Vehicle Rescue Equipment

The following is a list of some of the extrication equipment available to rescuers. While not intended to be complete, it does list capabilities and instructions for use where applicable.

AIR BAGS

Since their introduction to the American rescue service in the 1970's, air bags have been used in many rescue operations. Because of their unique design, their adaptability makes them a vital resource of any rescue squad or fire department.

Air bags have been used successfully in response to accidents involving automobiles, trucks, rail cars, elevators, building collapses and heavy equipment. Their powerful force allows rescuers to lift, spread, shift, bend, force, or move. Air lifting bags were developed by Manfred Vetter in Europe in the mid 1960's and were first approved by the German government for use in vehicle rescue. They came into use in USA in the early 1970's. The air bag gets its name from its source of power - air. The air used to inflate the bag comes from compressed air cylinders (SCBA), compressors, apparatus air systems, or a hand pump. The SCBA is the most commonly used system.

There are high, medium, and low-pressure air bags. The low and medium pressure bags, operating at approximately 7 to 14 psi, are used to lift, support, or move heavy objects. Because of their lower pressure they can be used against the thin skins of cars without damaging them. Weighing as little as thirty pounds, these bags are capable of lifting 7 tons to a height of almost 24 inches. They are constructed of neoprene and Kevlar fabric; are highly resistant to oil and chemicals, tears, punctures, and heat; are very durable, and are available in special carrying cases that allow for transporting to remote areas. It is always advisable to use low and medium pressure bags in pairs for safety reasons.

High-pressure air bags operate at higher pressures, usually over 100 psi. They come in a variety of sizes and can lift from one ton to 60 tons. High-pressure bags can lift tremendous weights, but have one serious shortcoming. They can only lift their maximum rated weight one inch. This may be enough to slide someone out from underneath a bulldozer for example, but not high enough to work underneath a car. Maximum lifting height and maximum lifting force cannot be achieved simultaneously because as the bag is inflated, the bag arcs and reduces surface contact and a loss of lifting power and height is seen. When not lifting their maximum rate, high-pressure bags can lift a lessor weight to a height of almost 20 inches. Achieving maximum air bag height usually means that only one-half of the capacity of the bag is available. (Always use as big a bag as possible).

High-pressure bags are constructed of neoprene with either steel wire or Kevlar fiber as reinforcement.

100% Contact.

A high-pressure air bag maintains its theoretical 100% capacity only until the center is approximately 2 inches in height. Further inflation diminishes the capacity.

50% Contact

Higher inflation means lower capacity. Maximum height yields one-half maximum capacity.

While high-pressure bags are like a flat radial tire and inflate from a stable to an unstable state, low-pressure bags are different. They are more like a large air cushion and inflate from an unstable state to a stable, firm platform. Low-pressure bags rely on its sidewalls for strength, and must always be inflated fully. (Unlike high-pressure bags, lowpressure bags are designed to lift maximum weight at maximum height). Low-pressure bags should never be stacked on top of each other, and should always be used in conjunction with one another to distribute the load evenly.

Each type of air bag is labeled with the capacities for lifting height and weight, air volume and operating pressure. A distinguishing mark indicated the center of the bag is used for proper placement during operations.

AIR BAG COMPONENTS

A high-pressure regulator reduces the SCBA cylinder pressure down to the operating pressure. The regulator contains two gauges, the low and high pressure. The high pressure gauge indicates the cylinder pressure while the low pressure gauge is set for the operating pressure of the air bag system. (This depends on the type of bag used and the manufacturer). A hose is connected to the air outlet connection, which is the supply line for the controller. This system - SCBA cylinder, regulator and hoses - is portable, fast and easy to operate, especially in confined spaces.

The air bag itself has a label that shows the cubic feet capacity of the air volume for complete inflation. An important part of your operating plan must allow for having sufficient air on hand, depending on the number of bags, their capacities and the number of lifts that may be required for a particular operation. A six-inch by six-inch high pressure bag requires 14 cubic feet of air, while a 36 inch by 36 inch high pressure bag requires 47 cubic feet. (A standard SCBA bottle has 45 cubic feet of air).

Air hoses come in varying lengths and colors. It is very important for different colored hoses to be used in multi-bag operations. Often, the operator of the controller will not be able to see the air bag being used. Instructions to the operator from another member should be given by code color to prevent confusion. Picture two bags positioned to lift a heavy vehicle off a pinned victim. They are supplied by one controller and are at

opposite ends of the vehicle, out of sight of the operator. The member directing the operator relays, "Inflate the green hose," "Take up easy on the red hose," and the like. The bursting pressure of air hose is approximately 1,000 psi, well above the operating pressure. The hose has a male connection at one end a quick-connect, locking safety couple on the other.

The controller operates the air bag itself, and is designed for either single or dual capacity. A dual controller has a separate low pressure gauge and safety valve for each air outlet. Built-in safety relief valves prevent over pressurization of the bags. The controller contains control buttons which are "deadman" in nature. This means that should the operator let go of the controls, all action stops at that point. The components of the controller are:

a) air inlet valve & hose coming from the air supply.
b) operating gauges
c) control valve
d) safety relief valve
e) air outlet connections

Air bag's capabilities are directly related to their size. A six-inch by six-inch bag has a working surface area of 4.74 x 4.74 inches, which equals 22.46 square inches. This multiplied by the input pressure, 118 psi, gives you the bag's lifting capability, which in this case is 2,650 pounds. (This bag can lift over a ton). A 30-inch by 30-inch bag can lift approximately 53 tons. Stacking two bags does not increase lifting capacity, it only increases lifting height. If two bags of different lift capability are stacked, the bag with the least capability is the rated load. (Example, if a 2 ton bag and a 4 ton bag are stacked, only 2 tons can be lifted).

For this air bag, the theoretical lifting capacity is the bag's length (30 inches) times the bag's width (30 inches) times the system's maximum pressure (118 psi), which equals 53 tons.

OPERATIONAL GUIDELINES

Setting up the system is easy. Using an SCBA cylinder, connect the regulator to the cylinder, making sure the connection is tight, and open the air source slowly. The high pressure gauge will indicate the cylinder pressure. The low pressure gauge is then set to the operating pressure. During operations, the high pressure gauge must be checked to ensure that sufficient air is available. In extended operations, additional air should be readied. All valves and controls should be in the closed position to prevent accidental discharge of air.

After the regulator is attached, connect the supply hose from the regulator to the controller, making sure that the locking couplings are secure. Opening the outlet valve on the regulator will provide airflow to the controller. Once the connections on the controller are secure, a supply hose attached to an air bag can be connected to the outlet of the

controller. After a check that all connections are secure, the bag can be positioned under the load, with the air inlet nipple pointing outward. Whenever possible, the hose should be attached to the air bag prior to placing the bag under the load. This provides an additional safety factor by keeping the rescuer away from the load, limiting exposure time.

The operator now uses the control lever, or toggle switch on the controller to inflate the bag. Bags should be inflated slowly to prevent shifting of the load and should be inflated only as much as needed, which really depends on the incident itself. Over inflation of the bag is prevented by the safety relief valve of the controller.

Centering the bag under the load is extremely important. Centering provides a stable lift and prevents the bag from "popping out" from under the load. A bag popping out can be very dangerous; the load loses its support, possibly injuring the victim and/or rescuer.

