EXTRICATION
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INTRODUCTION

The purpose of this manual is to provide rescue personnel with an understanding of the current challenges, techniques, and equipment available for the safe and effective extrication of victims trapped in vehicles or machinery. The tools outlined in this section adhere to NFPA 1936, *Standard on Powered Rescue Tools*. The techniques outlined in this section adhere to NFPA 1670, *Standard on Operations and Training for Technical Rescue Incidents*. The tools and techniques described in this manual represent the current state of the art as practiced by rescuers throughout North America including the fire agencies in the North Zone, but they are not the only ways that extrication can be performed safely and efficiently. Since neither single tool nor any single technique will be safe and effective in every situation, the readers are encouraged to master a variety of extrication tools and techniques.

This section will familiarize rescue personnel with the **S.H.A.D.E.** acronym. S.H.A.D.E. is a "systematic approach" to vehicle disentanglement outlined in the "Procedures" portion of this section. No one should expect to become proficient at vehicle extrication simply by reading this manual or any other book on the subject. The information contained in this manual must be combined with hands-on training delivered by qualified instructors and experience on extrication incidents.

Terminology

Action Circle = Area where Disentanglement Group will be operating
Disentanglement = Cutting/ Dismantling Operations
Extrication = Packaging and Removal of patient
Stabilization = Eliminating all potential movement of a vehicle

Objectives

- Personnel should be able to identify the proper personnel protective equipment that is to be worn at an extrication incident.

- Personnel should be able to describe each of the four means of vehicle stabilization described in this manual.
    a. Cribbing
    b. Step chocks
    c. Shoring/ Struts
    d. Rigging

- Personnel should be able to describe the three types of hand tools discussed in this manual.
    a. Striking tools
    b. Prying tools
    c. Cutting tools

- Personnel should be able to describe the different hydraulic tools discussed in this manual.
    a. Porta-power
    b. Power unit
    c. Spreaders
    d. Cutters/Shears
    e. Extension rams
    f. Combi-tool

- Personnel should be able to describe the different components of a vehicle's anatomy.

- Personnel should be able to describe the different procedures used in extricating a trapped victim from a vehicle.

EXTRICATION EQUIPMENT

Over the years, vehicle extrication has become a major responsibility for the fire service. During those years many extrication tools and equipment have remained the same. Differences include changing rescue technology as well as evolving vehicle construction technology. Personal protective equipment and a number of traditional hand and power tools continue to improve as well.

This section will discuss the personal protective clothing and equipment that rescuers require in order to perform vehicle extrication safely. We will also cover the many types of tools and equipment that are used to perform vehicle extrication.

Personal Protective Equipment:

During vehicle extrication, rescue personnel may be exposed to many hazardous environments. It is important that all rescue personnel wear the proper protective equipment to ensure their safety.

Protective Clothing must be worn to protect the body. Included shall be turnout jacket, pants and steel toe boots, gloves, helmet and eye protection. When responding to a vehicle rescue, company members must have their protective clothing on prior to arrival. Turnout gear can protect rescuers from sharp protruding or flying objects, and many other hazards found on the extrication scene.

Foot protection must also be considered for the same reasons. Equipment used during extrication can be extremely heavy and can crush a rescuers foot if not properly protected.

Hearing protection should be considered during vehicle extrication, as operations can be extremely noisy. There may be generators, hydraulic power units, and multiple types of power tools in use.

Hand protection is also very important when dealing with vehicle extrication. The types of gloves worn by rescuers vary with the job they are doing and the level of protection required. Standard structural firefighting gloves should be appropriate in most vehicle extrications. Medical examination gloves should also be worn to protect the hands if rescuers will come in contact with blood or other bodily fluids. Some rescuers wear exam gloves beneath their leather gloves.

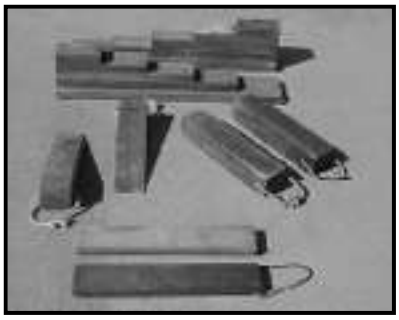
Respiratory protection should be considered to protect from respiratory injuries, especially if glass is being cut, as in a windshield removal operation. Use of a N95 or similar type mask will be sufficient to provide for this safeguard.

Eye Protection is essential when operating in or around any vehicle involved in extrication operations. Flying debris can be expected to always be present, anticipated or otherwise. It is important to note that helmet face shields may not be sufficient to adequately protect your eyes from surrounding hazards. Approved safety glasses or goggles should be worn in addition to the face shields built into your helmet.

TOOLS AND EQUIPMENT

Stabilizing Equipment:

One of the first and most important steps in performing vehicle extrication is stabilizing the vehicle. Any sudden or unexpected movement of the vehicle while rescuers and victims are inside can be dangerous, even fatal. The means used to stabilize vehicles most often includes the application of cribbing, step chocks, shoring, and rigging.



