

SAN FRANCISCO FIRE DEPARTMENT



AUTO EXTRICATION MANUAL

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Auto Extrication Manual
July 2025
San Francisco Fire Department
698 2nd Street
San Francisco, CA 94107

Chief of Department
Dean M. Crispen

Manual Revision Project
Deputy Chief Patrick J. Rabbitt

Contributors
Assistant Chief Frank Cercos-IV
Battalion Chief Rick Gering
Captain Brook Mancinelli
Lieutenant Justin Tassone
Firefighter/Paramedic David Halpin

Editor
Assistant Chief Frank Cercos-IV
Assistant Chief William Storti

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INTRODUCTION

This manual provides a foundational understanding of vehicle extrication; a critical emergency response procedure focused on safely removing trapped occupants from wrecked vehicles.

Key Points

1. **Collaborative Effort:** Vehicle extrication typically involves firefighters, emergency medical personnel (EMS), and other responders working together as a team.
2. **Patient Safety:** The primary objective is to swiftly extricate occupants while minimizing any additional injuries.
3. **Diverse Techniques:** A variety of methods may be employed, including using specialized hydraulic tools to cut through vehicle parts, deploying pneumatic bags for lifting, or manually manipulating doors and windows to gain access.
4. **Complexity and Risk:** The process can be intricate and hazardous due to the use of heavy machinery, sharp tools, and the proximity to injured individuals.
5. **Specialized Expertise:** Firefighters involved in extrication require specific training, equipment, and well-honed teamwork abilities to ensure a safe and efficient operation.
6. **Life-Saving Importance:** Vehicle extrication plays a vital role in emergency response, potentially saving lives and minimizing further injuries in time-sensitive situations.

Manual Scope

1. **Foundational Knowledge:** This manual serves as a starting point, introducing basic safety principles, essential tools, and fundamental techniques used in extrication.
2. **Continuing Education:** For those aspiring to become extrication experts, further education and training is required.
3. **Scenario and Technique Limitations:** Since this is a basic manual, it doesn't cover every possible scenario or advanced technique.
4. **Valuing Experienced Responders:** Firefighters with additional training and experience are valuable resources during extrication operations, both in the field and during training exercises.

VEHICLE ANATOMY AND CONSTRUCTION

In the context of vehicle extrication, standardized terminology is important for clear communication among responders. For instance, rather than using directional terms like "left" and "right," referring to the "driver side" and "passenger side" avoids confusion. Figures 2.1a and 2.1b illustrate commonly accepted terms for vehicle components. Figure 2.2 depicts a dash support, a key element in dash lifts and rolls (covered in the CUT SEQUENCE of this manual). The number of dash straps on a vehicle can vary between one and two, and their material composition can be either metal or tubular plastic.

Figure 2.1a Vehicle Anatomy

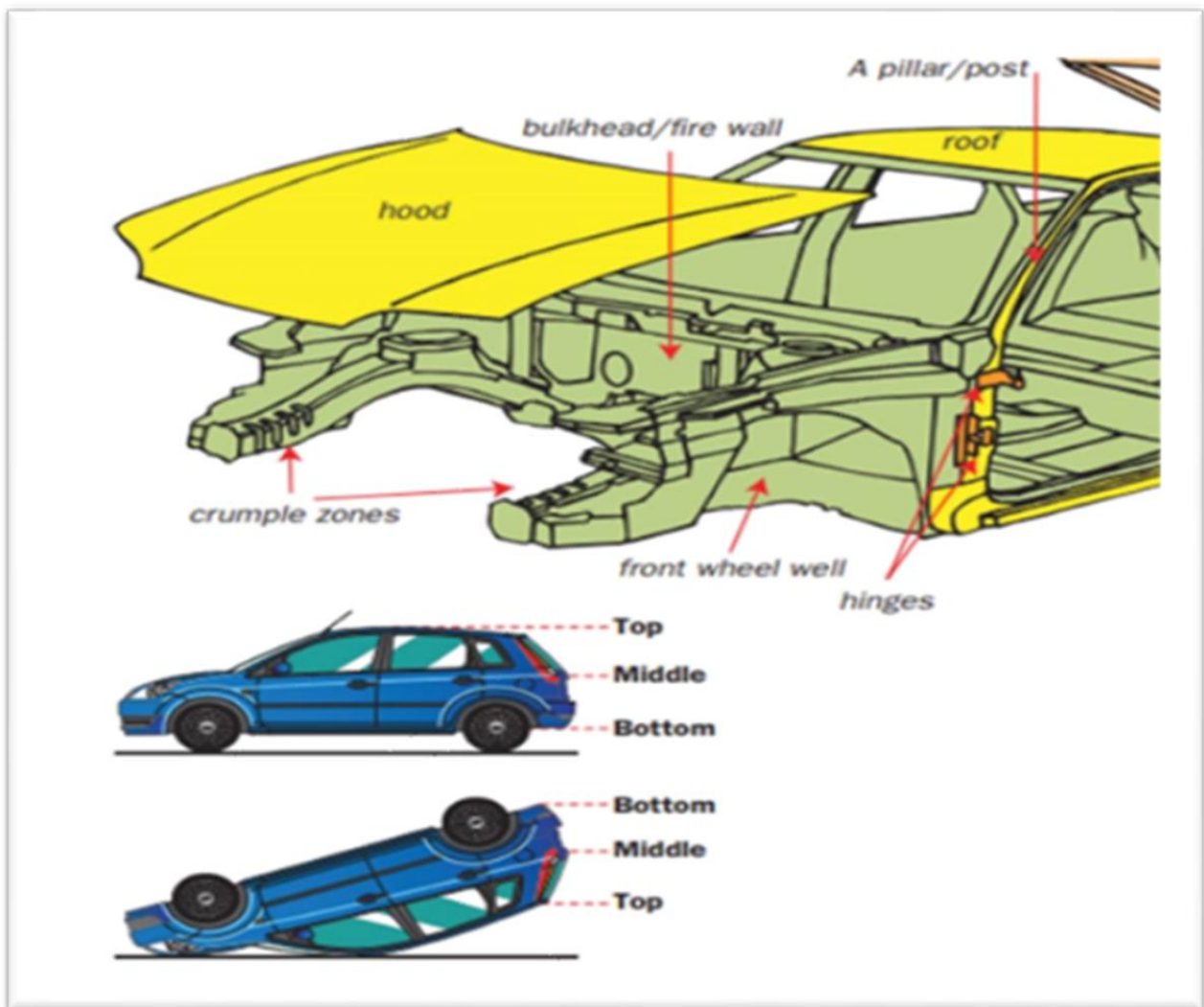
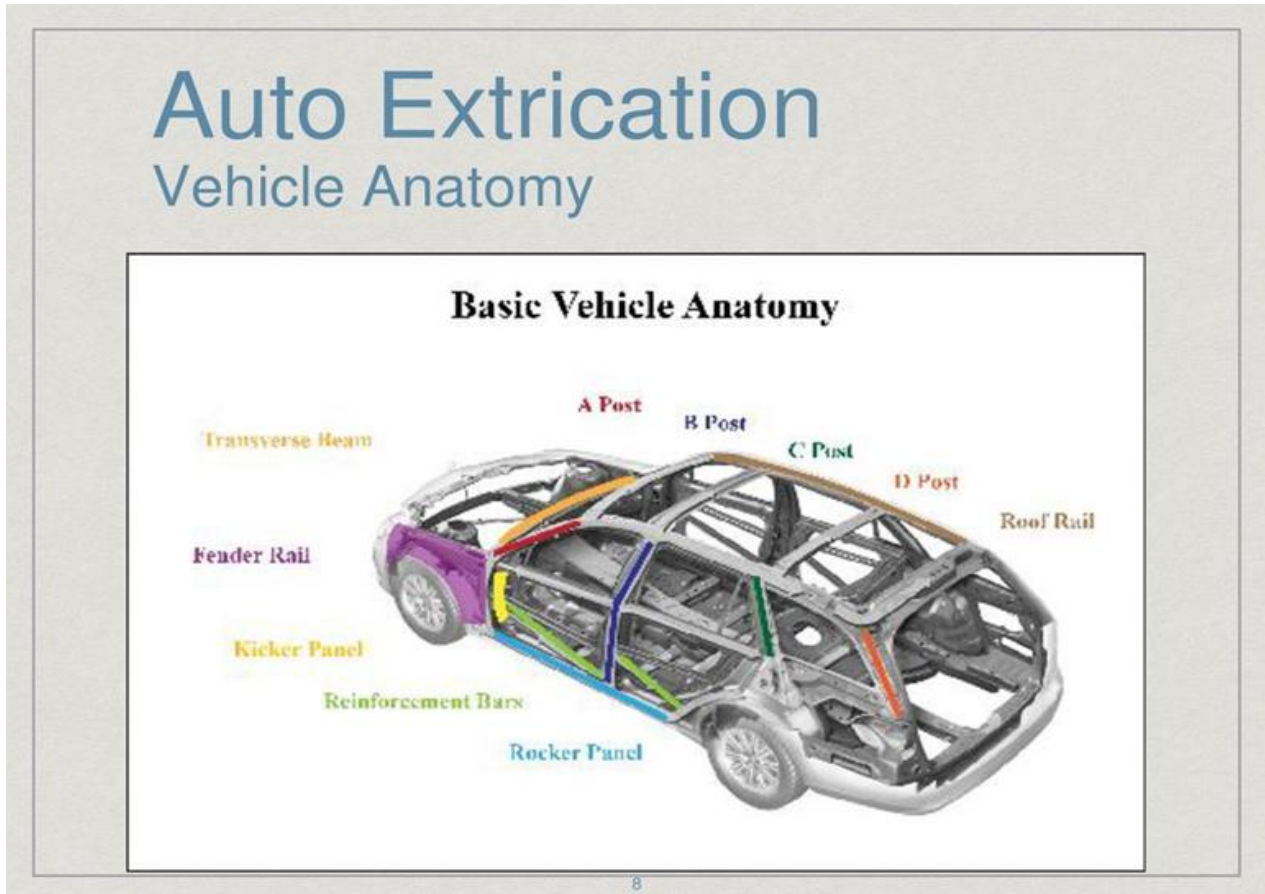


Figure 2.1b Vehicle Anatomy



Figures 2.2 and 2.2a showcase some typical vehicle construction features.

Figure 2.2 Dash Support



Figure 2.2a Vehicle Construction



Vehicle Anatomy and Construction

Modern Vehicles have reinforced wheel and Engine deflection systems. During a crash, these systems move the wheels and motor under the car away from the passenger compartment. This can make cutting in this area for techniques like a dash roll more challenging.