When using two bags, always place the larger bag on the bottom and center the smaller bag on top. Use two hoses of different colors to prevent accidental inflation of the wrong bag, and always inflate the bottom bag first. If two bags of the same size are used, center both under the load. Inflate the bottom bag to its maximum capacity and then the top bag to the height required. Never use more than two bags on top of each other. To obtain the maximum capabilities of air bags, use the largest bag when possible, use cribbing or shoring religiously and use two air bags to gain additional height.

Cribbing is sued to gain height, support the bags and protect the bag from objects or surfaces that could damage it. Cribbing should also be used to support the load that has been lifted to prevent shifting or to completely support it. The safety of rescuers should always be the number one consideration.

AIR BAG SAFETY RULES

Operators should follow these safety rules when using air bags:

- Plan the operation before starting the work.
- Be thoroughly familiar with the equipment; its operating principles, methods and limitations.
- Keep all components in good operating condition and all safety seals.
- Have an adequate air supply and sufficient cribbing available before beginning operations.
- Position the bags on or against a solid surface.
- Never inflate the bags against sharp objects.

When placing air bags, personnel should avoid heat sources such as the engine block, exhaust system and catalytic converter.

BOTTLE JACKS

Hydraulic bottle jacks are designed for lifting, but not sustained rated capacity loads. They can be used vertically or angled to 5 degrees from vertical position. Suitable for horizontal and vertical use in a appropriately rated and designed press or clamping fixture. These jacks are not recommended for use in lifting or positioning houses or buildings. Bottle jacks come in the capacities that range from 2 tons to 30 tons.

General Safety Information:

1. This is a lifting device only. Off center loads and loads lifted while jack is not level may damage jack and cause personal injury.
2. Bottle jacks are intended for lifting part of a total vehicle, only one wheel or axle at a time.
3. Do not exceed rated capacity. Use only on hard, level surfaces capable of sustaining rated capacity loads.
4. Inspect jack before each use. Do not use if bent, broken, leaking or damaged components are noted.
5. Avoid “shock loads” created by quickly opening and closing the release valve as load is being lowered. This may result in overloading of the hydraulic circuit and possible damage to the jack.

Lifting Operations:

1. Help prevent inadvertent vehicle movement by fully engaging emergency brake, putting transmission in park. Use wheel chocks in pairs on the wheel diagonally opposed to the wheel or axle lifted.
2. Close relief valve by turning the handle clockwise until it is firmly closed.
3. Position jack under proper lift point, operate jack until solid contact with lift point is made. Ensure load is centered on saddle.
4. Raise load to desired height by pumping handle or squeezing air control valve. Immediately transfer load to jack stands or box cribbing.

Lowering Operations:

1. Insert handle into release valve and slowly turn counterclockwise no more than one full turn.

CRIBBING

"IF YOU LIFT AN INCH, YOU CRIB AN INCH"

The tools used to redistribute the weight of a vehicle range from the simplest of wood blocking to more complex hydraulic and pneumatic devices. This article is about the simplest of your entire rescue tool cache, wood. The common name for blocks of wood used for this purpose is cribbing. Cribbing is wooden blocks of different shapes and

sizes and is used to stabilize large and heavy objects. It is one of most useful and versatile tools at the rescuer disposal. There are 2 important factors about cribbing that you should be aware of:

1. It is very cheap.
2. It seems as though you never have enough.

Every fire engine and squad truck should carry as much cribbing as can fit.

Cribbing should:

- not be painted or varnished since this makes the surface slippery and may hide
cracks.
- have handles to facilitate movement. Handles should be either rope or webbing.
- be made of oak, hard maple or ash for strength, but oak is not only expensive, it's not available to much of the country.. For those in the South, southern yellow pine (usually treated) will give the best load bearing capacity for heavier jobs, such as semi's, buildings, etc. Do not use white pine, spruce of fir since these soft woods will crush and splinter.
- be inspected regularly for the following:
  - Large cracks.
  - Petroleum saturation.
  - Chemical exposure.
  - Rotting.
- Be checked constantly for tightness (have someone assigned to do this).

Cribbing will work loose as work progresses, especially if the car has not been isolated from its tires. (Radial tires tend to sway.) Cribbing can be stored in numerous ways. It can be stacked in the compartment with the grab handles facing out for easy access. It can also be placed on end inside an old milk crate. You should experiment with storage methods and select the one that best suits you needs. One last note on cribbing… don't scrimp or be cheap. Cribbing is often the most important safety tool you have. If you intend to crawl under a load to rescue a patient, you deserve the most safety possible.

SIZES

Cribbing can come in any size you wish. The most common sizes are 2 x 4 's, 4 x 4 's, and 6 x 6 's, (size indicates height and width). The most common lengths found are 18" to 24". You will want to carry a variety of sizes for the different situations you may come across. (4 x 4 's are the most commonly used size, 2 x 4 's are too small while 6 x 6 's are difficult to store and transport). Cribbing comes in forms other than blocks. Wedges are needed to fill in narrow spaces where the next size block won't fit.

Wedges can be used with or without other cribbing to fill gaps (left) or tilt cribbing to better fit the vehicle (right). They are also valuable for increasing an

opening for a tool to fit. A step chock should be constructed with either waterproof wood glue or construction adhesive plus countersunk wood or drywall screws. A single 8-footlong, 2-by 6-inch board will yield one chock. (Step chocks are not suitable as vehicle repair ramps.)

One step chock which increases ground contact by 30 inches can be fashioned from an 8-foot long, 2 x 6 board. Because the step chock is built ahead of time, it's easy to place, yet it stores easily on most apparatus. A step crib is best used to stabilize a car that is on its wheels.

Remember that you will never have too much cribbing on the scene of an accident. You will need to learn ways to best utilize this limited resource. One of the best ways to use a little to get a lot is to build a box crib. Instead of laying the blocks on top of each other, stack the blocks in alternate layers, each layer at right angles to the previous one.

BUILDING A BOX CRIB

At the scene, blocks are stacked in perpendicular layers to create box cribbing which fits under the vehicle at strategic support points. This is known as the 4 point box crib.

Using a 4 point arrangement, 4 x 4 wooden blocks will hold a estimated weight of 24,000 lbs. (12 tons), while 6 x 6 wooden blocks will hold 60,000 lbs. (30 tons). By adding a third layer it will double the weight handling capacity, but will use up more blocks. This is known as a 9-point box crib. The third layer is really only needed for heavy rescue situations, (tractor-trailers, bulldozers, etc.), and will not be covered in this basic class.

ELECTRICAL GENERATORS

In this section, you will learn about the 3 types of electrical sources available on extrication incidents and electrical requirements of some of the major equipment found on most fire & rescue trucks.

TERMS

Volts - Volts is the force of electrical current. The higher the voltage, the greater the electrical force is applied. Compared to water, this would be most like pounds per square inch (psi).

Amperage - Amperage is the flow of electrical current. The higher the amperage, the higher flow of electricity is moved through an electric wire. This is like gallons per minute (gpm).

Watts - Watts is amount of work being produced. The product of volts x amperage = watts. For example, 120 volts at 1 ampere = 120 watts. One watt is equal to 1/746

horsepower **Kilowatts or Kw** - is equal to 1000 watts or 1 Kw.

10/3, 12/3, 16/3 - Refers to the size of electric wire in a electric cord or in wiring in a truck. The smaller the first number is, the larger the diameter of the wire. The second number refers to the number of wires inside a electric cord. The number 10/3 means a 10-gauge wire with 3 total wires in the cord. The larger the gauge of wire, the higher the amperage load it can carry.