Cribbing is a combination of different sizes of blocks. They are usually constructed of wood material, recycled rubber products or plastic. Cribbing sizes range from 2X4 to 4x4 blocks, or a combination of both. Wedges are also part of the cribbing equipment and may also come in the same sizes as above. Wedges are tapered on one end so they can fill small gaps to tighten up the vehicle or load.

Step chocks are prefabricated pieces of wood or plastic, notched in steps. The advantage of using step chocks is they require less time to set-up. After the step chock is placed under the vehicle, the step chock can be secured with a wedge driven underneath the bottom.

Shoring has a wide range of uses and is commonly used to stabilize vehicles during a rescue. Shoring provides for a sturdy support of a vehicle on its side, roof or vehicle-on-vehicle. Shoring can be used in conjunction with ratchet straps, ropes or chains, known as a tension buttress system. Shoring can be made of wood, composite or metal and are operated mechanically or pneumatically.

Rigging includes the use of ropes, chains, and webbing. When securing a vehicle using the rigging method, it is important not to exceed the limitations of the equipment. Always consider the weight of the object being secured.

Hand Tools:

Striking tools are the most common of basic hand tools. Most striking tools have a heavy metal head with a long handle. This category includes axes, battering rams, ram bars, punches, mallets, hammers, sledgehammers, and picks. Safety is your first concern when using striking tools because they can cause serious injuries if used improperly. Also remember to use striking tools with short quick strokes. This is important because long swinging strikes have a possibility of striking somebody nearby, as well as reduced accuracy.

Prying tools use leverage to provide a mechanical advantage. Prying tools are used to pry open doors, windows, hoods, and trunk lids of vehicles. These tools can even be used to lift vehicles or heavy objects. When these tools are used correctly, prying tools are safer than striking tools because of the absence of ballistic movement.

Cutting tools are the most diversified of the tool groups. Most cutting tools are used on specific materials. It is important to use the proper tool on the proper material that the tool is specified for. Misuse can destroy the tool and endanger the operator. Manual cutting tools can be divided into the following four distinct groups:

- Chopping tools
- Snipping tools
- Saws
- Knives

Chopping tools are characterized by a metal head with a cutting edge attached to the end of a relatively long handle. Chopping tools include the flat-head axe, pick-head axe, pry-axe, and various types of picks.

Snipping tools are used in situations where access is limited and the material is thin (e.g., sheet metal). These tools are also much safer when working close to victims. Examples of snipping tools include scissors or shears, tin snips, bolt cutters, and wire cutters.

Saws, such as handsaws, are important when a controlled cut is required. They are also important when working close to victims and in hazardous atmospheres. Handsaws commonly used in extrication include carpenter's saws, hacksaws, coping saws, keyhole saws, and windshield cutters.

Knives of many kinds may be useful in vehicle extrication. While a sharp pocketknife may be adequate in some situations, knives specially designed for

vehicle rescue are usually more efficient. Specialty knives include V-blade (seat-belt) knives, linoleum knives, and utility knives.

Specialized Hand-tools:

Some extrication hand tools are so specialized they are used for single purposes. The most common examples of this type of tool are spring-loaded center punches and glass hammers.

Center Punches are a standard tool designed to break tempered glass. Inside the center punch is a spring which, when depressed, causes the tool to "punch" the window causing the glass to break. This is much safer than using a striking tool. Some center punches come without a spring and they must be struck with a striking tool.

Glass hammers may also be used to break tempered glass. They consist of a pointed metal head attached to a plastic handle. Striking it against the glass as you would a regular hammer causes the tempered glass to break.

Pneumatic (Air-powered) Tools:

Pneumatic tools use the energy of compressed air for power. Air pressure is usually supplied by a compressed air cylinder, but it may be supplied by vehicle mounted air compressors or cascade system cylinders.

Pneumatic- powered chisels (air chisels) are especially effective for auto extrication by cutting through the roof, roof support posts or doorjambs, seat-bolts, and door lock assemblies.

Pneumatic Lifting Bags:

These devices allow rescuers to lift or displace objects that cannot be lifted with standard extrication equipment.

High-Pressure Air Bags are constructed of neoprene rubber reinforced with either steel wire or Kevlar aramide fiber and have a rough, pebble-grained, surface to improve purchase. Before inflation, the bags lay virtually flat and about 1" thick. The bags come in various sizes and each

is rated for a particular weight and height. The largest bags can lift up to 75 tons. Depending on the size of the bags, they may inflate to a height of up to 20 inches.

Electric Tools:

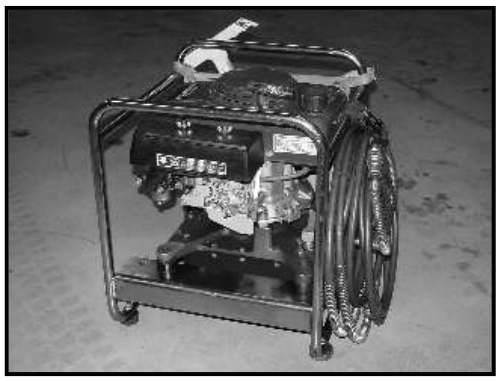
Reciprocating Saws are easy to control and are well suited for cutting metal or wood because they produce far fewer sparks and airborne debris than a rotary rescue saw. These saws may be used where space is limited and when working close to victims. When equipped with a metal cutting blade, reciprocating saws are very effective in cutting automobiles during an extrication operation.