1. **Crumple Zones:** Designed to absorb crash energy, significantly improving occupant survivability in collisions compared to older vehicles.
2. **Reinforced Dashboards:** Enhance driver and passenger protection during frontal or side impacts. This can make traditional one-sided dash rolls more difficult to perform.
3. **Frame Materials:** To counteract the weight gain from additional safety features, car manufacturers are using High-Strength Low-Alloy (HSLA) or even Ultra High-Strength Low-Alloy (UHSLA) steel to reinforce the roof and pillar structures. This makes cutting these areas more challenging.
4. **Ultra & High-Strength Steels:** Micro-alloy and boron steel are used for a better weight-to-strength ratio. Rescue efforts can become more complex if the rescuers are faced with automobiles that utilize high strength steel components, or if the impact pushes the door's reinforcement bars into the frame.
5. **Airbags:** Found not only in the steering wheel and dashboard but also in doors, seats, roof rails, and even some seatbelt systems. This presents several challenges for extrication. Undeployed airbags can jam older cutting tools. Knowing if the airbag system is electronic or mechanical is crucial. Potential hazards include difficulty locating airbags, sensors, and control modules, accidental deployment during rescue, and unintended exposure to wiring or chemicals.
6. **Seatbelt Pre-Tensioners and G-Force Limiters:** Work together to reduce both impact force and potential injuries from airbag deployment. These pre-tensioners use either springs or explosive charges to tighten the seatbelt in a crash. Accidental activation during extrication can cause serious harm to both rescuers and patients.
7. **Body Materials:** Modern vehicle bodies are increasingly made from high-impact plastics, carbon fiber, aluminum, and composite materials, replacing traditional sheet metal on some or all of the exterior. These materials can be difficult to work with. Plastic may crumble or shatter instead of bending, making it hard to find secure points for tools. Composite materials can be challenging to cut, and carbon fiber specifically poses a hazard due to its dust particles and combustible byproducts.
8. **Side or Rear Window Glass:** Tempered glass, sometimes used on side and rear windows, is being replaced with laminated glass or rigid plastics. Unlike tempered glass, these materials are highly resistant to shattering in the traditional sense and create a significant obstacle when accessing patients.

Crumple Zones

Crumple Zones are areas in the vehicle body and chassis that have been designed to “crumple” and therefore absorb the impact energy of a collision. This energy absorption reduces the collision energy being transferred to the occupants of the vehicle, therefore reducing their injuries. Figure 2.4 shows front crumple zones after impact. Crumple zones are typically present in the front and rear of a vehicle.

Figure 2.4 Crumple Zones



frontal impact crash test



partial frontal impact



full frontal impact



deformation due to crumple zones

The use of crumple zones has dramatically increased the ability of vehicle occupants to survive massive impacts. Ironically, these very crumple zones that increase survivability can complicate rescue efforts, due to the strength of the deformed metal structures.

Airbag Systems

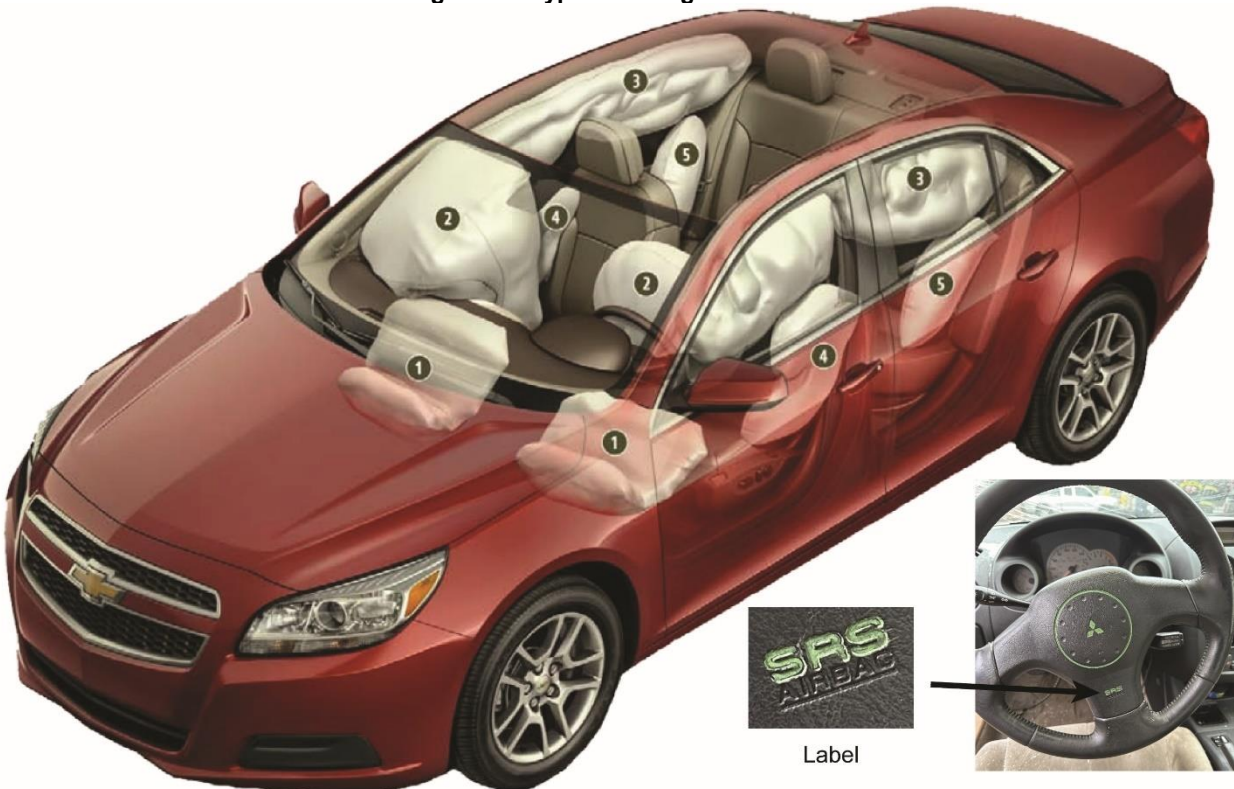
In the 1960s, the concept of airbags for cars gained traction in the United States thanks to the work of Dr. Allan S. Breed. By the 1970s, some automakers began offering airbags as an optional feature. Throughout the 1980s, manufacturers promoted them as "Supplemental Restraint Systems" (SRS) to complement seat belts. Airbags became

mandatory equipment in all new vehicles during the 1990s. Over time, additional safety features like side airbags, rollover protection systems, and seatbelt pretensioners were added for even more comprehensive occupant protection.

Airbags in a vehicle can be labeled as

1. SRS – Supplemental Restraint Systems (Front, back seats, knee and floor area)
2. SIPS – Side Impact Protection Systems

Figure 2.5 Typical Airbag Locations



Airbag Safety During Extrication

1. **Airbag Deployment:** Airbags can be triggered electronically or mechanically, and they generally function independently. The activation system is generally a two-stage process, and sometimes only one stage deploys.
2. **Undeployed Airbags:** An airbag that hasn't deployed, or is only partially deployed, poses a serious risk to rescuers. Therefore, it's crucial to locate all airbags in the vehicle and avoid them when possible.
3. **Airbag Deactivation:** Disabling an undeployed airbag can never be guaranteed. Rescuers are best protected by disconnecting the car battery.
4. **Treating Airbags:** Always assume an airbag is active until it fully deploys.
5. **Gas Cylinders:** Rapid inflation of airbags is powered by small gas cylinders (as shown in Figure 2.6). These cylinders are filled with a compressed gas up to 5000 psi. and *must* be located. They can be found in various areas throughout

the vehicle, such as pillars, doors, and roof rails. ***Always expose the airbag module before attempting to cut through any car component.***

Figure 2.6a Peel and Peek Tools



The halligan is often too large for peel and peek and may injure patients in close proximity. Smaller tools are recommended.

The two photos below demonstrate what to look for when Peeling and Peeking.

Figure 2.6 Airbag Gas Cylinders



Rear Pillar



A Pillar

Airbags

Lifesaving for car occupants during accidents present significant hazards to firefighters performing extrication procedures. Mini gas cylinders and undeployed airbags can trigger unexpectedly and cause serious injuries to both patients and rescuers. The fire service has developed specific strategies to mitigate these risks, focusing on working "around" airbag systems whenever possible.

Here are key principles to remember:

1. **Identify and Avoid:** Whenever possible, extrication strategies should prioritize identifying, locating, and avoiding airbag components.
2. **The 5-10-20 Rule:** This rule establishes safe working distances from undeployed airbags to minimize the risk of accidental deployment during extrication. Here's a breakdown of the recommended distances
5 inches: Minimum distance from side curtain airbags.
10 inches: Minimum distance from steering wheel airbags.
20 inches: Minimum distance from passenger dashboard airbags.
3. **Peel and Peek:** This method is a crucial safety protocol used to locate avoid airbag components, mini gas cylinders, pretensioners, and electrical wiring within vehicle pillars and door frames (areas where rescuers will be working).
4. **Interior Trim Removal:** The interior plastic trim panel is peeled away from the targeted area of the post or doorframe (Figure 2.6a). Best done with a smaller pry tool.
5. **Visual Inspection:** Once the trim is removed, firefighters can see where hazardous components are located.

Safety

1. **Hydraulic Tool Precaution:** Absolutely no hydraulic extrication tools (spreaders, cutters, or rams) should be used in an area before it has been thoroughly peeled and peeked. Damaging undeployed airbags or other components can cause serious harm to rescuers and tools.

2. **Cutting Restrictions:** Never cut through airbags, mini gas cylinders, or pretensioners.
3. **Car Seat Safety:** If there's a possibility of extrication procedures damaging child car seats, they must also be subjected to the peel and peek process.

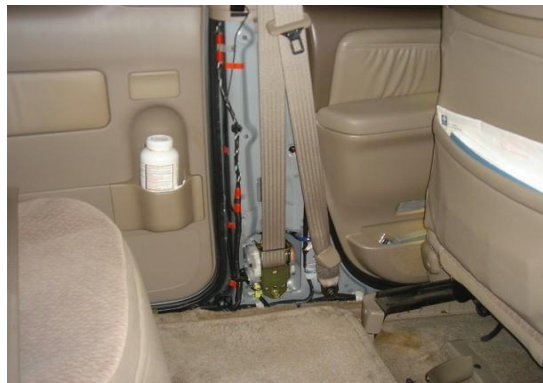
In some cases, seat upholstery might also require careful cutting to expose any hidden hazards (Figure 2.6a).

By following these airbag safety guidelines and utilizing the 5-10-20 Rule and Peel and Peek techniques, firefighters can significantly reduce the risks associated with airbag systems during extrication, ensuring the safety of everyone involved.