TYPES OF ELECTRICAL SOURCES

12 Volt DC. The 12-volt system electrical of the squad truck can be used to supply power for electrical equipment. Most of the time this source is only used to supply power to the lights on the truck and in not used to power any major lights or equipment. The reason for this is that 12 volts is does not provide a high enough force of electric current to equipment. In order to overcome the lower force, a higher amperage load is needed. With higher demand for amperage, a larger gauge of wire must be used connect the equipment to the truck to handle the load, higher capacity alternators must be installed and additional batteries may be required. A 120-watt light powered by a 12-volt system would require 10 amperes to light the bulb. A 2850-watt Hurst electric pump powered at 12 volts would require 237.5 amperes. This source of electricity is available, but is not very efficient in powering the heavy equipment we use.

120 Volts AC. 120 volts, (also sometimes referred to as 110 volts), is the main source of electrical power found on rescue & fire trucks. This electric source is usually supplied by a generator either driven by the engine of the truck or its own small power plant. Most all hand held electric tools are 120 volt operated. 120 volts is efficient up to about 800 to 1000 watts of output for our use, (6.67 to 8.33 amperes). Beyond 1000 watts of output, a higher amperage is required and you may exceed the specification of your electrical wire, causing the wire to overheat and starting a fire.

240 Volts AC. 240 volts, (also sometimes referred to as 230 or 220 volts), is usually reserved to power heavy electrical motors or large lights. This is because it is more efficient to power equipment with heavy electrical demands at a higher voltage. A 1000-watt light powered at 120 volts requires 8.33 amperes of electricity to operate, but when powered at 240 volts the light only requires 4.17 amperes of electricity. The smaller the amperes load though a line, the less likely you are to exceed the rating of the wire. Not every generator is designed to provide 240-volt power. A generator that can supply 240-volt power, produces 2 phases of 120 volt power on 2 opposite phases 180 degrees apart. Phases will be described later.

ELECTRICITY PRODUCTION

Generators produce electricity on most squad trucks. Some trucks may use a device called an inverter, which is used to transform the vehicles 12 volt DC power to 110 volt AC power. The inverter is not very efficient at producing power so it is not

normally used for the type of work we do. Generators come in two types, stand alone or power take off models.

Stand-alone generators are units that do not rely on the truck for anything. A diesel or gasoline engine powers these units. Most squad trucks that carry this type of system usually produce 6 Kw to 15 Kw of electricity. The main advantage of this system in the fact that it is independent of the functions of the truck. For convenience, most of the systems use the vehicle batteries to start the generator engine and draw fuel from the vehicles fuel tanks. The main disadvantage is weight of the unit. Stand-alone generators can be of any electrical size, but the weight would far exceed the benefits.

Power take-off models use the truck engine for source power to turn the generator. These generators come in two types, direct drive or hydraulic drive. Direct drive is a physical mechanical linkage of drive train of the truck to the generator while disengaging the driveline of the truck. These generators usually turn in a 1 to 1 relationship to the rpm of the truck. The advantages this system is that it is very simple and easy to maintain. Also it is very good at supporting generators that produce very high electrical output. A disadvantage of this system would be that the truck's engine has to turn in a 1 to 1 relation or if a mechanical reduction in the gearing is done, a higher horsepower engine has to be in the truck. A hydraulic fluid, under pressure from a pump powers a hydraulic driven generator. The pump is driven by a power take off from the drive train while disengaging the driveline of the truck. The advantage of this type of system is the ability for the truck engine to turn at a certain rpm and the generator to turn at another, either faster or slower depending on the valves in the system. This system also tends to weigh less that direct drive units. The disadvantages of this system it that it leaks hydraulic fluid. This type of system does not usually produce anything over 30 Kw. This major advantage of both of these systems is the weight saved by not having the extra engine that the stand-alone system requires.

ELECTRICAL RATINGS OF ELECTRIC CORDS

10/3 - This size of cord is usually used to supply 240-volt power. The cord can handle safely up to 30 amps of power flowing through it. That can either be 30 amps total of 120 volts or 240 volts if the cord is used in a dual-purpose role. This size wire is excellent when used on a electric cable reel to function as the backbone of a electrical system. A 10/3 line can safely handle a load of 4 - 1500 watt lights when powered at 240 volts.

12/3 - This size of cord is usually used as extension cord for an 120/240 volt equipment or can be found as the primary cord on a 120 volt electric cable reel. This size wire can handle up to 20 amps of electrical load.

16/3 - This is the smallest cord that should be used in rescue operations. It can operate at either 120 volts or 240 volts, but it is recommend that it only be used in a 120-volt system. This wire can handle up to 15 amps of electrical load.

POWER WINCHES

Most squad trucks and brush trucks are all equipped with power winches which can be used to pull cars out of ditches, stabilization of vehicles, moving large objects such as construction equipment, trucks and other vehicles, and many other different applications. Because of the great mechanical force involved, a thorough understanding is essential for safe operation.

The winches on these units have a pulling capacity of 12,000 lbs. (The rated capacity of a winch is while the first layer is still on the drum, as more cable is layered on the drum its capacity is reduced). A 2:1 mechanical advantage can be realized by attaching a snatch block to the object to be moved. This is also a safe practice as it limits travel of a broken cable, but whenever a snatch block is used the length of useful cable is cut in half. Snatch blocks can also be used to change the direction of pull of the cable, an example being when it is impossible to position the squad where you need it. Front and rear winches on squads can be used with snatch blocks to pull against each other, an example being unwrapping a vehicle from a tree.

Most winches are electric. The control device is carried unattached, (usually in the glove box or nearby compartment), and is attached when use of the equipment is necessary. Since these winches are electrically powered, it is best to have the vehicle's engine running at high idle. Avoid using electric winches on just battery power since the current drain will probably drain the battery very quickly. The control device is a simple 2-way switch, pushing the switch one way will retract the cable while pushing in the other way will feed cable. If you drop the control, the winch will stop immediately, (dead-man switch). A control located on the winch will allow the drum to free-wheel in order to get a lot of cable out quickly, versus slowly feeding out by power.

A cable that breaks under tension can be fatal. In order to reduce the chance of injury you should clear the area of personnel for a circular distance equaling the length of the winch cable out. To keep a safe scene all persons should be kept from in line of the cable. You should also cover the middle of the taunt cable with a turnout coat or tarp, this can both mark the line and absorb any kinetic energy released should the cable snap. The amount the winch can pull is a direct result of the amount of friction the wheels have on the ground. Wheel chocks must be used on both wheels nearest the winch. A winching vehicle on wet pavement or leaves will not be able to pull as much as one on dry pavement. The hooks of the cable should never be hooked back to the cable, they should be attached to the object with chains designed for this specific purpose. The cable should not pass over sharp angles nor should the tip of a hook be a point of pulling.

Good maintenance of winch cable is essential for safety. Replace any frayed cable immediately since it can no longer carry its rated load. After every use, inspect the cable for kinks or other damage. Always wind the cable back on its drum with a load attached and make sure it goes back on evenly. You can always tell a poorly cared for cable by the way it appears on the vehicle; if it is knotted, kinked frayed and/or rolled loosely then it will be dangerous to work with.

One other point, because of the tremendous force generated not allowing the operator to feel any resistance, winch cables should not be directly attached to a victim or rescuer. If the attached individual gets snagged on anything, they risk severe injury or death.