Hydraulic Tools:

Porta-Power systems are a common auto body shop tool used for vehicle extrication. It operates by transmitting hydraulic pressure from a hand-pumped compressor through a hose to a tool assembly. There are a number of tool adapters that can be placed on the end for different applications. The primary advantage of the porta-power tool is its ability to work in tight places close to rescue victims. Modern extrication equipment has excluded the use of the porta-power in some departments.

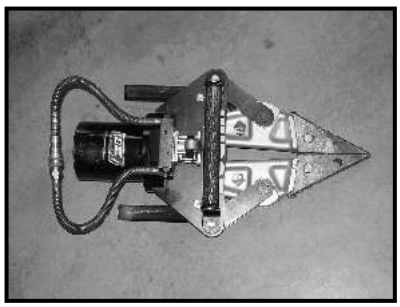
Power-Driven Hydraulic Tools have revolutionized the process of removing victims from various types of entrapments. The wide range of uses, speed, and the superior power of these tools has made them the primary tools used in most extrication situations. These tools receive their power from hydraulic fluid under pressure supplied through special hoses from a pump, commonly referred to as a
power unit. Although a few hydraulic power units are operated by compressed air, most are powered either by electrical motors or by two or four-cycle gasoline engines. These power units may be portable and carried with the tool, or can be permanently mounted on the vehicle and connected to hose reels. Manually operated pumps may power tools powered by these units if the power unit fails. In addition to the power unit, there are three common pieces of powered hydraulic tools used in vehicle extrication: spreaders, cutters, and extension rams.

Power Unit The power unit (Amkus, Hurst, or Holmatro) is the heart of the hydraulic system. Some units provide power to multiple tools without switching directional valves while others operate one tool at a time. As mentioned earlier, the power unit is operated with a gasoline-powered motor. A positively displaced hydraulic pump, rated up to 10,000 psi, pumps the hydraulic fluid. A

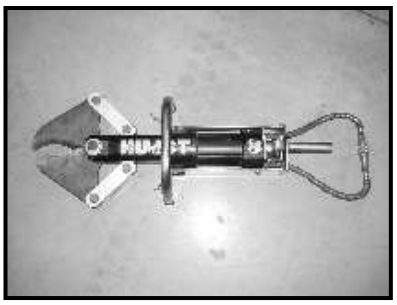


hydraulic fluid reservoir rests in the base. Check manufacturer's instructions for type and amount of hydraulic oil.

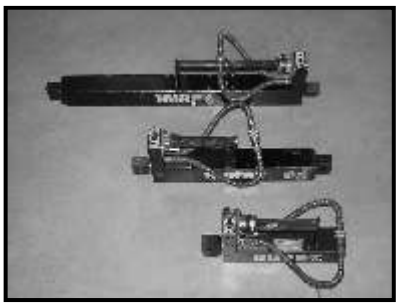
Spreaders were the first hydraulic powered tools of extrication. They are useful for a variety of different operations involving pushing and pulling. Zone 1 departments use Hurst, Amkus, and Holmatro spreaders. They are rated up to 18,000 psi of spreading/pushing force and can spread apart as much as 32 inches wide. The spreaders can weigh up to 70lbs.



Cutters/Shears which are hydraulically powered provide maximum cutting force and flexibility. They are powerful enough to cut through automobile bodies, chain link fence, and even concrete reinforcing bar. The cutters are most commonly used to cut the posts/pillars of a vehicle. However, they may be used for various purposes around the vehicle. The cutting force at the blades varies but can range from 10,000 to nearly 100,000 psi.



Extension rams are primarily used for straight pushing operations. They may also be used for pulling under certain circumstances. They come in three different sizes: 20", 30", and 60". The size used is determined by the application. The extension rams also have a tip adapter kit, which provides different bases/tips to enhance the performance of the tool. The extension rams have a weight between 21 and 40 lbs.

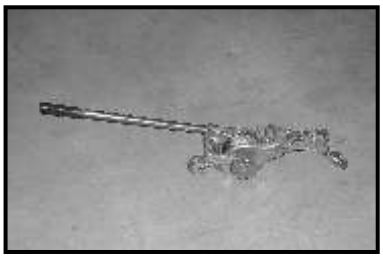


Other Power Tools and Equipment:

In this section of vehicle extrication, we will discuss the different types of power tools used during vehicle extrication. Please consider the fact that most power tools are used in special circumstances only. Because of their ability to produce heat and sparks, they create the potential for an ignition and could cause harm to occupants of the vehicle.

Circular Saws As mentioned earlier in the chapter, it is important to select the proper blade for the specific material to be cut. There are three types of blades

used in the fire service: carbide, metal, and masonry. Take advanced steps to cover the patients. Be aware of vapors from leaking flammable liquids. A spark may ignite the vehicle causing further problems for rescuers. Any time a circular saw is used during vehicle extrication a hose line should be in place.