Seatbelt Pretensioners

Seatbelt pretensioners are designed to automatically tighten seatbelts during a collision or hard braking. They work in conjunction with airbag systems to improve occupant protection. Pretensioners can be activated electrically or mechanically. Their location varies depending on the vehicle make and model, but they are typically found either in the seat itself or in the B, C, and D pillars (upright supports along the sides and back of the car). The B-pillar is the most common location, and they are often found near the bottom of this pillar (as shown in Figure 2.7). However, some vehicles may have them placed on or near the top of the B-pillar or as part of the seatbelt buckle assembly near the center console.

Figure 2.7 Pretensioner at the Bottom of a B Post



Car Battery Locations

In most passenger vehicles, the battery is found within the Engine compartment. However, be aware that some newer car designs may have the battery placed in non-traditional locations (refer to Figure 2.8 for examples). Additionally, larger vehicles like pickup Trucks or SUVs may have more than one battery. It's also worth noting that some manufacturers include a safety feature that automatically disconnects the battery upon collision.

Figures 2.8 Car Battery Locations



Under the Hood



Under the Rear Seat



In the Trunk



In the Wheel Well



Behind the Side Front Bumper

SCENE MANAGEMENT

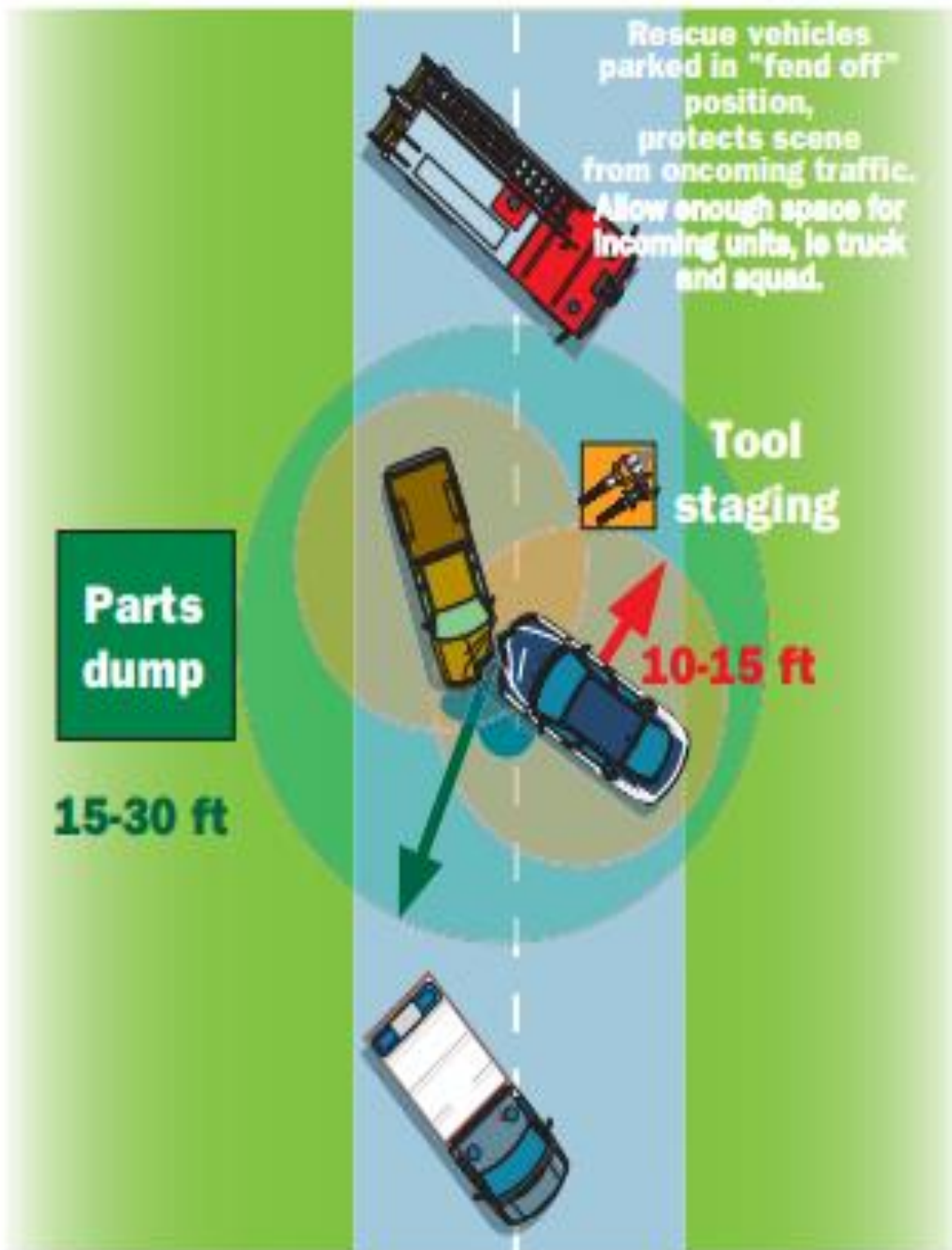
Like all emergency calls, scene management for vehicle extrication is critical for a successful and efficient outcome. Correct apparatus placement, scene size up, establishment of the scene layout, company actions, scene safety, and proper communication are required for extrication. This section will outline basic scene management for vehicle extrication.

Scene Anatomy (Figure 3.1)

Just like any emergency response, vehicle extrication relies heavily on good scene management for a safe and efficient rescue. Here's a breakdown of some basic scene management principles:

1. **Apparatus Placement:** The first arriving apparatus needs to find a safe spot to park. This spot should block oncoming traffic from reaching the accident but also allow enough space for other emergency vehicles to access the scene, especially rigs with extrication tools. Ideally, the vehicle should be positioned to protect the lane(s) where the accident occurred, plus an additional lane for removing patients and placing rescue tools.
2. **Rescue Zones:** To keep the rescue area organized and safe, responders establish specific zones
 - a. **Inner Circle (10-15 ft radius)** This is the innermost zone around each involved vehicle. Only people directly working on rescuing those trapped inside should be in this area.
 - b. **Outer Circle (15-30 ft radius)** This zone surrounds the inner circle. It should be clear of anyone not actively involved in the rescue. Depending on the situation, this area might even be cordoned off with tape to prevent unauthorized entry.
3. **Tool Cache:** Located outside the inner circle but within the outer circle, this designated area stores all the rescue tools needed for extrication. Easy access to these tools is crucial during the rescue.
4. **Parts Dump:** As parts of the vehicle are removed during extrication (doors, roof panels, etc.), they are placed in a designated "parts dump" area just outside the outer circle. This keeps the working area clear and prevents tripping hazards.

Figure 3.1 Scene Anatomy



Company Responsibilities

First Arriving Apparatus (Engine, Truck, or Rescue)

First arriving apparatus will complete the following tasks as well as their unit's specific tasks below in their relevant sections.

1. Communicate:
 - a. Scene Safety and Traffic Control
 - b. Apparatus Placement
 - c. Scene Size Up
 - d. Number of vehicles
 - e. Number of patients
 - f. Hazards wires, fuel, fire, gasoline
 - g. Traffic hazards
 - h. Additional resources needed
2. Patient Contact, Assessment, and BLS Treatment
3. Vehicle Prep – the Down and Dirty Process and Peel and Peek

Engine Company

In addition to the above list if first on scene

1. Overall, Scene Safety
2. ALS Treatment
3. Charged 1 ¾" hose line (staffed)

Truck Company

In addition to the above list if first on scene

1. Complete or Additional Vehicle Prep (if needed)
2. Rescue Zone Establishment
3. Equipment cache
4. Extrication
5. Debris pile
6. Assist Squad as needed

Rescue Squad

In addition to the above list if first on scene

1. Complete or Additional Vehicle Prep (if needed)
2. Rescue Zone Establishment (if needed)
3. Equipment cache
4. Extrication
5. Debris pile

Company officers are encouraged to evaluate each rescue scene independently, and make tactical decisions based on patient condition, crew safety and situational factors.

VEHICLE PREPARATION

Vehicle preparation (vehicle prep) is a crucial stage in extrication, setting the foundation for a safe and efficient rescue. It's important to acknowledge the distinct roles of Engines, Trucks, and Rescue Squads in this process.

Engine and Truck Capabilities: Fortunately, a significant portion of vehicle prep can be effectively addressed by Engines and Trucks. This empowers Engine and Truck companies to initiate and perform the Down and Dirty Process and Peel and Peek without waiting for a dedicated Rescue Squad. Early prep and intervention can be critical for patient survival in time-sensitive situations.

Truck Crew Responsibilities: While Rescue Squads possess specialized training and advanced equipment to handle complex extrications, Truck companies play a vital role in the initial extrication process. Truck companies should initiate an extrication once the vehicle prep process is completed. Time is crucial for patient survival in many extrication scenarios.

Rescue Squad Command: Upon arrival at the scene, the Rescue Squad assumes command of the extrication process due to their specialized training and advanced equipment.

Through a well-coordinated approach, Engine, Truck companies and Rescue Squads can work collaboratively to optimize scene efficiency and ultimately increase the probability of a successful rescue operation.

Vehicle Stabilization

Vehicle prep and stabilization, often overlooked by the urgency to reach trapped occupants, is the **critical first step** in any extrication process. Even a seemingly stable car resting on all four wheels can shift or roll unexpectedly during rescue efforts, jeopardizing the safety of both firefighters and patients.

By establishing a well-coordinated approach responders can create a secure working environment that prioritizes the safety of everyone involved in the extrication process.

Stabilization MUST also be placed below the vehicle where hydraulic tools will be utilized. This will ensure that the forces exerted by the hydraulic tool will be transferred to the ground (**See Figure 4.1**). This is most often done under the A and B pillars.