Safe Winching Operations

It is a popular notion that when you pull up and connect the winch cable to an object, the object will move (or be stabilized). This is not always the case since there are many variables that you must take into consideration. What is the capacity of your winch? What is the vehicle load resistance? What is the weight of the pulling vehicle? The amount of force required to start a vehicle moving is equal to the vehicle load resistance.

Estimating vehicle load resistance will help you determine if your winch has the capacity to pull the vehicle. Consider the following:

1. A certain percentage of the vehicle's weight is needed to start it moving. It takes more force to begin this move versus continuing the movement.
2. Is the vehicle being moved forward, sideways or backward?
3. What surface are you working on? Is it level?
4. Are there obstructions in the desired path of travel?
5. Is the vehicle damaged, creating more resistance to movement?

The following equation can be used to give you an idea if you can perform the task at hand with the equipment you have.

Problem: You have a 3,000 lb. vehicle mired in mud, down a 15 degree slope, with two wheels damaged. Your winching vehicle weighs 18,000 lbs. and has a 12,000 lb. rated winch. *Will your winch do the job?*
We will use the following equation to see if we can do this:

RR +[-] GR + DR = TR

RR = rolling resistance. Rolling resistance is considered when evaluating the surface the vehicle rests upon.
SURFACE % OF VEHICLE WEIGHT
pavement or hard surface 1/4
gravel on hard surface 1/3
mud on hard surface 1/2
swampy 3/4
GR = gradient resistance. Gradient Resistance is considered when the surface is not level. It may add or reduce the amount of force needed to begin movement.
DEGREE OF ELEVATION % OF VEHICLE WEIGHT
15 degrees 1/4
30 degrees 1/2

45 degrees 3/4
* add or subtract 1/60 of vehicle weight for each degree
DR = damage resistance. Damage resistance is created by any existing vehicle damage. Generally it is accepted that ¼ of the vehicle's weight is added for each wheel affected by damage. Obstructions in the travel path must be considered as well.

Determining Total Vehicle Load Resistance

1. Evaluate the total situation.
2. Estimate the total vehicle weight (TVW).
3. Estimate the rolling resistance (RR).
4. Add or subtract the gradient resistance (GR).
5. Add damage resistance (DR).

For the example problem we have above:

RR=2250 + GR=750 + DR=1500 = 4,500 pounds of force required

The job can be done with the equipment at hand. How about this problem:
You have a 10,000-lb. vehicle on a gravel surface, 15-degree slope and with 3 wheels damaged. Your vehicle weighs 18,000 lbs. and it with a 12,000 winch. *Will your winch do the job?*

RR=3,000 + GR=2,500 + DR=7,500 = 13,000 pounds of force required

You cannot do the job with what equipment you have.
Sometimes you can estimate if you can do a job just by looking at the overall picture. You have a 2,000 lb. zone car with a 12,000 lb. winch. The load is a 10,000 vehicle on a hard surface, slight incline and no damage to the wheels. You cannot do the job with the equipment that you have. *Why not?* Look at the weight of the winch vehicle! The load weighs much more than the anchor, the load will pull your vehicle towards it.

Safe Winching Rules

- Always wear full PPE during winching operations.
- Fully understand the winch components, capacities and operating procedures.
- Position the winch squarely to the work area. Use snatch blocks to change direction of pull. Anchors must be sufficiently strong for the load you are pulling.
- Set winch vehicle brakes; use wheel chocks.
- Don't free-spool winch when the cable is under tension.
- Don't hook into the cable to produce a choker.
- Load hooks properly.
- Take up cable slack slowly. Check and double-check all rigging.
- Locate the safety observer out of the danger area to watch the winching operation.
- Keep bystanders well out of danger.

- Properly store, lubricate and inspect the winch, cable and connections after each use.

COME-ALONGS

The come-along is a hand winch, and can be used for many of the same functions. Most come-along's have cables that are 22' long, are rated a 1.5 tons of pulling power and are rescue grade. The come-along can be double-rigged to allow twice the load to be pulled, but it cuts the useful cable length in half and takes twice as long to pull. Come-along's perform one basic function. They work in a straight line to move two lengths of chain closer. When positioned horizontally between a stationary object and a movable one, the tool pulls. The cable should never be secured directly around the stationary or movable objects. Instead, separate lengths of rescue chain should be used. Attempting to pass the cable of a come-along around a sharp corner of an object is unsafe since it cause damage to the cable. As with a winch the hook of the come-along should not be hooked to the cable.

Rescue come-along's have a "fuse" that prevents you from damaging the tool should you apply too much force. The handle will bend and fail before the maximum capacity of the cable is reached. Both squad trucks carry extra handles should you bend one. The come-along is probably the most under-rated piece of extrication equipment found on the rescue unit. Like most specialized tools the use of a come-along may be difficult if the rescuer has not practiced with the tools previous to trying to use it on the rescue ground. Like your entire rescue tools cache you should pull it out and practice with it every chance you get. Make sure that you are familiar with all pieces of the come along prior to using it. The come-along can be very complicated to those who are unfamiliar, but very simple who understand it's workings intimately.

CHAINS

Chains are a very safe way of attaching a load to a pulling device. The reason is simple, chains do not store energy like cables do. If a chain breaks, it falls to the ground. If a cable breaks, it whips around cutting anything in its path in half, (like you). Use only rescue quality chains in vehicle rescue work. They are made of the best quality steel with good strength and the ability to absorb shock loads.

Rescue quality chains should be at least 3/8" in diameter, made of grade 80 alloy steel and with some maintenance, kept free of rust and thick grease. Chains usually enjoy a 4:1 safety factor. The table on the next page gives the safe working loads for various sizes of chains.

WORKING LOAD LIMITS, PROOF TEST LOADS AND MINIMUM BREAKING LOADS FOR ALLOY STEEL CHAIN

Nominal Working Proof Minimum

Size of Chain (in.)	Load Limit (lb.)	Test Break (lb.)
¼	3,250	6,500 10,000
3/8	6,600	13,200 19,000
½	11,250	22,500 32,500
5/8	16,500	33,000 50,000
¾	23,000	46,000 69,500
7/8	28,750	57,500 93,500
1 3/8	750	77,500 122,000
1 1/8	44,500	89,000 143,000
1 ¼	57,500	115,000 180,000
1 3/8	67,000	134,000 207,000
1 ½	80,000	160,000 244,000
1 ¾	100,000	200,000 325,000

Source: Specification for Alloy Chain, American Society for Testing and Materials, A-391-65. Alloy Steel Chain Specifications, No. 3001, National Association of Chain Manufacturers.

The National Association of Chain Manufacturers has agreed on a grading system for welded chain that makes it easier to evaluate and select the proper chain for your needs. The grading system uses grades 30, 40, 70 and 80. The actual markings in use by manufacturers may be one, two, three or four digits that are embossed onto the links of the chain.

Grade 80, for example, is a heat-treated, high-strength alloy chain that has a high strength-to-weight ratio. A grade 80 chain would be marked on the links with an A, 8, 80 or 800, and should have a metal tag attached when you buy it that certifies the strength rating and the grade of the chain.

Rescue chains have 6 parts. They are...

1. Chain - made of the links.
2. Hooks - either a catch (snatch) or open (slide) for attaching another chain.
3. Oblong Link - the attachment point for lifting or pulling
4. Component Connector - connects the chain to the oblong link
5. Chain Shorteners - a short section of chain used to take up slack
6. Identification Tag - shows the type and size of the chain as well as the serial number, date of purchase and the working load of the chain.