Come-Along Another lifting and pulling tool often used is the come-along. The most common sizes range from 1 to 10 tons. This tool uses leverage and a ratchet/pulley mechanism to increase pulling capacity. The come-along has a drum that is rotated by a lever handle directly or through gear action. A cable is attached to the drum that makes the effective pull of the come-along equal to the length of the cable. The come-along should is anchored to a secure object, and the cable is extended out to the load to be moved. Once both ends are attached, the lever handle is operated to pull the load toward the anchor point. The lever handles on some come-along's are designed to bend before the cable reaches the breaking point.

Vehicle Rescue Incident Safety

All responders to a vehicle rescue incident must realize this type of incident presents many hazards which must be mitigated in order to reduce the likelihood of injury to both victims and rescuers. These hazards can be classified as environmental hazards, scene hazards, or vehicle hazards. A thorough and continuous size-up along with well maintained situational awareness must be the standard for all personnel on scene. This section will outline many of the common safety concerns for personnel at a vehicle rescue as well as provide information crucial to scene safety. Remember that NFPA 1670 calls for a designated Safety Officer at all technical rescue incidents. See Truck Module 903.00 for hazard control information.

Environmental:

- Weather, Time of Day

Scene:

- Approach: Scan for downed power lines, possible vehicle fire, fluid leaks, and crowd.
- PPE: Ensure all personnel have appropriate PPE donned including head, eye, and respiratory protection
- Apparatus Placement: Ensure path of oncoming traffic is blocked by large apparatus. Consider uphill/upwind if hazmat involved.
- Traffic Management: Traffic warning/re-direction devices in place

Vehicle:

- Stabilization: Ensure all vehicles are stabilized appropriate to their position. Re-evaluate throughout the incident.
- Vehicle 12 Volt power: Vehicles with an active 12V system intact can deploy built in safety systems that can injure rescuers/occupants.
- Alternative Fuel: This variation must be considered as a scene safety factor. Perhaps the most dangerous factor is that this vehicle can be silent yet accelerate quickly and unexpected.
- 5-10-20 air bags zones maintained.
- All areas to be cut are exposed prior to cutting (Peel-N-Peek)
- Glass properly managed

Supplemental Restraint Systems:

Air bags-

Vehicle air bags have evolved significantly from their introduction and will continue to do so. Air bags generally are inflated one of two ways once the vehicle's sensors tell them to. The first way is via a small chemical reaction that causes a sudden release of gas that fills the bag. The other way is the release of gas (argon or nitrogen) from a stored pressure cylinder usually located in a roof rail or side pillar. These cylinders store significant pressure and must never be cut into. It must be understood these cylinders could be found anywhere in a vehicle so all trim panels must be removed prior to cutting. The air bags themselves will deploy from many areas in a vehicle. These areas include the steering wheel, dash, seats, roof rails, knee panels, and doors.

****Very Important-** A deployed air bag is not a safe air bag to work in proximity to. Modern air bags can re-deploy in a second stage. Additionally, air bags can still deploy for some time after the vehicle has been de-energized. Treat all air bags whether loaded or deployed as dangerous.

It is good practice to avoid cutting air bag control modules (located under center console, under seats, or behind kick panels) as this may cause an accidental activation. Yellow wires are standard for air bag control and should be avoided.

Seat Belt Pre-Tensioner-

The pre-tensioner device serves to remove slack from the seat belt at the time of collision. There are several types of these mechanisms. They usually will be found in the seat where the belt buckles or low in the B pillar. Rescuers should avoid cutting these devices as doing so may cause fragmentation.

ROPS-

With the popularity of convertible top vehicles it is not uncommon to encounter automobiles with **R**oll **over P**rotection **S**ystems. This system deploys a hidden roll bar up when sensors detect a near roll over situation. Responders should stay out of the zone behind seats when dealing with this type of vehicle.

Procedures:

S- Size-Up/Windshield (Report on Conditions)/360 degree view of the scene.
H- Hazard Control/Assessment (Apparatus Placement/Scene Safety)
A- Access Patients (External/Internal Observations)
D- Disentanglement (Plan A and B are recommended)
E- Extrication (Removal of the occupants)

S - Size-Up:

Size-Up is an essential component in organizing on-scene activities and incoming resources. The size up process begins at the time of dispatch, which can include information received from dispatch, time of day, location, weather, and any special information. It is the responsibility of the first in fire officer to determine the number of vehicle(s) and occupants so that he/she can make additional resource requests as needed. This initial "windshield report on conditions" should be brief in description.

- Establish command
- Relay anticipated needs for executing an efficient disentanglement/ extrication
- Determine number of vehicles and their configuration/positioning
    - Overturned, side resting, stacked vehicles, etc.
    - Degree of damage (minor, moderate & major)

Secondary to the initial size-up is the 360 degree view of the incident.