Primary Prep: The Down and Dirty Process

The "Down and Dirty Process" is a crucial set of procedures performed by the first fire apparatus arriving at an extrication scene. This process requires no specialized tools, allowing for immediate action. **If the vehicle is in a particularly precarious position, some, or all, of these steps might need to be delayed until further stabilization measures are implemented.**

Here's a breakdown of the **Down and Dirty Process**:

1. **Gain Access and Secure the Vehicle:**
 - a. Open any unlocked doors or access the interior through windows if needed.
 - b. Turn off the vehicle's ignition. ***Electric vehicles are extremely quiet and may appear to be OFF.***
2. **Transmission and Parking Brake:**
 - a. Shift the vehicle into "Park" for automatics or 1st gear for manuals.
 - b. Engage the parking brake (either electrical or mechanical).
3. **Seat and Window Management:**
 - a. Adjust all seats (electrically or manually) to create more space for potential patients *if injuries allow*.
 - b. Lower all windows, following proper glass management techniques to minimize hazards (refer to "Glass Management" section for details).
4. **Door:**
 - a. Unlock all remaining doors to facilitate access for rescuers and medical personnel.
5. **Headlight and Electrical Safety:**
 - a. Turn off the headlights, particularly High-Intensity Discharge (HID) headlights as they step up voltage to a dangerous level. Turning the headlight switch in the "OFF" position will cut the power to the headlights.
 - b. Turn on the hazard lights (flashers). This will help confirm that the 12-volt battery has been disconnected. If the flashers remain lit after cutting the battery ground cable, a second 12-volt battery will need to be located and disconnected.
 - c. Locate the 12-volt battery and disable it by cutting a 2-inch section out of both battery cables, starting with the ground (black) cable.
6. **Wheel Chocks:** Should be quickly placed at the front **and** rear of 1 wheel to prevent uncontrolled rolling of the vehicle.

Secondary: Vehicle Stabilization

Auto extrication activities require stabilization measures. This section details basic stabilization techniques specifically for the vehicle's exterior, preventing unwanted movement during rescue efforts and providing support for rescue tools during specific operations. If staffing allows, both primary prep and vehicle stabilization can and should occur simultaneously.

First Arriving Apparatus

Wheel Chocks: They should be quickly deployed to prevent uncontrolled rolling of the vehicle.

First Arriving Truck

Step Chocks and Cribbing: Ladder Trucks typically carry step chocks and cribbing for more thorough stabilization. Step chocks are progressively shorter wooden blocks stacked to create a customized fit under the vehicle's frame rails. Cribbing refers to lumber used to fill gaps between the vehicle and the ground.

Safety First

Never position body parts under a vehicle: Always use tools or spare cribbing to position step chocks or cribbing that require placement entirely under the vehicle (as shown in Figure 4.1).

Tire Deflation: *Though rarely needed,* it may be necessary if the situation dictates. Once step chocks and cribbing are placed, tires can be deflated to further secure the vehicle onto the stabilization points. Several methods can be used, such as pulling the valve stem, cutting the valve stem, or removing the valve core.

Step Chocks: Step chocks offer a quick and easy way to achieve initial stabilization. They are essentially stacked 2"x6" wooden pieces with progressively shorter lengths, creating a step-like shape (refer to Figure 4.1). This allows for adjustments based on the vehicle's height. Chocks are primarily placed under the vehicle's A, B or C posts.

Traditional Placement: For best results, the step chock will have a large surface area touching both the vehicle and the ground for maximum stability. If the vehicle height is in between two steps, we can raise the vehicle's suspension by lifting on the wheel wells to place the vehicle onto the higher step.

1. **Upside-Down Step Chocks:** While quicker to deploy, an upside-down step chock provides reduced contact area with the ground. ***Company officers MUST evaluate the situation to determine best orientation and placement.***

Company officers are encouraged to evaluate each rescue scene independently, and make tactical decisions based on the patient condition, crew safety and situational factors.

Figure 4.1 Step Chocks



Step Chock



Proper Placement of a Step Chock



May be Placed Upside Down



Lifting Car to Step Chock

Cribbing

Cribbing plays a vital role in vehicle stabilization, providing support when gaps are too large or require more weight-bearing capacity than step chocks can handle.

Cribbing (Figure 4.2a) on Trucks include:

1. 4x4 blocks
2. 2x4 blocks
3. Wedges
4. All lengths are 18" minimum

Box Cribbing

The most common and reliable cribbing method is the box crib. Imagine a rectangular frame built by interlocking wooden blocks in a log cabin style (Figure 4.2a). The open center space is called the "footprint," and the connection points between the blocks are called "corners." The number of corners bearing weight determines the overall stability of the crib.

1. 2x2 Crib has 4 corners.
2. 3x3 Crib has 9 corners.

Essential Cribbing Principles

1. **Solid Foundation:** Always construct cribbing on a firm, level surface like plywood or concrete to prevent uneven settling.
2. **Overlapping Ends:** Ensure a secure fit by overlapping the ends of each wooden block by 1.5 to 3 inches (Figure 4.2a).
3. **Maximizing Contact Points:** The more corners that bear weight within the crib stack, the stronger and more stable it becomes (Figure 4.2b).
4. **Spread box cribbing over as wide an area as possible.**

5. **Stack Height Limits:** There's a maximum safe height for a crib stack depending on the number of corners bearing weight
 - a. 1 Corner 18 inches maximum height
 - b. 2-3 Corners 27 inches maximum height
 - c. 4 Corners 54 inches maximum height

If all four points in a box crib have load, it can be 3x as high as the crib lengths.
 $18'' \times 3 = 54''$ max crib box height

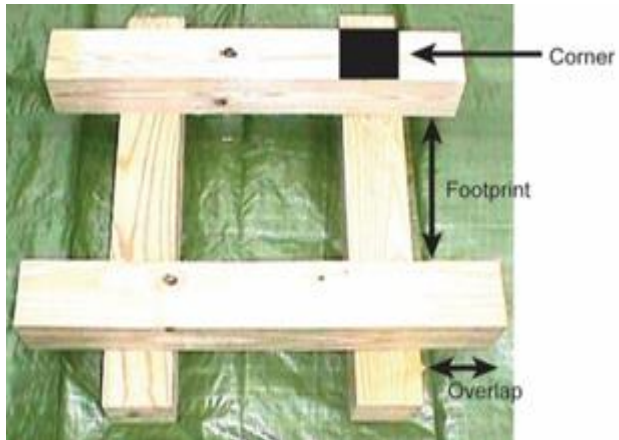
6. **Weight Distribution:** For optimal effectiveness, the vehicle's weight should be distributed directly down the center of the crib stack on all contact points.
7. **Imperfect Situations and Additional Tips:** While a box crib is ideal, there will be times when the vehicle's position makes constructing one difficult (Figure 4.2c). Here are some safety measures to follow in such situations:
 - a. **Reduced Height:** Limit the height of the crib to a maximum of 18 inches.
 - b. **Footprint and Stability:** A non-rectangular crib will have a smaller footprint, so pay close attention to the overall height to maintain stability. A 1 to 1 ratio of height to length is a safe rule to follow. This is also true for angled cribbing.

Here are some additional points to remember when using cribbing:

8. **Patient Access:** Never position cribbing in a way that blocks access to the trapped occupants.
9. **Lifting and Cribbing:** If lifting is necessary, only lift the vehicle a small increment (about an inch) and immediately secure it with cribbing before lifting further, capturing lift gains with wedges until able to preplace with full dimension blocks.
10. **Constant Reassessment:** Extrication activities can shift the vehicle, so regularly evaluate the stability of the cribbing and adjust as needed.

By understanding and applying these cribbing techniques, firefighters can create strong and reliable support structures during extrication, ensuring a safe working environment for themselves and the people they are rescuing.

Figure 4.2a Cribbing



Stack Anatomy

2X2 Stack



3X3 Stack



Using Wedges



Non-Box Stack

Figure 4.2b Load Bearing Corners

- Cribbing
- Load Bearing Corner
- Load

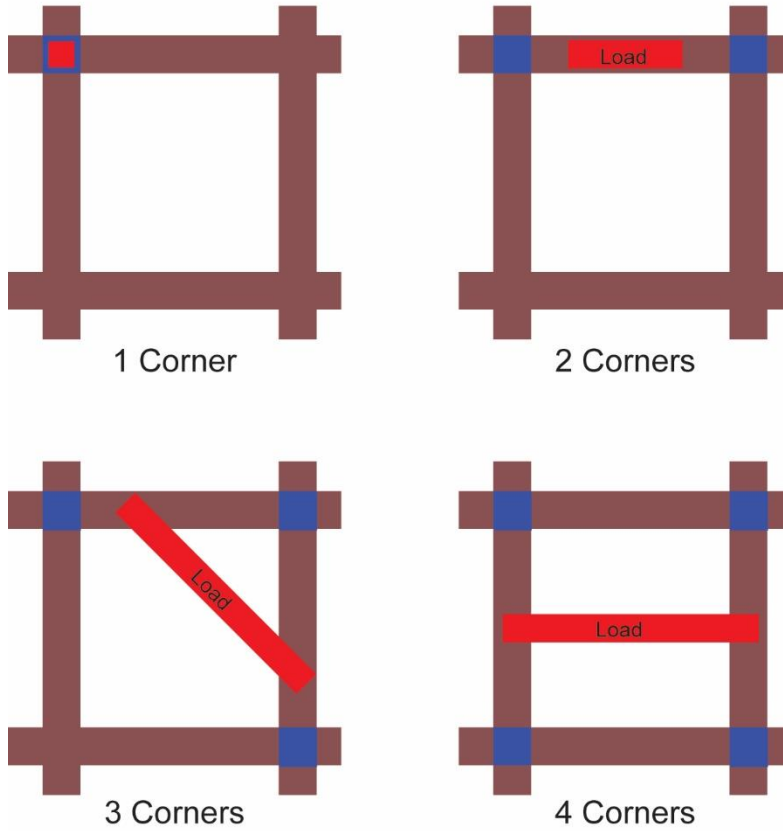


Figure 4.2c Cribbing Examples



Glass Management

Glass management is the controlled removal of vehicle glass to gain access to patients and minimize injuries to victims and rescuers.

Any windows that are involved in the extrication should be removed.

Whenever a window is broken, all glass fragments must be removed by using a tool to sweep the window frame (Figure 4.4). For any glass near the patients that must be removed or cut, the removal should start as far away from the patient as possible. For example, if the windshield needs to be removed and there is a trapped driver and no passenger, the cutting of the windshield should start in the far corner of the passenger side. Window cutting and breaking are always started in a corner.

Some modern vehicles utilize laminated glass for driver and passenger windows.

Protect the Patient

Before any glass is removed, the patients must be protected by covering the patients with a soft covering to protect them from falling debris. Patients can be covered with a tarp, blanket, or carryall.

Side Door Windows (Tempered Glass)

1. Before the battery cable is cut, all door windows should be rolled down.
2. If the door will not be involved with extrication, completely roll the window down.
3. If the door is involved in the extrication, roll down windows until $\frac{1}{2}$ "-1" of glass is visible. Break windows inside door.
4. Break windows using a spring-loaded center punch (preferred), axe, or Halligan (Figure 4.4 Breaking Side Door Windows).
5. If the window cannot be rolled down due to door damage, then break it in place using a spring-loaded center punch (preferred), axe, or Halligan (Figure 4.4).
6. The adz from the Halligan can be slid into the windowsill and torqued to break the window (Figure 4.4).