Observe the following safety rules when using chains:

- Do not drag a load from underneath when using a chain.
- Do not cross, knot, or hammer a chain into position (for example, tie a knot to shorten).
- NEVER exceed the listed safe working load.
- Destroy bad chains.

- Avoid impact loading on chain.
- Do not re-weld links on alloy chain.
- Make sure that all appliances are of equal strength or greater than the load being handled (hooks, pins, links, etc.)
- Do not heat treat alloy chain or expose it to high heat levels.
- Never splice a chain by placing a bolt between two links.
- NEVER put force on a kinked chain. Take up all the slack and make sure all the links are straight.
- While is cost extra to order rescue chains that are rated, it is well worth the money to know that you have the highest quality equipment to work with.
- Hydraulic equipment usually has it's own chains. While it is OK to use these chains with other appliances, it is not OK to use regular chains with hydraulic equipment. Make sure the chains in your department are marked for its intended use.

POWER HYDRAULIC TOOLS

In the distant past, personnel who were equipped with nothing more than pry bars and much hard work performed vehicle extrication. It was not unusual to spend more than 30 minutes to open jammed doors and automobile accident victims subsequently suffered. Only in the early seventies were efforts made to develop a rescue technology with hydraulic tools. This was triggered by a tragic accident that happened in 1970. George Hurst, a mechanical engineer and enthusiast of auto racing, witnessed a fatal accident during an Indy car race. Consequently, because the driver could not be rescued quickly enough, Hurst came up with the idea for a hydraulic rescue tool for racetrack use. He then sought out his friend, Mike Brick, to design and build the device. The first hydraulic tool was mounted on an A-frame on the front of a car and ran off the power steering pump. Since it weighed over 500 pounds it did not meet the criteria of a being a portable rescue tool. It also did not have sufficient power. However, it was the first step in the right direction. After more developmental work, George Hurst and Mike Brick succeeded in designing a tool weighing only 100 pounds and called it the "Jaws of Life".

Hurst wanted to sell the tool to just race tracks, but the Board of Directors of Hurst Manufacturing said "no," that the device must be sold to a much larger market to be profitable. The decision was made to sell to rescue squads and fire departments and on December 28, 1971 the first Hurst rescue tool was delivered. Hurst as the only manufacturer of rescue hydraulic tools sold about 10,000 of these tools. How many lives were saved will never be known.

However, a new chapter in saving human life was begun, promoting cooperation between

expert knowledge and reliable rescue technology. The original "Jaws" was the model 32 and it came out in 1972. It could produce 10,000 psi at the tips and many models still exist today. The 2nd generation came out in 1975 and was named the model 32A. The model 32A has a 12,000-psi spreading force and is equipped with titanium arms. Since the USSR was and is the main producer oftitanium, this precious metal was expensive and hard to come by. Subsequently, in 1980, the model 32B was brought into production utilizing aircraft aluminum arms (with a 75,000-lb. yield strength) and a 18,000 psi spreading capability. Although the 32B weighs 75 lbs., and the 27 weighs 48 lbs., they are still considered a one-person, hand-held, completely portable tools.

Today there are 15 different brands of power rescue tools on the market. They all have distinctive differences as well as similarities. The following is a discussion of the more popular brands, it is up to the student to become familiar with the specifics used by his/her department.

HURST TOOL RESCUE SYSTEM

Hoses: The hose that is used in the Hurst system is electrically non-conductive, Kevlar reinforced, thermoplastic. The working pressure of these hoses is 5,000 lbs., with a burst pressure of 20,000 (4:1 operational safety factor). They are 1/4" in diameter and should not exceed 100' from the pump to the tool, (this is due to friction loss). The couplings are aircraft type, and owing to the presence of a ball check, they can be disconnected under pressure. However, caution must be exercised, since a certain amount of fluid may spray out. The addition of manifold blocks eliminated this problem, provided the by-pass pressure valve is in the dump position. Keep in mind a property called "volumetric expansion." The hose will expand while under pressure, which increases fluid use and reaction time. The hose is always the weakest link in any system. Hose sets are available in either 16-foot or 30-foot lengths.

Fluid: The fluid used is fire-resistant, electrically non-conductive and is non-corrosive. This type of fluid has been in use in the aircraft industry for the past 30 years. There is a danger of becoming burned should this ester product encounter the skin. Contact with eye tissue is to be avoided at all costs, (WEAR SAFETY GOGGLES!). The use of silicone hand cream will also reduce this problem.

Manifold Blocks: allow you to hook 2-3 hydraulic tools to a single power unit and simplify hydraulic hose layout. Manifolds are available with o without pressure dump valve and come with one removable jumper hose assembly. Rescuers over the years have experienced a phenomenon known as lock-up caused by intensification. This problem begins with the use of a manifold. Manifolds are not used as intended. Some rescuers operate under the false assumption you can operate three tolls simultaneously with a manifold, not so! Manifolds are only management tools. You can attach three tools at the same time to the manifold, but you can only operate one tool at a time.

There are three positions on a manifold system: 1, 2 and 3. Spreaders should

occupy the #1 position, cutters the #2 and ram the #3. Sequential operation simultaneously can create pressure spikes of 10,500 psi which causes the tools to lock up. This mathematical property occurs when you attempt to operate these tools together. The 5,000 psi is channeled into the A side of a spreading tool which displaces fluid under pressure. This intensifies in the second tool whereby you now have approximately 6,540 psi into the cutters, then the rams (third tool) intensify by 1,400 psi to a maximum pressure of 7,800 psi.

To prevent lock-up, follow this sequence to relieve pressure after operation:

1. Retract the piston/cylinder (B side closes).
2. Throw the dump valve after working the trigger mechanism twice. This bleeds the entire system (power unit).
3. Disconnect the supply line (pressure side) all the way around.

With all extensions hooked up to a manifold system and three tools operating at various intervals, the reservoir will drop by as much as 40%. This low fluid can result in fluctuation in the tool head on a spreader. This is caused by air developing in the system and expands when it hits the reservoir. To prevent this problem, add hydraulic oil and recycle the tools.

Power Units: The power plant is the means through which the system pressurizes the fluid. Power units can use gasoline engines, diesel engines, 12 volt electric motors, 110 or 220 volt electric motors, compressed air, water turbine, or a manual hand pump. Gasoline engines come in either 2-stroke or 4-stroke models. Typically, the 2-cycle gasoline engine is for use where weight is a consideration, although reliability is a problem because of the gas-oil mix gumming the engine up. The 2-cycle Chrysler engine is easy to repair and it is not unusual to find 20-year-old models still in use. The 4-cycle gasoline engine is heavier, but is much more reliable and quieter. Electric motors are coming into widespread use because of both reliability (starts at a flick of the switch) and light weight. Another advantage is that it is extremely quiet. The disadvantage being that it must be connected to an electrical power source, usually the power plant of the squad vehicle. Electric current draw must be taken into account so that the capacity of the generator is not exceeded.

The current specifications for the types of power units are as follows:

Gas 2-cycle: The 2-cycle Chrysler 700 series engine is rated at 4 hp. The one-qt. fuel tank provides 10-15 minutes of operation. The gas must be mixed with oil or the motor will quickly burn-up. One unusual feature of this engine is that it constantly cycles up and down, giving it a characteristic sound.

Gas 4-cycle: The 4-cycle industrial (Briggs & Stratton or Honda) engine is rated at either 4 or 5 hp. No oil needs to be mixed with the gas. Diesel models are also available.