- 7 side survey of the vehicle(s)
- Number of actual vehicles involved
    - Any need to divide the incident
        - ✓ Vehicles spread apart by distance unmanageable by initial resource response(e.g., freeway incidents)
- Number of potential patients/ injuries, trapped occupants or ejections
- Determine need for additional resources
- make assignments
- Re-evaluate and make adjustments as needed

H- Hazard Control:

Hazard control is the systematic and necessary step throughout all vehicle accidents needed to ensure the safe operations and actions of rescuers, as well as the overall safety of the victims and bystanders on scene. Attention is to be directed toward current and anticipated hazards present at the incident. Hazard control must be an ongoing process in order to maintain continuous control and safety of the scene for those involved.

- Scene/Traffic control – Protection of rescuers and victim(s) is priority
  - Establishing a temporary work zone using apparatus and/or law enforcement as necessary
    - ✓ Maintaining access for the truck is to be a consideration
  - Attempt to remove any uninvolved bystanders from your working area, using Law enforcement as needed.
- Lighting of the scene shall be carried out when necessary utilizing portable or apparatus scene lights
- Ensure there is adequate fire protection in place
  - Charged hose line and possibly an extinguisher as needed.
- Isolate potential energy sources
    - ✓ ***Attempts to isolate any energy source within a vehicle should always be preceded by a confirmation that there are no hazards as a result of its instability. Stabilization procedures may be required prior to any other activities.
  - Downed power lines – ensure they are de-energized before approaching vehicles involved
  - Disconnect vehicle batteries
    - ✓ Consider first rolling down power windows, unlocking doors, unlatching trunk, moving seats back, etc.
    - ✓ Disconnect negative cables first – double cutting is recommended and ensuring there is no chance of re-contact
    - ✓ Remove the keys from the ignition to prevent a restart
      - Never assume that a vehicle cannot be restarted if a key is not present (e.g., proximity keys)
      - Disconnection of the 12v battery will prevent a restart
    - ✓ 4-way hazard lights shall be turned on to alert rescuers of an existing power source which still exists.
- Isolate/mitigate fuel leaks and fluids
  - Dam/dike/divert
    - ✓ Prevent leaking fuel or other fluids from becoming a factor in your rescue operations.
  - Secure the leak using a temporary repair (i.e., plug`n'dike, wood plug, etc.)
  - Soil or absorbent should be used to provide a layer of protection for spilled fuel or fluids in and around your work area.

- For larger spills or fuel tanks, class B foam should be considered in conjunction with your hose lines, and consider HAZMAT mitigation and protection tactics.

- Glass Management may be required to facilitate access to the victim(s), protect from loose or flying glass, and protect those involved from remaining shards of glass. As is the case with all extrication functions, proper PPE including hand and eye protection is a must.
  - Take care to prevent broken glass from falling in toward the victims.
  - Cover victim(s) and rescuers inside the vehicle with a tarp or blanket
  - Laminated glass consists of two or more layers of glass with a plastic layer in between each and will be generally used in front and sometimes side and rear windows
    - ✓ When an option, leave front windshield intact
    - ✓ If the only option is to remove the glass, the best methods are with a saw or hand tool, such as:
      - Reciprocating saw
      - Axe
      - Hand saw / windshield saw
      - Pry bar
    - ✓ It is important to note that the fine dust created when cutting through laminated glass is considered to be damaging to your lungs and respiratory protection should be considered.
  - Tempered glass is reinforced glass that has been heated and rapidly cooled resulting in increased strength and the ability to break into many small pieces
    - ✓ Remove glass where disentanglement is planned
    - ✓ If removal is needed to gain access to the occupants, choose a window as far away from the victim(s) as is reasonable
    - ✓ Use of a window punch or other tool with a sharp pointed end is most effective.
    - ✓ Although the chances are less likely with tempered glass pieces, they can still be sharp, so proper PPE must be in place for protection
  - Apply the tool to the bottom corner of the glass taking care not to allow your hand or tool to enter into the passenger space towards the occupants
    - ✓ The use of duct tape, adhesive paper or aerosolized spray adhesive is effective in keeping the broken glass together for removal

- Determine the contents of the trunk
  - If time permits and access is available, investigate the contents of the trunk for dangerous substances or material.

Hybrid vehicles:

- What is a Hybrid:
  - An automobile with more than one power source, such as an electric motor and internal combustion engine or an electric motor with battery and fuel cells for energy storage.
  - The internal combustion engine does not need to be running for the vehicle to be in motion.
- Current models:
  - Toyota, Lexus, Ford, Mazda, Nissan, GM, Honda.
  - Commuter buses, School buses, UPS/Fed Ex, Cargo/Utility, Military.
- Power down procedures:
  - To disable vehicle (HV battery pack, SRS airbags, and gasoline fuel pump)

Procedure #1

- ✓ 360° inspection
  - From a safe distance
  - Check underneath vehicle
  - Stabilize vehicle
  - Silent running hazard
- ✓ Observe dash for vehicle running status
  - Ready light/illumination
- ✓ Place vehicle in park, set parking brake
- ✓ Turn ignition off (power button or key)
  - Reach behind steering wheel
  - Smart key – press power button once (not necessary to remove keys)
- ✓ Confirm ready light off (instrument lighting is not illuminated)
- ✓ Turn off headlights (HID)
- ✓ Turn on hazard lights (indicates 12v power)
- ✓ Locate and disconnect 12v auxiliary battery
- ✓ Confirm hazard lights are off
  - Capacitors will store voltage for a period of time (SRS, inverter/converter)
- ✓ Continue extrication procedures