Swinging tools to break windows can injure the patient. Through direct contact with the tool, flying glass fragments, or movement of the vehicle/patient (C-spine considerations).

Figure 4.4 Breaking Windows



Breaking a Rolled-Down Window With Center Punch



Breaking a Rolled-Up Window with Center Punch



Breaking a Rolled-Up Window with a Halligan (Pry Down)



Sweeping with a Tool to Clear Glass

Windshield (Laminated Glass)

For most extrications, the windshield will need specific cuts, but not complete removal before hydraulic tools are used. The windshield is made with laminated glass, so it is cut instead of broken. The windshield can be cut with an axe (preferred), Halligan, or handsaw (Figure 4.5). A 6' prybar can also be used to 'cut' a windshield. Insert the bar at the upper A post cut, then lower angle of the bar, resting the end of the bar on the dash. Move upper portion toward the front of the vehicle which will 'cut' through the laminated glass (Figure 4.5)

Reciprocating Saw to cut glass. Historically, reciprocating saws have been used to cut laminated glass. However, this aerosolizes glass dust, which can permanently lodge in the lungs. The methods described in this manual reduce the creation of glass dust. Though it takes more effort to use an axe, with the right technique it is quick and is the safer method for patients and rescuers. *If reciprocating saws are used by rescuers N95 masks must be worn by ALL rescuers and patients.*

The windshield is cut, along the A Post, from the roof to the dashboard (Figure 4.5)

Figure 4.5 Windshield Cutting



Cutting a Windshield Along the A Post with an Axe



Breaking a Windshield Along the A Post with a Prybar

Figure 4.5 Windshield Cutting cont.



Cutting a Windshield Along the A Post with a Halligan



Cutting the Bottom of the Windshield

If doing a Roof Lift, the bottom of the windshield is cut all the way across the dashboard so that the entire windshield can be taken off along with the roof (Figure 4.5).

TOOLS AND TECHNIQUES

Axe and Halligan

The axe and Halligan tools are versatile pieces of equipment used by firefighters for a variety of purposes during extrication procedures. Here's a closer look at their applications

Window Management

1. **Sweeping:** The axe or Halligan's fork can be used to sweep away broken glass fragments from window frames, creating a clear workspace for further actions (Figure 4.4).
2. **Breaking:** In some cases, the Halligan's pointed tip can be used to break tempered glass windows (Figure 4.4). However, a spring-loaded center punch is generally the preferred method due to better control and precision.

Door Manipulation

1. **Spreading:** The Halligan's forked or adz end can be used to pry open car doors by increasing the gap at the door seam. This exposes the door pins or hinges, allowing firefighters to strategically place hydraulic tools for further breaching (Figure 5.1).

Vehicle Access

1. **Front Grill and Headlight Removal:** The Halligan tool can be used to pry off a vehicle's front grill and headlights. This may allow access to the hood release cable, which can be helpful in gaining entry to the engine compartment (Figure 5.1).
2. **Windshield Cutting (Laminated Glass):** While an axe is the preferred method for cutting tasks, the Truck Officer's axe, Halligan, prybar and reciprocating saw can be used to cut through laminated glass (Figure 4.5).

Though the axe and Halligan tool's versatility and effectiveness make them a vital part of a firefighter's toolkit during extrication, officers must be prepared to utilize any tool available to achieve an extrication. Familiarity with SFFD tools and frequent company drills can help firefighters to efficiently gain access to trapped occupants, remove obstacles, and create a safe working environment.

Figure 5.1 Halligan Uses



Create Purchase Point



Removal of Front Grill



Hood Release Cable

The Johnson Bar: An Effective Lever

The Johnson Bar is a specialized tool firefighters can use during vehicle extrication or for various lifting tasks.

THE JOHNSON BAR MUST BE USED WITH THE JOHNSON BLOCK AND A MINIMUM OF 4 MEMBERS

1. **Victim Removal:** When a trapped person is underneath a vehicle, the Johnson Bar can be used to lift the vehicle quickly, creating enough space to safely extract the victim.
2. **Vehicle Maneuvering:** In situations where people are trapped between two vehicles or a wall, the Johnson Bar can be used to lift and gradually move the vehicle in small increments ("walking" the vehicle). This creates space for rescuers to access the trapped individuals.

Safety First: Cribbing is Recommended

It's important to remember that when the Johnson Bar is used for lifting it SHOULD be paired with cribbing for safety (Figure 5.2).

On rare occasions the Johnson Bar alone can be used for quick short lifts where the patient's medical condition dictates fast extrication. ***Company Officers MUST be cognizant of the extreme risk of this technique.***

Securing the Lift: Cribbing helps to secure the gained height by the Johnson Bar, preventing the vehicle from settling back down unexpectedly. This ensures the safety of both the rescue personnel and the trapped occupants.

By following these safety guidelines and using the Johnson Bar *in conjunction with the Johnson Block* and cribbing, firefighters can leverage this tool effectively to lift vehicles safely during extrication procedures.

Figure 5.2 Johnson Bar and Block



Sawzall

The Sawzall is a versatile cutting tool when used with a metal or preferably a rescue metal cutting blade. It can cut posts, dash straps, roofs, and any other metal or plastic parts. Technique is important as with any tool. Cuts should be made as close to the saw

body or shoe as practiced. If the blade tip bounces off the metal, it will bend and become ineffective. It will need to be replaced before finishing any additional cuts.

Spreaders (Hydraulic Tool)

The spreaders have two working arms that open and close (Figure 5.3). The end of each arm has a tip which is where contact with the vehicle should be made. They are used to apply force in a spreading function when the arms spread apart or to apply force in a crushing function when the arms are brought together (Figure 5.3).

Figure 5.3 Spreader Anatomy



Safety First: Essential Safe Practices

Safe spreader use is paramount. Here are critical guidelines to remember:

1. **Designated Handles Only:** Hold spreaders by the designated handles designed for control (refer to Figure 5.3). Never place hands or fingers on spreader arms or tips during operation.
2. **Maintain a Safe Distance:** Always avoid working between the spreader and the vehicle. Spreaders exert immense force, and accidental contact can lead to serious injuries.
3. **Stay Alert and Reposition:** Spreaders naturally shift during operation. The rear of this tool will move in the direction of least resistance. Be prepared to stop and reposition the spreader as needed to avoid getting trapped yourself or endangering others.
4. **Maximize Tip Contact:** For optimal effectiveness, spreader tips should make full contact with the intended vehicle component whenever possible.
5. **Monitor Tip Grip:** If the spreader tips lose grip or begin to slip, stop the operation immediately and reposition the tool for better purchase.
6. **Prioritize Patient Safety:** When using spreaders within a vehicle, always be mindful of the patient's location and ensure the spreader's movement won't

cause any part of the vehicle to come into contact with or injure the trapped occupant.

7. **Airbag Awareness:** Avoid using spreaders in a way that directly or indirectly applies force to airbag sensors, airbags, airbag gas cylinders or pretensioners in a vehicle. These components can deploy unexpectedly and cause harm if compromised.

Spreader Applications for Vehicle Extrication (Figure 5.4)

Spreaders serve a variety of purposes in extrication, helping firefighters gain access to trapped occupants and manipulate vehicle components safely.

Here are some common spreader applications:

1. **Door Access:**
 - a. **Spreading Window Frames or Pinching Doors:** Spreaders can be used to pry open or widen gaps in window frames or car doors. This gives access to door hinges and latches, which can then be manipulated to open the door.
 - b. **Fender Pinching:** Spreaders can be used to pinch a car's fender, creating space to expose the hinges that connect it to the vehicle frame.
2. **Fender Peeling:** A fender can be peeled away from the vehicle frame, exposing the upper frame for possible relief cuts or access to hinges.
3. **Hinge and Latch Manipulation:** Spreaders can be used to apply controlled force to fail (break) door hinges and latches, thereby gaining entry into the vehicle.
4. **Dash Lifting:** Spreaders can be used to lift the vehicle's dashboard, creating space to access trapped occupants underneath. Cribbing **MUST** be placed under the A Post during this technique.
5. **Lifting a vehicle:** Spreaders can be used to lift a vehicle for quick access to trapped victims. **THIS TECHNIQUE IS VERY UNSTABLE DUE TO THE NARROW WIDTH OF THE SPREADER TIPS. Cribbing MUST be used in this application.**

Figure 5.4 Spreader Uses



Spread Window Frame



Spread Gap



Failing Latch



Pinch Door



Pinch Fender



Peel Fender

Figure 5.4 Spreader Uses (cont.)



Lift Dashboard



Lift Vehicle

Cutters (Hydraulic Tool)

Hydraulic cutters, another vital tool in a firefighter's extrication toolbox, act like powerful shears to cut through various vehicle components during rescue operations.

Like spreaders, cutters consist of two opposing blades (arms) that open and close hydraulically (Figure 5.5). However, unlike spreaders that push apart, the key feature of cutters lies in their opposing blades. These blades are designed to make contact and slice through targeted objects when the arms close.

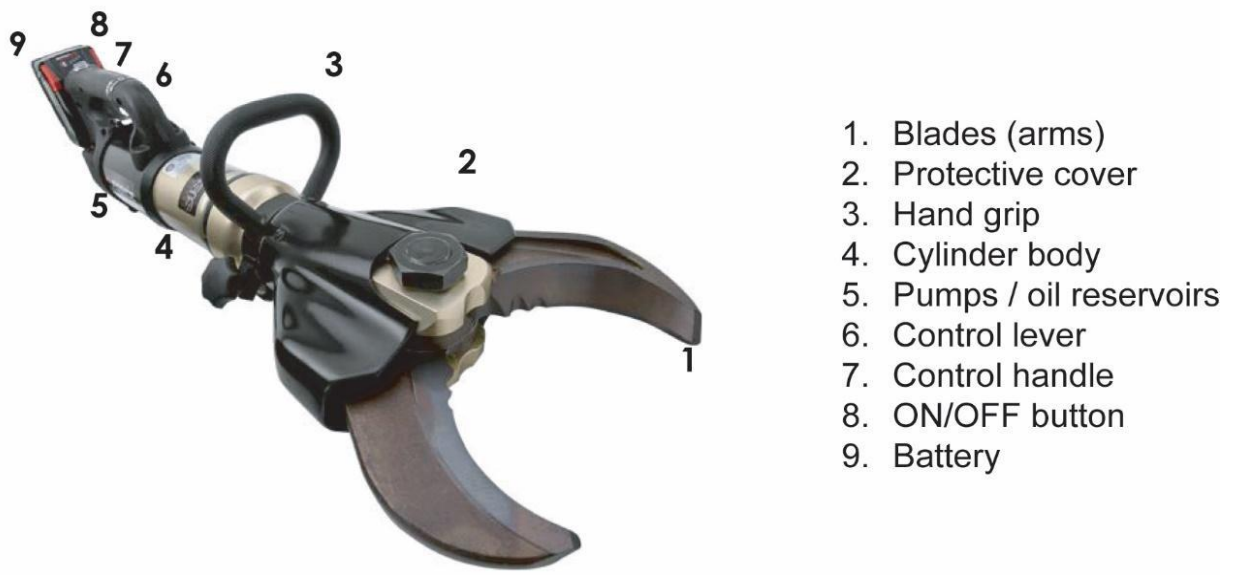


Figure 5.5 Cutter Anatomy

Safety First: Essential Safe Practices

Safe cutter operation is critical. Here are some critical guidelines to remember

1. **Designated Handles Only:** Always hold cutters by the designated handles specifically designed for operator control (Figure 5.5). Never place hands or fingers on the cutter arms or blades themselves during operation.
2. **Airbag and Component Awareness:** Avoid cutting airbags, mini gas cylinders, pretensioners, or reinforcement components around seatbelt mounts. These components can deploy unexpectedly and cause harm if compromised.
3. **Reposition:** Cutters will move naturally during operation. Be prepared to stop and reposition the cutter as needed to avoid getting trapped yourself or endangering others. Do not allow cutter arms to continue moving if the material is spreading the cutting surfaces away from each other.