Electric: uses 110/220 volts single-phase AC 60 cycle (3.8 Kw draw) or 12v DC (100 amp draw). Electric units usually require 26 amps on start-up if using 110 volts. Units wired for 220 volts only draw 13 amps. When using electric units, start and run them before lighting equipment is turned on. The single-phase motor is rated at 1.1 hp. There is a simo-pump model available that allows dual lines for two line simultaneous operation. This model uses a 4-hp 220v motor that has a maximum draw of 24 amps.

Hand Pump: The two-stage pump operated by hand will develop sufficient pressure to operate all Hurst equipment. The hand pump is a most valuable backup in the event there is a breakdown of a power unit, or where an explosive atmosphere is present.

Pump: The hydraulic pump is a direct drive, positive displacement piston-type, connected directly to the power unit. The pump is rated at 10,500 psi but operates at 5,000 psi to 5,500 psi for longevity purposes. It has six pistons in the positive displacement pump consisting of four high-volume, low-pressure and two high-pressure, low-volume. (In an emergency, removing the spark plug and pulling the starter cord can operate any hydraulic tool). There is a common misconception associated with the use of ethylene glycol as a substitute for phosphate ester fluid. It will work for up to one year at which time evaporation will set in and ruin the tool. The hydraulic system is self-purging, and automatically eliminates air from the system. The reservoir holds 6 quarts of the hydraulic fluid.

The unit is constructed with two stages for operation. The first stage opens and closes the spreader/cutter arms and blades. It will pump 1.5 gallons per minute at 800 psi. The second stage or working stage, circulates .5 gallons per minute at 800 psi until demand and loading requirements increase at which time the pressure will shift from the first to the second stage. After the load is released, the psi drops back down to the first stage. During second stage operation, back pressure is developed necessitating the need for a relief mechanism. What this means is that when using hydraulic devices, the real force will develop when the tool stops working. When a tool stops working, maintain pressure for a five-second count and see what happens. Don't be quick to give up.

Jaw Tips: The jaw tips are attached to the ends of the arms and are held in place by retainer pins. The standard jaw tip is the Automotive Jaw. Three accessory jaw tips are referred to as the Aircraft Cutting Jaw, the Aircraft Spreading Jaw and the Grabber Jaw. The standard jaw tip is normally kept on the tool and is used for most extrications. The

tips do not have to be removed when shackles are attached for pulling purposes. (On older models, the retainer pins have to be removed, and longer pins inserted). Aircraft Jaws are installed specifically for piercing and cutting sheet metal, e.g., aircraft skin, railroad car sides/tops, truck bodies, etc. The Grabber Jaw is used for tough applications where grip is a problem.

Spreaders: (AKA the JAWS) The arms of the model 32B will open fully to 32 inches in 50 seconds when under a load, while the model 27 will open to 27 inches in the same amount of time. The 32B opens with 18,000 psi of force, closes with 18,800 psi and weighs 70 lbs. The model 27 opens with 14,500 psi of force, closes with 15,080 and weighs 48 lbs. The maximum pressure is exerted at the tips, with a decrease in psi as the work is moved toward the hinges. In the event of a power failure, the arms are designed to maintain their purchase, even if the thumb control is inadvertently activated. Like all such devices, the final 1/3 of opening spread is where the tool gives its best force. Keep in mind that spreaders open in an arc, if used to lift an object such as a car, they will push the load away.

Cutter: There are several models available, the most popular being the model O-150. The unit weighs 36 lbs., and has a cutting force of 12.5 tons (25,000 lbs.), at the blade center. When under load, the closing time is sixteen seconds. The 0-150 also has a cable-bar cutter (inner part of the blades) which exerts a force of 70,000 lbs. Attempting to cut hardened steel, (i.e. steering columns or Nader pins), will result in blade damage in the form of nicks, which can eventually cause a fracture of the cutter. As with a cutter tools, the maximum amount of force is at the notch.

Combo Tools: The Maverick, Roadrunner and the Paladin are attempts by the Hurst Company to combine the capabilities of both the spreaders and the cutters into one tool. Lightweight and compact, they are ideal for quick response and decrease extrication times greatly. The downside is that they are not as powerful nor do they have the same maximum spreading widths as the single-use tools. The Maverick exerts 13,000 psi spreading force and a 60,000 psi cutting force and weighs only 38 lbs.. Spreading width is 16” (1/2 of the 32B).

Rams: The hydraulic ram is an expansion tool. There are three hydraulic ram models: the model 20, which weighs 21 lbs. and has an opening length of 22 inches; the model 30, which weighs 28 lbs. and opens to 36 inches; and the model 60, which weighs 41 lbs. and opens to 60 inches. All have an opening force of 15,000 lbs., and a closing force of 9,500 lbs. (the Model 20 should not be used for pulling purposes). Under load the spreading time is 20.5 seconds. Note that when using the "Daisy Chain" method for coupling together more than one tool, the ram should be the 2nd tool in-line. As with all hydraulic devices, once a push has been made, you may disconnect the hose to use with another tool since internal check valves will prevent the piston from collapsing back.

Chains/Hooks: The chains and hooks are used to extend the operating limits of the spreader and the rams. Two six foot chains with a hook at one end, and one chain that is twelve feet long, with hooks at both ends, are supplied with the system. These chains are

case-hardened, are designed to be used with the Hurst Rescue System, and should not be substituted for any other kind of chain.

Attachment Set: The attachment set increases the capability of the system. The set includes a conical point, base plate, V-block and wedge that mount directly to any of the rams. An adapter permits the base plate to be used with the 32B and the 27 for lifting applications. The components are cast alloy steel for strength and durability.

SAWZALL

The electric reciprocating saw, better known by the trade name sawzall, is a valuable addition to your inventory. Either electricity or small gasoline motor can power Sawzall's. In the hands of a skilled operator, the reciprocating saw could safely and effectively remove many portions of a car trapping an occupant. Indeed, many fire departments are now starting to carry on their engine companies to start extrications before the arrival of squad trucks. With today's lightweight metal and plastic construction, you can easily saw a car in half in a few minutes. Sawzall's have become very popular for vehicle rescue the past few years. Originally designed for the construction industry, they have all the qualities (cheap, easy to use, durable, etc.) to make a valuable asset and addition to your rescue tool repetoir. New Sawzalls are coming out now that feature higher amp motors (8 amps versus the standard 4 amps), 18 volt battery operated models and light-weight 2-stroke gasoline motors. The gasoline-powered models tend to be somewhat cranky to start, but run well and do an excellent cutting job. Battery operated models feature instant starting and good cutting power, but are severely limited on the length of time they may be employed. The length of electric cord, (which also tends to get in the way), limits cord models. Just about all manufacturers are designing quick-change devices for rapid changing of depleted/broken blades. Some of these designs do not work well when the blade heats up. The best is to have a variety of models on your rescue vehicle but if this is not possible, try each and pick the one that is best for your need.

It is important for rescue personnel to understand the function of the part of the saw along the side of the blade where the blade secures into the saw itself. This part is called the "foot" and its function is to assist in guiding the saw blade as it cuts. To work properly, this foot must be in contact with the surface of the object being cut at all times. Inexperienced operators of reciprocating saws tend to lift the foot off the surface, virtually eliminating the efficiency of the blade's cutting action and stressing the blade to the fracture point. It is also important for the foot of the saw to move along the surface being cut with a gentle rocking action of the entire saw. This pivoting back and forth enables the saw to yield its greatest efficiency.