Procedure #2 (if the electronic key cannot be located or the power button is not accessible)

- ✓ 360° inspection
  - From a safe distance

- Check underneath vehicle
- Stabilize vehicle
- Silent running hazard

✓ Observe dash for vehicle running status (if possible)
- Ready light /illumination

✓ Initial patient contact
- Use power options to maximize patient access (i.e. seats, windows)

✓ locate and disconnect 12v auxiliary battery
- Vehicle will remain in ready mode

✓ Remove high voltage disconnect (if possible)
- Confirm power down (lighting, hazards, or ready mode)

✓ Pull fuses in fuse block
- Starting with the largest first (green, yellow, blue, red)
- Confirm power down (lighting, hazards, or *ready* mode)

✓ If fuse block is not accessible, cut wiring to fuse block
- Capacitors will store voltage for a period of time (SRS, inverter/converter)

✓ Continue extrication procedures

***WARNING:**

✓ Never assume vehicle is shut off simply because it is silent
✓ 4 way hazards shall be turned on to confirm absence of power
✓ Always observe the driver's instrument panel for an absence of illumination to verify the vehicle is shut off.
✓ If either of the disabling steps above cannot be performed, proceed with caution as there is no assurance that the high voltage electrical system, SRS, or fuel pump is disabled.
✓ As a last resort, the high voltage cable (orange) can be cut without the risk of electrocution
✓ Refer to the *Hybrid Vehicle Technology* power point for more detailed info.

Vehicle Stabilization:

Vehicle stabilization is always necessary when involved in rescue operations at a vehicle accident and especially when there is the potential for extrication procedures. This is vital to prevent additional risk of injury to the patient and rescuers on scene. A lack of vehicle stabilization can result in sudden and unexpected movement of the vehicle, particularly one that is on its side, top or resting on another vehicle.

<u>No disentanglement needed</u>

- Full 360 is needed to observe all variables and safety issues

- Place the transmission in park (or in gear if it is a manual transmission) with engine off and parking brake applied.
- Remove the keys from the ignition to prevent a restart
- Chock the vehicle wheels in both directions if on level ground or on the downhill side, if on a slope.

Disentanglement is required with all 4 wheels are on the ground

- Perform steps as outlined above. Additionally;
- Remove all windows in proximity to extrication functions and the patient by either rolling down the windows or breaking them out, taking care to prevent glass from falling toward the patient
- Crib the vehicle
  - 4 points of cribbing is preferred with contact made to the frame of the vehicle.
  - Remove the suspension by deflating the tires by either removing the valve core, cutting the valve stem or pulling out the stem with pliers.

    - ✓ Be advised that some movement will occur as the tires deflate. Make sure that involved rescuers are aware and ready prior to this action.
    - ✓ Make sure that vehicle is fully resting and stable on the cribbing and no longer on the tires or rims.

Technical Stabilization

Any vehicle which is not on all 4 wheels (i.e., resting on its side, roof, car on car, etc.) will require technical stabilization using pneumatic or manual struts (shoring), cribbing, ropes, come-a-long, etc. Technical stabilization is always a dynamic operation, completely unique to the particular conditions of the vehicle(s) and surrounding circumstances. The goal of all stabilization and technical stabilization in particular, is to reduce the vehicle(s) high center of gravity by increasing its footprint. All actions should be directed towards safely removing the possibility of further movement of the vehicle prior to and after extrication procedures.

- Perform steps as outlined above, if appropriate. Additionally;
- An array of different techniques and equipment can be used for stabilizing a vehicle which may be in an unstable position (i.e., side resting, roof resting, car on car, etc.)

- Although tension buttress systems are the preferred and most stable method, stabilization can also be accomplished using ropes, cribbing, ratchet straps, come-a-longs, or any combination thereof.
- Any method is going to be dictated by the position of the vehicle, its relation to its surroundings, the ground on which it is resting, as well as access.
- Cribbing should always be used in conjunction with the selected stabilization method to provide for more complete contact with the ground.

As discussed above, there are several different techniques and types of equipment which can be utilized in the stabilization process. Generally, for vehicles resting on their side, adjustable shoring devices are most efficient in achieving overall stability. Although you can stabilize the vehicle with 2 struts, if the situation allows, you should use a minimum of 3 struts, with 4 being optimal, to properly secure the vehicle. The triangular or "pyramid" shape produced through use of these tools, along with ratchet straps connected between the vehicle and struts, provide for a large footprint relative to the vehicle's high center of gravity, minimizing or removing lateral and horizontal movement. For vehicles resting on their roof, a chain saddle often creates a strong base in combination with strut set-ups as described above.

When the situation of a vehicle resting on another vehicle is encountered, "marrying" the vehicles together using ratchet straps or ropes significantly improve stabilization efforts when used in combination with the afore mentioned stabilization techniques. This action reduces the likelihood of the vehicles shifting during the stabilization process and extrication procedures.

