



PHOTO COURTESY DAVE ADLER

A vacuum truck can quickly remove the soil pile to help make the work area safe. This process enables rescuers to complete rescue operations in minutes rather than hours.



PHOTO COURTESY DAVE ADLER

The safest and most effective way to excavate a trapped person is to create a sump area in front of them. This helps reduce pressure on the chest and abdomen, facilitating a better respiratory exchange. Once you create the sump area, the air knife can blow soil from around the patient into the sump for quick removal.

(see sidebar on the Rescue Vac system, p. 64). Use an air knife to blow dirt toward the sump and to pulverize and aerate the soil to be vacuumed. *Remember:* Protect the victim's head and face from blowing dirt, and do not allow the victim's arms or legs to enter the vacuum nozzle.

Uncover the victim completely prior to removal. You can best accomplish this by using a combination of manual and pneumatic soil removal. Once free of soil, rescuers can extricate the patient with a basket or a patient-lifting device, such as the Yates Spec Pack.

THE REAL WORLD

Important: If you're called to a trench emergency with lots of dirt and/or flooding, vacuum trucks are helpful tools, but should not come near the trench. If you don't have a Rescue Vac System, there are some alternatives: For body recoveries, shore the trench and then vacuum the soil using the truck's standard equipment without putting rescuers in the trench. Remove the truck from the area to dump so rescuers can then enter the properly protected trench to finish extrication. Consider benching and/or sloping options also.

In other situations, such as trench rescues involving flooding, use common sense and good risk management. I'm not going to tell you that you should never work inside a trench while the vacuum truck is within 50 feet of you, because we are in the life-saving business and there's a lot of gray area during a rescue operation—but you must be realistic about the risks and benefits of entering a trench, and stack the odds in your favor. If you choose to operate outside of policy, be prepared to accept responsibility for that decision.

CONCLUSION

Pneumatic soil reduction and removal (vacuuming) is an innovative way to quickly rescue someone partially or completely buried in a trench. If you think you might use these tools, get the right equipment and practice with your public works department and/or local contractors to understand how to use them. Create a resource list with emergency phone numbers so you can get these resources moving fast, and remember to base your decisions on realistic, objective thought processes, not the compassionate, desperate desire to save someone. ☺

Rescue Editor Tom Pendley is a captain/paramedic with the Peoria (Ariz.) Fire Department and a member of its technical rescue team. Pendley teaches technical rescue for the Phoenix Fire Department and is currently a technical rescue instructor for the Arizona State Fire Marshal's office. He is also the author of *The Essential Technical Rescue Field Operations Guide*. He can be reached at 623/533-1234 or tom@desertrescue.com.