Whenever possible during sawzall operations, have a second rescuer spray a lubricant on the action area. This does several things. First, it keeps the blade cool which makes the blade work more efficiently. Second, spraying keeps sparks down which can become a real hazard. Third, spraying the blade helps clean the teeth, also making the blade work

more efficiently. Cool blades also last longer and to not have the tendency to break when pushed hard. The best lubricant to use soapy water in a spray bottle. Carry a bottle of Dove or Joy and an empty plastic spray bottle in the sawzall kit. When you need it just add water and soap and you are good to go. Don't carry this pre-mixed since it tends to leak out and ruin equipment.

The best blades for the Sawzall are the Lenox Rescue Blade 650R, 12tpi, (6"x3/4"x0.050"), The Lenox 960R blade (has a little better reach), the Hackmaster 614R, or the Starrett FASTCUT 10-14T are examples of the best quality "shatterproof" blades. Although not really unbreakable, these blades are very rugged and durable. Some rescue teams even make a small velcro pouch that attaches to the sawzall to hold extra blades. Keep one thing in mind, the future of auto extrication is cutting tools, not spreading tools. For just $300, any fire company can add extrication capability to their engine.

Random Thoughts on Vehicle Extrication

- Size-up of the extrication begins with the receipt of the call for help.
- Drive defensively and controlled en-route to the scene. You can't help if you don't get there.
- Establish a command system for your rescue team. The worst type of command is no command at all.
- Establish standard operating procedures (SOPs) for your rescue team. SOP’s help avoid unnecessary confusion at the scene.
- Get the big picture at the rescue scene. Don't get caught with tunnel vision.
- Know the limitation of your rescue personnel and your rescue tools. Don't over-extend either of them.
- Don't get caught in over your head and play catch-up. Call for assistance early.
- Position the rescue vehicle to protect the rescuers. When possible, park between the accident and the oncoming traffic.
- Provide adequate warning for vehicles approaching the accident scene. Use vehicle emergency lighting and traffic control devices to provide the warning.
- When your rescue vehicle is facing traffic, cut off the headlights to avoid blinding oncoming traffic.
- Establish a hazard zone around every accident scene and allow only authorized personnel to enter it.
- Don't let a rescuer become a victim. Stress safety and supervise actions at the rescue scene.
- Protective clothing for all rescuers is a must. Insist that all rescuers wear full turn-out gear.
- Make every rescue a wet one. (Always have at least one charged hose line standing by at every rescue scene.)

- Always consider the possibility of hazardous cargo. Check the scene carefully before committing your entire unit.
- Never assume a car involved in an accident is stable. Stabilize every vehicle before beginning extrication procedures.
- Treat every downed electrical wire as if it were energized.
- Do not forget evidence preservation. If evidence must be moved, make a note of it.
- Keep control of the accident scene. Don't allow bystanders to interfere in the extrication.
- Do not remove the battery cable from the battery unless you have a real need to, (such as an electrical fire).
- Always try before you pry. Don't assume something can't be opened until you try it.
- Gaining access is allowing the entry of emergency medical personnel to the victim. It doesn't have to be neat and pretty. It just has to be safe and quick.
- Protect the victim from any further injury. Provide adequate protection for the victim from the extrication process.
- After gaining access, the rescuer must provide emotional first aid as well as physical first aid.
- Once a first responder has gained access, he is the eyes and ears of the rescue team.
- He/she calls the shots - the "do's" and the "do nots."
- The telltale signs of a distorted and damaged automobile interior - spidered and broken windows or mushroomed steering wheel, for example - may indicate additional injuries that weren't obvious from the victim's position. Look for these signs - they tell a story.
- The exit route from the vehicle must be large enough to remove a packaged patient. The more packaging, the greater the size of the exit route.
- Continually size-up and survey the scene for developments. Operations can get out of control quickly. Stop the momentum before it gets started.
- Explosive forces can be encountered when working on and around damaged vehicles. Be alert and prepared for them.
- Don't make extrication more difficult than it has to be. Take the easy way in and the easy way out, but make sure it is the safe way.
- Make sure all victims are accounted for. Don't leave until you are certain of this.
- Make good decisions on extrication procedures; take the sure things first and use long shots only as last resorts.
- A successful extrication is not based on how much you do to the car but, rather, how quickly and safely the victim is removed.
- Extrication scenes are like kitchens, don't leave until you clean up.
- The extrication incident is not complete until the paperwork is done. Be sure that you document everything you did, what equipment you used, times involved, personnel involved and what they did, etc.
- Extrication equipment is only as good as the personnel using it. Become familiar with your equipment and train with it frequently.

- Do not rely solely on powered rescue tools. Train with and be prepared to use hand tools.
- Maintain your rescue equipment. Check it whenever you come on duty and after each use.
- Never modify rescue equipment. It was built to operate safely.
- Cross training among fire/rescue & EMS personnel is a must, making it much easier to understand each others' problems and to work together.
- Extrication is a team game. If the police, fire, rescue, and EMS units all play by the rules, everyone comes out a winner.

Glossary of Common Terms

Action Circle: A "clear zone" established early at an extrication scene, extending ten to fifteen feet in all directions from the vehicles involved in an accident.

Air Chisel: A metal-cutting tool adapted from industry, comprising an air gun, a compressed air hose, a regulator, chisel blades and a compressed air supply.

Air Rescue Bag: An extremely powerful pneumatic tool used for lifting; consists of a bladder that fills with air, a pressure regulator, a controller, an inlet hose, two fill hoses, and a compressed air source.

Air Restraint Bag: A part of the passive restraint system of a passenger car, consisting of a deflating air bag which is filled quickly by gas, using a device which is either electrically or mechanically activated upon impact of the vehicle. This bag system affords extra protection to the front seat's occupants during a vehicle accident.

Cribbing: Generally refers to the specially cut and/or assembled pieces of hardwood used to support raised objects, such as ground pads or bases to placed tools that are in use and as blocks over which chains and cables pass while they are moving objects.

Critique: Usually a type of training session after an emergency incident or practical training session, during which rescue workers review their efforts and how these could be improved as well as the actions that they performed well.

Dash Roll: A lifting maneuver performed on the front dash of an automobile; a technique used to lift the dash assembly up and off trapped patients, normally performed with heavy hydraulic rams.

Displacement: A term that describes moving a part of a vehicle beyond its normal operating range, making space for access and removal of trapped patients.

Door Latch: The device, which keeps the door of a vehicle, closed; it generally consists of a pin in the doorjamb to which a clasping device in the door itself hooks when the door is closed.

Engine Compartment: The area of the vehicle in which the engine is located. It is generally separated from the vehicle's passenger area by a solidly constructed firewall.

Evolution: Usually employed as an educational term, denoting a practical procedure (i.e., roof flap evolution).

Bottle Jack: A common lifting device consisting of a piston driven by hydraulic fluid as the handle is pumped by the rescuer. Name comes from it's shape.

Box Crib: An arrangement of four-inch or two-inch by four-inch wood cribbing that is stacked in parallel pairs at right angles to the parallel pair immediately below, thus taking the outline of a box.

Broad-Based Command: A command concept, developed for vehicle extrication, which describes the use of personnel. Simply stated, it means that more than one task is accomplished simultaneously by multiple rescue personnel.

Catalytic Converter: Part of a vehicle's exhaust system pollution control; that superheats exhaust fumes, turning them into inert gases. This device can be extremely hot and is located under the car body, in the undercarriage area.