As should always be the case, firefighter and victim safety should play the lead when determining the tactics you pursue in stabilizing an unsecure vehicle or vehicles. Knowledge, hands on training and familiarity of equipment is the only way to be proficient with these techniques.

A- Access Patients:

As firefighters enter the vehicle(s) for patient access, they must observe external and internal hazards that may injure firefighters and the occupants within the vehicles. The firefighter must always scan the vehicle for airbags while maintaining the 5-10-20 rule near airbags zones. The 5-10-20 rule is the distance in inches that is maintained between the side (5"), steering wheel (10"), and passenger (20") airbags. This will protect firefighters in vehicles where the 12 volt system is still possibly active and any accidental activation. Once firefighters gain access to the patients, all seatbelts must be removed or cut in case pre-tensioner devices are cut in the disentanglement phase. If the seatbelts are not removed and the pre-tensioner device activates, it can cause significant injuries to the patients and/or rescuers.

The firefighter should observe the numbers of patients, their configurations within the vehicle, potential injuries, access issues, and any information that will assist in the patient removal strategy. Patient comfort and covering will also take place in this category.

The disentangle procedures will include the communication with the firefighter operating in the vehicle with the patient(s). The firefighter shall maintain constant communication with the patient(s) to comfort and provide information on the ongoing operation. The firefighter can also provide treatment to the patients while they are trapped within the vehicle.

D-Disentanglement:

Disentanglement is the phase of vehicle rescue that removes or relocates the portions of the vehicle entrapping the occupant allowing for a safe patient extrication. This process usually involves reversing the forces that caused the entrapment or some form of dismantling of the vehicle.

There are many ways in which occupants can be trapped within a vehicle therefore the rescuer must have a working knowledge of vehicle anatomy, safety systems, and various rescue techniques. Most procedures for displacing the vehicle from the occupant can be placed into four categories:

- Door Operations
- Side Operations
- Roof Operations
- Dash Operations

The extent of damage and type of entrapment will dictate the methods used. These categories are not intended to represent every technique that may be required at a vehicle rescue scene but rather an overview of skills in which every rescuer should be proficient.

When developing a disentanglement plan, it is important for the rescuer to consider plans A, B, and C as no one single plan can be relied upon to be successful.

As vehicle technology improves so does the strength of the materials used. Modern vehicles are different from their predecessors in that they do not use bulk steel in all areas. They are engineered strong where needed. This construction technique allows the rescuer to exploit the weaker areas and avoid the stronger areas. It is helpful to understand the much of what gives metal its strength is its shape. Simply crushing or changing the shape of the material may allow it to be manipulated in our favor.

Before any disentanglement procedures begin, it is important that all set-up work is completed. This includes vehicle stabilization, 12 volt power disconnection, creation of a tool cache, glass management, exposure of all areas to be cut, removal of seat belts and covering of patient for protection. Every following skill outline assumes this set up work has been completed prior to disentanglement. It will be re-emphasized that no cut is to be made without removal of trim panels.

Door Operations:

The most common obstruction to patient removal is a jammed door. If unlocking the door and attempting to operate all handles fails, the next step is to force the door. The door can be just forced open or totally removed. The two most common points of attack are from the latch (handle side) or from the hinge side. The hinge attack is preferred when size-up reveals air bags in the doors. Remember that when forcing a door with hydraulic tools that the required force can be minimized by holding open the handle on the door while the tool is operating. The safest way to do this is by jamming an object under the door handle which holds the latch open. Whenever force is being used to open a door

all rescuers must stay clear of the path in which the forced part will travel. Door travel can be arrested with a safety strap around the door frame.

<u>Latch Attack:</u>

- Create purchase point on the latch side
  - Use blade of halligan bar rotated in door seam or
  - Open spreader arms in window opening to perform “Vertical Crush.”
- Roll Door down and out from Nader pin
  - Place spreader tips into opening between upper door frame and “B” pillar
    - ✓ Position inside spreader tip contact higher than outside tip contact to provide proper angle.
  - Open spreader tips until door rolls off the pin or door skin tears.
  - Reposition spreader tips lower toward Nader pin as necessary.

<u>Hinge Attack:</u>

- Create access to front hinges
  - Squeeze front fender vertically above front tire with spreaders.
  - Use spreader arms to fold fender back from hinge area.
- Separate hinges from “A” pillar using cut or spread method
  - Cut hinges
  - Spread hinges from “A” pillar
    - ✓ Above top hinge then below bottom hinge

- ✓ Keep feet and hoses clear
- Remove door from Nader pin
  - Open door handle to remove door
    - ✓ Refer to Latch Attack procedures if door fails to separate.

Side Operations:

Several types of entrapments may occur as a result of impact to the side of the vehicle. Compounding this problem is that many vehicles have rear seating but only front doors. This makes access to rear passengers very difficult. Even without collision displacement, the B pillar in most cars presents obstruction to proper patient removal. The following operations are the most universal for side impact entrapment.