Cutting Techniques

For optimal cutting effectiveness and safety, follow these techniques

1. **90-Degree Angle:** Whenever possible, position the cutter blades at a 90-degree angle to the surface you intend to cut (refer to Figure 5.6 for a visual reference).
2. **Deep Blade Placement:** Ensure the material you're cutting is positioned as far into the recess of the cutter blades as possible. Avoid cutting with just the tips of the blades (Figure 5.6).
3. **Blade Visualization:** Always be mindful of the cutter blades' position throughout the operation. This helps to avoid accidental overlapping or spreading of the blades, which can create hazards (Figure 5.6).

Figure 5.6 Cutter Safety



› Cut at 90 Degree Angle

Cut at the Base of the Blades

Cutter Applications for Vehicle Extrication (Figure 5.7)

Cutters serve a variety of purposes in extrication, helping firefighters gain access to trapped occupants and manipulate vehicle components safely. Here are some common cutter applications

1. **Cutting:** All around cutting tool used for cutting posts, wiring harnesses, door hinges, door latch pins, dash straps, seat backs, hood hinges and subframe.
2. **Door Removal:** cutting of hinges and or latches to partially or fully remove doors.
 - a. Used to cut the wiring harness that travels from the door to the dash. This will need to be cut for full door removal.
3. **Dash Straps:** If needed during a dash lift and dash roll, additional displacement may be needed to free the patient. The dash straps will need to be cut. This will nearly double the dash displacement, especially in the middle section of the dash. *Patient position may limit access to dash straps.*
4. **Posts and Subframe:** Relief cuts or for section removal, i.e. doors and roof.

Figure 5.7 Cutter Uses



Post



Dash Strap



Hood Hinge



Door Hinge



Lower Post



Upper Subframe

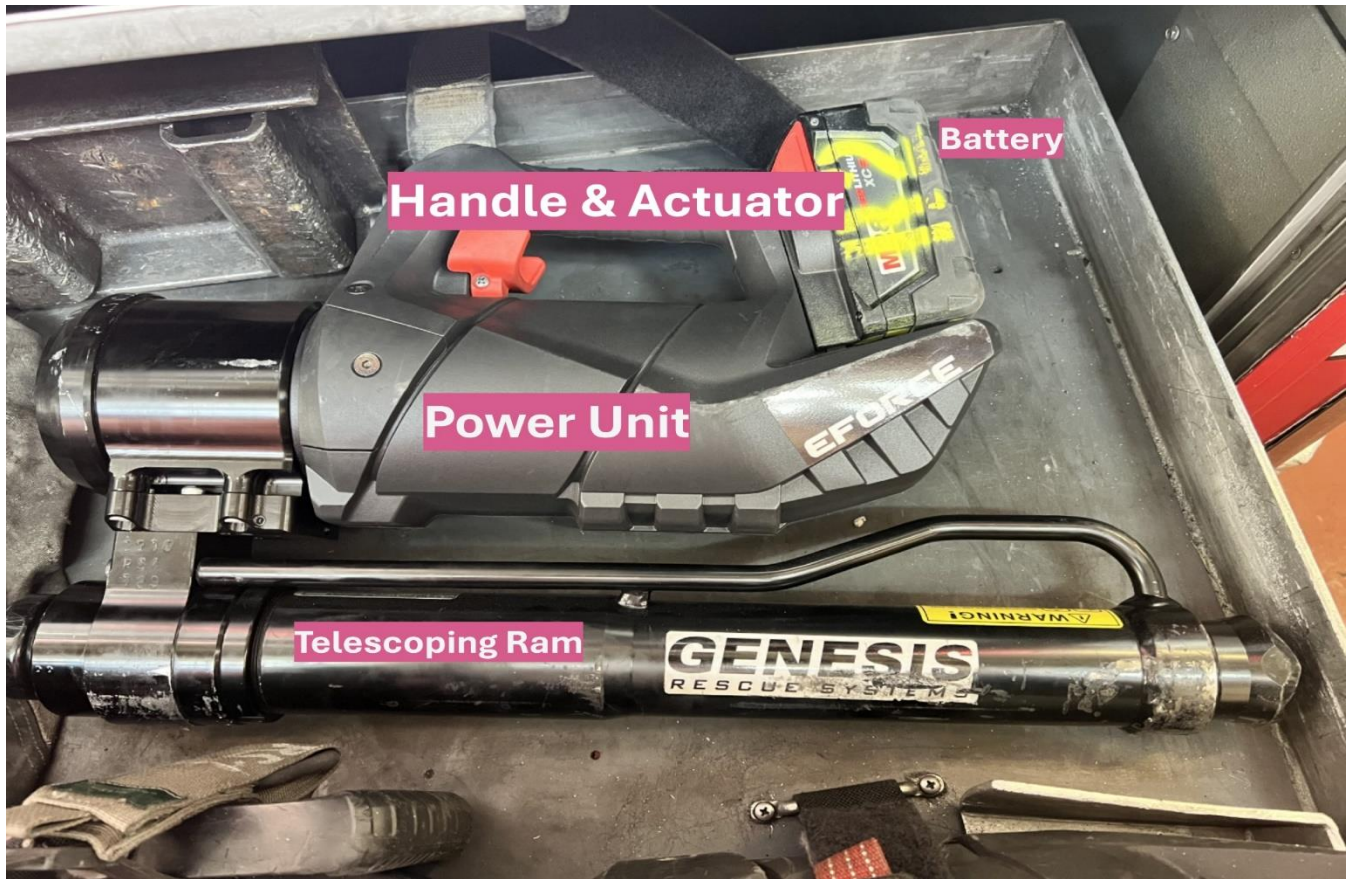
Ram (Hydraulic Tool)

Hydraulic rams are another essential tool in a firefighter's extrication arsenal. They apply immense pushing or spreading force in situations where spreaders might not provide enough reach.

Anatomy of a Ram

Unlike spreaders with two opposing arms, rams have a single hydraulically powered moving arm (Figure 3.14). This design allows for a more focused application of pushing or spreading force.

Figure 5.8 Ram Anatomy



Safety First: Essential Safe Practices

Safe ram operation is critical. Here are some key safety points to remember

1. **Handle Accessibility:** Always position the ram so that the control handle is easily reachable during operation.
2. **Maintain Safe Distance:** Operate the ram at arm's length to avoid getting caught in unexpected movements.
3. **Secure Footing:** Ensure both of the ram's purchase points (contact points with the vehicle) are secure and stable before applying force. Ram Support Boots should be used when the base of the ram is placed on the rocker. These provide the best purchase point for the base of the ram and will prevent the ram from tearing the rocker's metal skin. In RARE cases, the ram's base can be placed directly onto the vehicle's chassis using existing seat mounting bolts at the floorboard (Figure 5.9). Patient care must be considered before this technique is used. Cribbing **MUST** be placed below the ram's lower purchase point and rocker so that forces are transferred continuously into the ground.
4. **Control Handle Awareness:** If you need to stop the ram's pushing or lifting operation mid-action, pay close attention to the control handle's orientation when

restarting. This helps to avoid accidentally releasing pressure or lowering the ram in an unintended way.

Ram: Applications in Extrication (Figure 5.9)

Rams offer unique benefits during extrication procedures

Rolling Dashboards: In situations where access to trapped occupants requires creating space underneath the vehicle's dashboard, rams can be strategically positioned to roll the dashboard safely (Figure 5.9).

Figure 5.9 Ram Uses

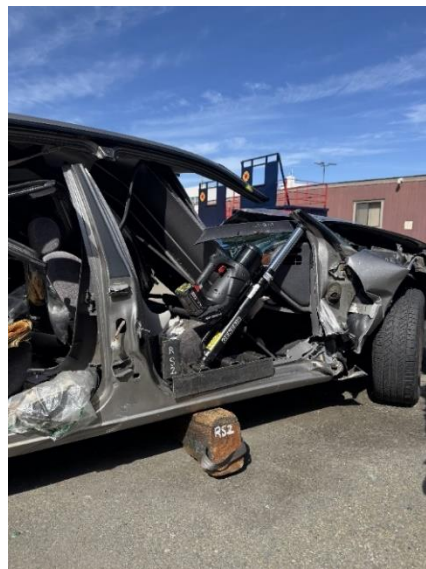
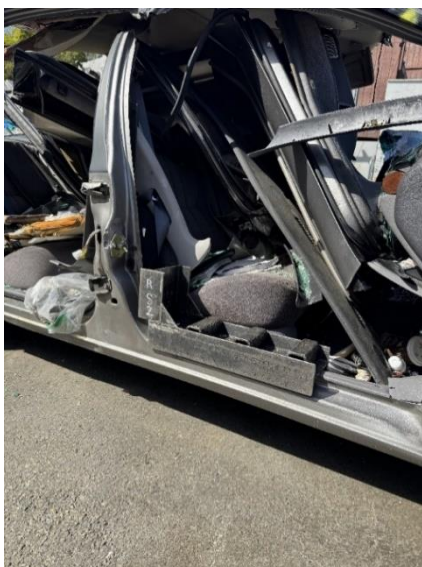


Ram Base Against Seat Anchor



Ram Extended in a Dash Roll

Figure 5.9 (Cont.) Ram Boot with Ram



CUT SEQUENCES

Extrication Cut Sequences

Building on the tool techniques covered earlier, this section describes cut sequences. These sequences outline the specific combination of tool uses to achieve an objective, like door removal, during vehicle extrication. It's important to remember that cut sequences only begin after completing vehicle preparation procedures.