Circle Survey: A method for rescue personnel to conduct a through inspection of the accident scene, which includes walking in a 360-degree circle around the entire area.

Come-along: A lifting or pulling tool; a portable hand-operated winch that includes an operating handle, cable spindle and casing, cables, and hooks and is designed to be used in conjunction with rescue chains or rescue chain sling devices.

Command: A term used either to describe the person in control of an emergency scene or to denote the action of controlling an emergency scene.

Command Post: The central position at an emergency scene where the overall scene commander will be located.

Extrication: A common vehicle rescue term, used here to describe procedures performed by rescue personnel to remove trapped patients, held by the wreckage or by their injuries, from vehicles involved in accidents.

Extrication Sector: The designation on the scene of the subsidiary command level of control that is usually responsible for supervising the actual rescue efforts of moving wreckage and freeing patients for removal.

Full-Frame: A type of vehicle undercarriage construction that is used in some station wagon automobiles and light trucks, in which two steel rails support the floor, suspension, drive train, and body.

GPM: A fire service abbreviation, meaning the flow of water in gallons per minute.
Hatchback: A common term for a vehicle with a rear access door to the passenger compartment area or rear storage area.

Hazard Control: A term for the handling of hazards on the extrication scene; it can also denote a command sector or subdivision of command that is concerned with hazards on the scene.

Hazardous Materials: Any materials, exposed on an emergency scene, that are hazardous because they are poisonous, flammable, explosive, carcinogenic, or environmental pollutants, also known as "Haz Mat" in the emergency services.

High Lift Jack: A mechanical lifting device designed to raise a vehicle which sits high above ground level; a device used in vehicle extrication for moving metal and stabilization.

Hoseline: A fire service term denoting hoses that carry water from the fire engine to the emergency scene.

Incident Command: A system of control on the incident scene, set up by predetermined procedures, for effective control of complex emergency operations, such as extrication operations.

Inner Circle Survey: The procedure of assessing a vehicle that has been involved in an accident; it includes a full circuit of the vehicle and assessment of the area in, around, and under it.

Joint Command Post: A central control position used by multiple emergency agencies on the scene of an emergency.

Laminated Glass: Specially designed glass used in automobile windshields, composed of layered plate glass separated by clear plastic.

Loaded Bumper: A safety term, describing vehicle bumpers that collide violently during an accident, compressing them upon their shock-absorbing pistons; the bumpers are held in this compressed position by the subsequent wreckage.

Manual Hydraulics: Hydraulically operated rescue tools for which the hydraulic power is generated by human effort on a manual pumping device.

Nader Pin: A door latch mechanism found in American-made automobiles, designed to assist in keeping the door closed during an auto accident.

Pancaked Vehicle: A vehicle rescue term used to describe an accident situation where the vehicle has come to rest on its roof, with the roof crushed in upon the passenger compartment.

Pneumatic Power: Compressed air power; any power source for a tool or device actuated by the application of compressed air from an air compressor or compressed air tanks.

Post Crib: A specialized vehicle rescue term, describing a long piece of wooden board, usually four inches by four inches by five to six feet, used to stabilize vehicles that are on their sides.

Posts: A vehicle construction term, denoting vehicle's rolled sheet metal assemblies that attach the roof to the main body of the vehicle (i.e., A-post, B-post, and so on).

Primary Survey: In vehicle rescue. the initial patient check done by rescuers of trapped victims.

PTO: An abbreviation for the term "power take-off"; refers to tools and equipment that are attached to the rescue apparatus and operate via the engine of that apparatus.

Purchase Point: A small opening made in wreckage that allows room for the insertion of rescue tools to move that wreckage.

Reciprocating Saw: A rescue tool designed for cutting metal ands wreckage, consisting of an electrically powered saw unit which operates the blade with an in-and-out motion.

Rescue Chain Assemblies: Chain assemblies used as anchor devices to which pulling tools are attached in order to move metal; these assemblies are made in configuration of chain, hooks, and an identification tag.

Roof Flap: On the extrication scene, the displacement procedure that involves cutting and folding up and away the roof of the vehicle.

Sectorization: The implementation of subdivisions of command on a scene into smaller areas of control called sectors.

Sectors: Incident command subdivisions that place specific asks or areas of the scene under the direction of individuals who report to command.

Space-Frame: A type of vehicle construction that uses "bird cage" type of frame assembly to which body panels and parts are attached.

Split Steering Column: A specific steering column design made up of two or more pieces in the straight column assembly.

Spreader: The part of a hydraulic rescue tool system used to spread apart wreckage; it may be manually powered or powered by mechanically driven units.

Stabilization: In vehicle rescue, usually refers to securing the wrecked vehicle in which an injured patient is trapped; it can also refer to gaining control of and handling a chaotic emergency scene or hazardous condition.

Stack Crib: The configuration of two-inch by four-inch or four-inch by four-inch wood cribs placed in a stack, as an object is being lifted by tools.

Staging Area: A designated area away from the extrication area where additional apparatus and manpower are placed in reserve until needed at the scene.

Standard Operating Procedure: Formal guidelines developed by emergency organizations to assist in pre-planning emergency operations and procedures prior to the incident; also known by the abbreviation SOP.

Step Chocks: Specialized cribbing assemblies made of wood blocks secured in a stair-step
configuration; usually used to stabilize vehicles.

Straddle Lift: A method of placing a prone patient on a long backboard by lifting him or her and sliding the backboard under the patient.

T-Bone: A descriptive term for the type of vehicle accident in which the front of one vehicle collides with the side of another vehicle.

Team Approach: The idea behind modern vehicle extrication procedures, in which one person is placed in charge of a rescue team and coordinates the team's efforts into successful and efficient results.

Tempered Glass: Specially designed glass, highly resistant to breakage, used in automobile side and rear windows.

Third-Door Conversion: A term for a displacement evolution used to open the rear side panel of a two-door automobile, creating a "third-door" or access opening to the trapped patient.

Tilt-Wheel Steering: The type of vehicular steering column assembly that adjusts up or down for the driver.

Tool Reaction: The movement of rescue tools while their force is being applied to the wreckage; may consist of the turning of the tool, the slipping of the tool, or the sudden release of the tool under force.

Tool Staging: A general vehicle rescue scene operation in which tools and equipment are placed in a central, designated area for potential use at the damaged vehicles.

Track Cribbing: A cribbing setup that entails placing four-inch by four-inch cribs so that they slide on themselves as chains or cables pass over them during steering displacement or metal-moving operations.

Traffic Control Sector: Command designation of that person assigned to coordinate control of traffic at a vehicle accident scene.

Training Evolution: Learning operations, generally practical in nature, that develop hands-on skills for fire and rescue personnel.

Transportation Sector: Command designation of that person assigned to provide for transportation of injured patients from a vehicle accident scene.

Triage Sector: Command designation of that person assigned to determine the priority of treatment of injured patients at a vehicle accident scene.

Trunk Access: The procedure for opening the cargo compartment area of a vehicle.

Unibody: A type of vehicle construction that uses the floor panels and undercarriage as a structural element of the vehicle, eliminating the need for a full chassis for vehicle body support.

Wedge Cribbing: Cribbing shaped in the form of a wedge, used to tighten and secure cribbing assemblies supporting weight; generally employed as a "gap" filler.

Working Load Limit: The recommended limit of a force, measured in pounds of weight, with which rope, chain or cable can be safely operated; denotes how much weight the rope, chain or cable can safely lift. (also known by the abbreviation WLL)