3rd Door Conversion:

This operation creates access to trapped occupants in the rear seat of a two door vehicle by creating a new "door" behind the front door.

- Open/Remove front door on side of operation
- Create relief cut into base of "B" pillar parallel to rocker panel
  - Use reciprocating saw or hydraulic cutter
    - ✓ Avoid seatbelt pre-tensioner
- Cut "B" pillar at roofline
- Create a vertical relief cut at rear of back window frame where it meets the "C" pillar
- Create hinge points to fold back the "3rd door"
  - Use spreaders to squeeze the door over relief cuts
- Force the "3rd" door down and out.
  - Option 1- squeeze top of door section with spreader tips and use weight of tool to fold the door down
  - Option 2- Use the spreader tips to force the "3rd" door out by placing one tip against the rocker panel and the other tip against the base of the third door. Open tips to spread door out.
- Another option is to use reciprocating saw to simply cut the rear quarter panel out creating the "3rd" door

B- Pillar Blowout:

This operation is a variation of the total side removal .This is method works well when confronted with jammed front/rear doors and B pillar intrusion from a side impact.

- Open rear door (see latch attack) and leave attached by hinges.

- Separate “B” pillar from rocker panel
  - Create relief cut low on “B” pillar parallel to rocker panel as deep as possible. (Avoid seat belt pre-tensioner)
  - Place spreader tips between rocker panel and lower hinge area of door.
  - Open spreader tips to tear the “B” pillar from the rocker panel causing the pillar to blowout.
- Cut “B” pillar at roof line. This step must be completed after the cut at the base of pillar near the rocker panel.
- Swing whole section open on front door hinges.
- Cut or spread front hinges from “A” pillar to remove whole section.

Roof Operations:

Roof removal, whether partial or total, offers the best access to trapped occupants. A few hazards must be considered however.

- Pillars and roof rails are a common location for high pressure air bag inflators
- Hydraulic struts are present in rear tailgate/hatch sections. Do not cut them.

- The vehicle roof provides a great deal of linear strength. Removing it requires additional support mid length to prevent collapse.

<u>Forward Fold:</u>

- Remove side and rear glass
- Cut rear pillars
  - Remove interior trim to view cutting area
- Cut remaining pillars working forward
  - Roof must be supported
- Make relief cuts on roof
  - Use reciprocating saw to cut into roof at least 12” on each side from “A” pillar parallel to windshield toward center.
- Fold roof forward and secure

<u>Total Roof Removal</u>:

- Cut rear pillars as per <u>Forward Fold</u> operation.
- Cut “A” pillars.
- Cut windshield from “A” pillar to “A” pillar.
  - Use reciprocating saw or chop cuts with axe
- Lift roof up and carry forward off of vehicle.

Dash operations:

The following operations are very helpful when confronted with head-on type dash intrusion. Do not overlook cutting of the steering wheel ring or spokes to offer additional clearance if needed.

Dash Roll:

This skill uses the hydraulic ram to push from low on the "B" pillar to high on "A" pillar near the dash to roll the dash away from the trapped occupant.

- Place additional cribbing under "A" pillar
- Remove 4" section of "A" pillar near roof line if roof still intact.
  - Windshield can remain intact
- Place relief cut in base of "A" pillar between rocker panel and lower hinge.
- Consider cutting upper rail (upper support for fender mounts that runs from firewall to front of vehicle).
  - Squeeze front fender vertically with spreader over front tire to create a hinge point.
  - Use spreaders to rip fender from its rear mounts and fold forward toward front of vehicle.
  - Use cutters to relieve the upper rail by placing a vertical cut into the upper rail between the strut housing and firewall.
    - ✓ Avoid any hood struts
- Place base of ram against "B" pillar and extend other end into "A" pillar near dash.
- Slowly extend ram to "roll" dash away from occupant.

Dash Lift:

This skill uses the spreaders to "lift" or "Jack" the dash up off the occupant.

- Place additional cribbing under "A" pillar.
- Cut upper rail (see procedure above).
- Remove 4" section of "A" pillar near roofline if roof still intact.
- Create slot in "A" pillar for spreader tips.
  - Use cutters to place deep relief cut into "A" pillar just above lower hinge.
  - Place similar cut 3" above first cut on "A" pillar.
- Squeeze metal between cuts with spreader tips and fold out perpendicular to rocker panel.
- Place spreader tips in slot perpendicular to rocker panel and slowly open spreader tips until desired lift is accomplished.

E- Extrication:

The extrication process is the process of removing the patient from the vehicle(s). The firefighter attending the patients should develop an extrication plan based on the mechanism of injury and configuration of the patients within the vehicle(s). The plan may include the path of removal of the patient(s), the equipment needed for patient removal (backboard, KED device, etc.). It is important that the needs of extrication equipment are communicated early in the incident so that as the disentanglement phase concludes, available person can transition into patient care and packaging.

Summary:

Vehicle rescue is becoming more specialized with every new model year. Rescuers have many more factors to consider than ever before with the dramatic changes in fuel types, safety systems, and construction methods/materials. The rescuer is required to have significant knowledge of these systems in order to operate safely at vehicle rescue scenes.