This manual covers the common extrication sequences, including Door removal, Dash Lift, Dash Roll and Roof Removal.

Extrications can be performed quickly and efficiently if crews have BOTH cutters and spreaders available at the same time.

These sequences are only **recommended techniques**. Officers are encouraged to use techniques and methods best suited for the circumstances found at their specific incident.

For more complex scenarios, additional equipment, training and knowledge will be needed. The Rescue Squads have this additional equipment and knowledge.

Before any Cut Sequence, ALWAYS complete the Vehicle Prep:

1. Down and Dirty Process
2. Stabilization with step chocks, wedges, and box cribbing if needed.
3. Peel and Peek

Door Removal

Removing car doors is a frequent step in extrication to access trapped occupants. Here's a breakdown of the process, keeping in mind that the most accessible and effective approach will depend on the specific vehicle damage

Door Removal Sequence

refer to Figure 6.1 for visual reference

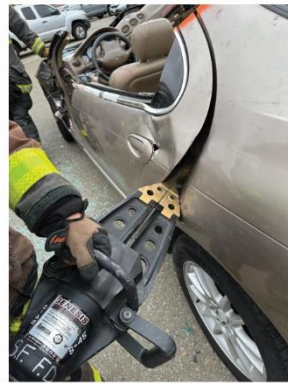
1. **Gaining Access:**
 - a. Depending on the damage, attempt to open the door using the handle first. Sometimes, a jammed door can still be opened this way.
 - b. If the handle doesn't work, assess the situation and focus on either the hinges or the latch, whichever is easier to access based on the damage. Both methods are effective for gaining entry.
2. **Hinge or Latch Manipulation:**
 - a. **Spreading Technique:** Using a spreader, carefully apply force to break (fail) the door hinges and/or latch, or to make room for the cutters.
 - b. **Cutting Technique:** Use cutters to strategically cut the hinges or latch pins.

Important Note *Avoid cutting the center pin located within the hinge. These are usually hardened steel and may damage the cutter blades.*

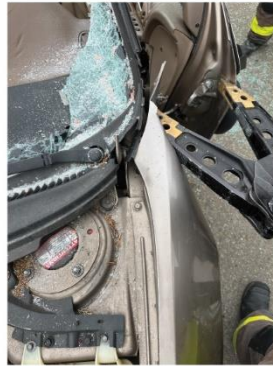
3. **Wire Harness Cut:** Regardless of the hinge or latch approach, you'll need to cut the vehicle's door wire harness to completely detach the door.

4. **Door Removal:** Once the hinge or latch is compromised and the wire harness is cut, the door can be safely removed and placed well outside the work area.

Figure 6.1 Door Removal Sequence

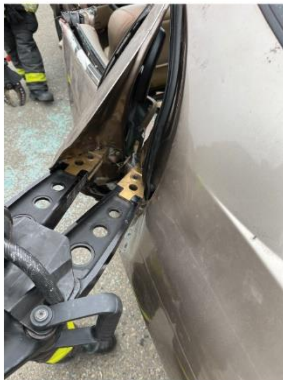


Spread Gap



Spread the Hinge to Fail or Cut the Hinge **(Not the Pin)**

Order Can
Be Switched



Spread the Latch to Fail



Cut the Wire Harness



Remove the Door

Dash Lift and Dash Roll

Creating Space for Trapped Occupants

In some vehicle extrication scenarios, gaining access to trapped occupants necessitates moving the vehicle's dashboard. Here, we'll explore the two primary techniques, the Dash Lift and the Dash Roll.

Understanding the Techniques

1. **Dash Lift:** This technique involves a vertical lift of the dashboard at the A post, creating space directly above the trapped occupant.
2. **Dash Roll:** Generally, creates a larger opening around a person trapped in the front seat. This technique essentially "rolls" the dashboard forward and upward. Cutting the dash straps will free the dash from the lower subframe of the vehicle. Though this can provide an additional 12 inches of clearance away from the passenger compartment, accessing the dash straps may be very difficult since they may be located behind a seat or blocked by a patient (figure 6.3).

Dash Lift Procedure

Refer to Figure 6.2 for visual reference

Preparation

1. **Vehicle Stabilization and Peel and Peek:** Determine the best stabilization points and peak for airbag canisters at cut points.

Creating Access and Preparing for the Lift

1. **Remove the Door:** On the side of the car where the victim is trapped.
2. **A-Post Relief Cut:** A complete cut is made along the A-post, below the roofline. This cut is needed if the windshield is NOT removed first. This cut will allow the dash lift to move better if the roof is NOT removed first. (figure 6.2).
3. **Lower A-Post "Flap" Cut:** A second cut is made just above the lower door hinge on the A-post. A third cut is made 4" above the second cut, making a square "flap" in the car body. (figure 6.2).
4. **Fender Removal (OPTIONAL):** The fender on the same side needs to be peeled or pulled away from the car's body to provide access to the upper subframe.
5. **Upper Subframe Cut (OPTIONAL):** A cut is made on the upper subframe, located between the strut tower (support for the shock absorber) and the firewall (the wall separating the Engine compartment from the passenger cabin). This is a relief cut separating the dash section from the front of the vehicle.

Lifting the Dashboard

1. **Cribbing:** Place cribbing or step chalk under the A-post.
2. **Spreader Placement:** After creating the “flap” cut above the lower door hinge, the spreaders are used to pinch the “flap” and “swing” it OUT, away from the vehicle. This creates an opening for the spreader tips to be inserted. Release the spreaders from the “flap” and insert the tips into the newly formed lower A-post notch (figure 6.2). By carefully spreading the arms of the spreader upwards, the dashboard is lifted vertically.

Spreader Positioning: It's important to position the spreaders perpendicular to the vehicle. This allows the tool to remain in place while the patient is being removed (figure 6.2).

Dash Roll Procedure

Refer to Figure 6.3 for visual reference

Preparation

1. **Vehicle Stabilization and Peel and Peek:** Determine the best stabilization points and peak for airbag canisters at cut points.

Dash Roll Procedure

1. **Remove the Door:** On the side of the car where the victim is trapped.
2. **A Post Relief Cut:** A complete cut is made along the A-post, below the roofline. This cut is needed if the windshield is NOT removed first. This cut will allow the dash lift to move better if the roof is NOT removed first. A second deep relief cut is made on the A-post between the two door hinges.
3. **Cribbing:** Place cribbing or a step chalk UNDER the rocker channel below the lower ram base.
4. **Ram Positioning:** If available, a ram support boot is placed on the rocker channel, against the B-post. The base of the ram is placed on the ram support boot while the top of the ram is positioned against the A-post, the upper door hinge assembly or the dashboard support bar on the A-post.
5. **Center Console Access (OPTIONAL):** Pull back the side plastic trim panel located at the center console, directly below the dashboard.
6. **Dash Strap Cutting (OPTIONAL):** Locate and cut the center support brackets, also known as dash straps (refer to figure 6.3 for reference).
7. **Rolling the Dash:** By extending the ram arm, the dashboard is “rolled” forward and upwards, away from the trapped occupant, creating additional space.

*Seat anchor bolts, at the floorboard of the vehicle, are more than strong enough to anchor the ram base as long as they are accessible, **and the patient is NOT impacted.***

Figure 6.2: Dash Lift Procedure



Remove Front Door



Peel Fender



Cut Upper Subframe
Relief Cut (OPTIONAL)



Upper A-Post
Relief Cut (OPTIONAL)



Cut Lower A-Post
Just Above Hinge



Place Spreader Tips In
Lower A-Post "Notch"



Dash Lift and Step Chock

Figure 6.3: Dash Roll Procedure



Pull Plastic at Center Console



Cut Dash Strap(s)



Ram Base Against Seat Anchor



Ram Extended in a Dash Roll

Roof Removal

During vehicle extrication, situations may arise where removing the roof becomes necessary to access trapped occupants. This section details two methods for roof removal, Hinging the Roof and Lifting the Roof.

Roof Removal Techniques

1. **Hinging the Roof:** Hinging the roof may be preferable because it requires one less glass cut. However, sometimes there is not enough clearance in the front of, or above the vehicle to allow hinging, making full removal necessary.
2. **Lifting the Roof:** This technique is used when the operation or vehicle damage dictates complete roof removal. For significant extrication operations, roof

removal is usually best. It provides the most operational accessibility and removes vehicle parts that can injure firefighters.

Hinging the Roof

Refer to Figure 6.4 for visual reference

1. **Post Cuts:** All roof support posts need to be cut based on Peel & Peek findings. Most of the time, it is best to make cuts low on the pillars if safe to do so. These cuts can happen simultaneously with cutters and a Sawzall.
2. **Windshield Cut:** Cuts are made on both sides of the windshield, following the line of the A-pillars. These cuts extend all the way down to the dashboard.
 - a. Glass Management all glass including the rear need to be addressed.
3. **Hinging the Roof:** With the posts and windshield separated, the roof is essentially hinged on the remaining section of the A-pillar where it connects to the windshield. Carefully fold the roof forward over the hood.
4. **Windshield Removal:** Once the roof is horizontal with the hood, apply a pulling force in an angled direction to shear the bottom portion of the windshield away from the vehicle.

Figure 6.4: Hinging the Roof



Do Not Cut Bottom of Windshield



Hinge Roof onto Hood



Pull Roof to Shear Windshield

Lifting the Roof

Refer to Figure 6.5 for visual reference.

1. **Post Cuts:** Like the Hinging method, all roof pillars need to be cut based on Peel & Peak findings. Most of the time, it is best to make cuts low on the pillars if safe to do so. These cuts can happen simultaneously with cutters and a Sawzall.

2. **Windshield Cut:** Cuts are made on both sides of the windshield, following the line of the A-pillars. A bottom cut is made, connecting the 2 side cuts allowing the windshield to be removed with the roof.
3. **Roof Removal:** With all supporting structures cut, carefully lift and remove the entire roof and windshield section as a single unit.

Figure 6.5 Lifting the Roof



Fully Cut Windshield



All Posts Cut



Lift Straight Up and Carry Away

Appendix A Genesis Information:

The Evolution of Extrication Tools: From Hose-Bound to Battery-Powered Solutions

In the field of rescue operations, speed, efficiency, and precision are crucial. The evolution of extrication tools over the years reflects the growing need to address these factors, ensuring that rescue teams can swiftly and safely respond to emergencies. From the early days of hydraulic hose-bound tools to the advanced battery-powered options available today, this transformation has had a significant impact on the capabilities of rescue teams worldwide. This article explores the journey of extrication tools, focusing on key technological advancements and how companies like **Genesis Rescue Systems** have contributed to this evolution.

The Early Days: Hydraulic Hose-Bound Extrication Tools

Hydraulic hose-bound tools have long been the backbone of extrication equipment, widely used for vehicle rescues, structural collapse scenarios, and more. Invented in the 1960s, hydraulic rescue systems provided unprecedented force and reliability, revolutionizing the way rescue teams approached extrication.

These tools work by applying hydraulic pressure to manipulate metal, making them extremely effective for cutting, spreading, and lifting in heavy-duty operations. Hydraulic cutters and spreaders, for example, are essential for opening vehicles to free trapped passengers, a task that manual tools simply could not handle efficiently.



Hose bound hydraulic spreader

Key advantages of hydraulic hose-bound extrication tools:

- **Power:** Hydraulic hose-bound tools are known for their immense power, making them suitable for cutting through high-strength materials, such as mangled metal in today's cars.
- **Reliability:** These tools are robust and designed to work in extreme conditions, making them a staple for many rescue operations.

However, despite their benefits, traditional hydraulic hose-bound rescue tools have several limitations. One of the primary drawbacks is their dependence on hoses and a central power unit. These hoses can restrict movement and make setup more cumbersome, especially in confined spaces or remote locations. Additionally, the weight and bulkiness of hydraulic hose-bound systems can limit portability, which is a major factor in time-sensitive rescue missions.

The Shift Towards Battery-Powered Extrication Tools

With the constant advancement in technology, the limitations of hydraulic hose-bound rescue tools paved the way for the development of battery-powered alternatives. The need for more portable, versatile, and efficient solutions led companies like **Genesis Rescue Systems** to innovate and bring battery-powered extrication tools to the market. This shift has not only streamlined rescue operations but also made the equipment more user-friendly and adaptable to a wider range of scenarios.



Milwaukee M18 Batteries for our EFORCE SLi Tool Line

Why battery-powered tools are a game-changer:

- **Portability:** One of the most significant advantages of battery-powered extrication tools is their portability. Rescue teams no longer need to be tethered to a hydraulic pump or deal with cumbersome hoses. Battery-powered tools allow for greater mobility, which is especially important in tight or hazardous environments.

- **Setup speed:** The time it takes to set up battery-powered tools is drastically reduced compared to their hydraulic hose-bound counterparts. This is critical in emergencies where every second counts. Rescue teams can deploy the tools immediately, without worrying about connecting hoses or waiting for a power source.

- **Versatility:** Battery-powered tools are versatile and can be used in a variety of rescue situations, from vehicle extrication to building collapses. They also require less maintenance than hydraulic hose-bound tools, which further improves their reliability.

Genesis Rescue Systems has been at the forefront of this transformation, designing and manufacturing a range of battery-powered extrication tools that meet the demands of modern rescue operations. Their tools are built to perform in extreme conditions, providing rescue teams with the power and reliability they need while minimizing the drawbacks associated with traditional hydraulic systems.

Advances in Battery-Powered Technology

Battery-powered extrication tools are not just about convenience; they also offer significant performance improvements. Over the past decade, battery technology has made huge strides, allowing for tools that rival, and in some cases surpass, the power of hydraulic hose-bound systems.

Modern batteries are now able to deliver more power for longer periods, ensuring that rescue teams don't have to worry about running out of power during a critical operation. This is particularly important in high-stress situations where downtime can be fatal.

Key advances in battery-powered tools:

- **Power improvements:** High-capacity lithium-ion batteries mean that tools can operate at full power than in previous years, allowing maximum rescue efficiency.

- **Rapid recharging:** Newer battery systems recharge quickly, ensuring that tools can be back in action with minimal downtime.

- **Durability:** Battery-powered extrication tools are now built to withstand extreme conditions, including heat, cold, and water exposure, making them as reliable as hydraulic hose-bound options.

Genesis Rescue Systems' tools are built with these advancements in mind, offering rescue teams the reliability and power they need, without the encumbrances of traditional hydraulic hose-bound systems. Their focus on delivering battery-powered tools that can operate in any environment has helped elevate the industry standard.

Safety and Training Considerations

As extrication tools continue to evolve, so do the safety and training protocols associated with them. While battery-powered tools offer many advantages, they require specialized training to ensure that operators can use them effectively and safely. Rescue teams must be familiar with the differences between hydraulic hose-bound and battery-powered tools, as well as the unique features that each offer.

Genesis Rescue Systems can provide comprehensive training for its customers, ensuring that rescue teams are equipped with the knowledge and skills needed to use their tools effectively. Whether it's understanding how to deploy battery-powered tools in high-stakes situations or maintaining the equipment for peak performance, proper training is crucial.

Additionally, modern extrication tools come with enhanced safety features, such as overload protection and smart diagnostics, which help operators manage risks during rescue operations. These tools are designed to prevent accidental injuries and ensure that rescue efforts are carried out as efficiently as possible.

The Future of Extrication Tools

The ongoing evolution of extrication tools is far from over. As vehicle technology continues to advance, so too will the tools needed to carry out successful rescues. Electric vehicles, for example, present new challenges for extrication teams, as they contain high-voltage systems that require specialized equipment and procedures.

Looking ahead, companies like Genesis Rescue Systems will be at the forefront to continue innovating, focusing on developing even more powerful, efficient, and intelligent tools. These tools will not only be faster and more portable but will also incorporate advanced real-time data feedback to further enhance rescue operations.

Conclusion

The evolution of extrication tools from hydraulic hose-bound systems to battery-powered solutions represents a significant leap forward for rescue teams worldwide. As the demands of modern rescue operations continue to grow, battery-powered tools have emerged as a critical component in ensuring fast, efficient, and safe extrication. Companies like **Genesis Rescue Systems** are leading the way, developing cutting-edge tools that empower rescue teams to perform at their best, even in the most challenging conditions.

By embracing these advancements, rescue teams can ensure that they are always prepared to meet the demands of any situation, providing lifesaving services when they are needed most.

Appendix B Heavy Vehicles

This section briefly discusses the distinct challenges posed by heavy vehicle extrication compared to standard passenger car extrication.

Heavy Vehicles: Trucks and Buses

Sturdy Design, Specialized Tools:

1. **Heavy-Duty Construction:** Unlike lighter vehicles, heavy vehicles are designed to haul significant loads. This translates to a sturdier build, which may necessitate the use of higher-capacity rescue tools to gain access to trapped occupants.

Stability Concerns

1. **Large Size and Weight:** The sheer size and weight of heavy vehicles can create complex stabilization challenges during extrication procedures. Factors like large ground clearances, unbalanced cargo distribution (off-center loads), and irregular vehicle shapes can all complicate stabilization efforts.
2. **Sprung vs. Un-sprung Weight:** Firefighters need to understand the difference between stabilizing the sprung weight (weight supported by the suspension) and the un-sprung weight (weight of axles, wheels, and tires) of a heavy goods vehicle. While stabilizing a vehicle resting on all its wheels on flat ground might seem straightforward, situations involving uneven terrain, obstacles, or overturned vehicles require a more technical approach to stabilization.

Working at Heights

1. **Elevated Cabins:** The elevated cabins of heavy vehicles often necessitate working from ladders or platforms to access trapped occupants.
2. **Platform Safety:** Working safely on platforms demands regular practice and clear communication among team members regarding tool handling and patient removal procedures over these platforms.

By recognizing these unique challenges and adapting their approach accordingly, firefighters can ensure safe and efficient extrication of occupants from heavy vehicles.

Unique Challenges of Heavy Trucks

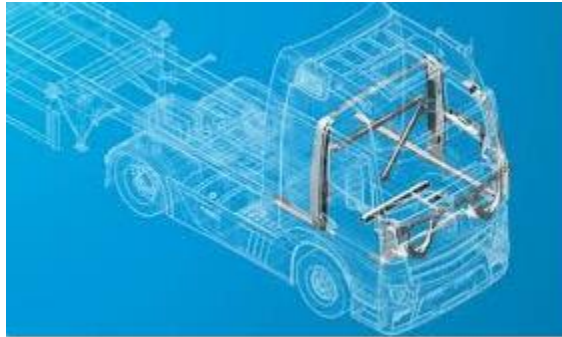
Extricating occupants from heavy Trucks presents distinct challenges compared to standard vehicles.

Here are some key points to remember:

1. **Double Chocking:** Stabilize both the wheels and the cabin of the Truck using chocks, cribs or struts.
2. **Cabin Strapping:** If the cabin's locking mechanism is compromised, secure the cabin to the chassis using straps.

3. **Heavy Doors:** Be aware of the significant weight of heavy Truck doors. Utilize tension belts for support during manipulation to prevent injuries.
4. **Steering Column Adjustment:** Moving the steering column upwards can sometimes be beneficial to create additional space for accessing trapped occupants. This can ideally be done using the vehicle's own column adjustment mechanism, but tools can also be used if necessary.

Figure 7.1 Reinforcement of Heavy Truck Roof



Bus Extrication Considerations

While categorized as heavy vehicles, buses have a different construction compared to Trucks

1. **Vulnerable Bus Compartment:** The bus passenger compartment is often weaker and more prone to collapse during accidents, potentially entrapping a large number of people.
2. **Seat Failure:** The forceful impact of a crash may cause the bus seats to break, further entrapping passengers.

Bus Extrication Procedures

Following vehicle stabilization, gaining access to trapped occupants in a bus becomes the primary focus. Here's a breakdown of the process

1. **Stabilization:** May require long struts or large crib-beds.
2. **Initial Access Points:** The most straightforward means of entry should be prioritized, such as using doors, side windows, emergency roof exits or cutting large openings in the roof with reciprocating saws or air chisels.
3. **Patient Assessment:** Once inside, assess the number of occupants and the nature of their injuries.
4. **Thorough Search:** Remember to check luggage compartments, beds, and restrooms if the bus is equipped with them.

Mass Casualty Management

Bus accidents can involve a large number of casualties. Here are some crucial considerations for managing such situations

1. **Staging Areas:** Designate clear staging areas for emergency vehicles to facilitate rapid patient transport.
2. **Teamwork:** Rescuers may be divided into smaller teams to work on different sections of the bus simultaneously.

Members and Officers shall be familiar with MCI procedures.

Extrication and Disentanglement

The core objectives of bus extrication operations are:

1. **Creating Space:** This involves creating sufficient space for initial access and ultimately removing patients.
2. **Disentanglement:** Once access is gained, disentangling occupants from potentially jammed seats becomes a priority.
3. **Maintaining Access:** Strategic handling of operations inside the bus should ensure a clear pathway for transporting patients on stretchers throughout the rescue.

By understanding these specific challenges and implementing the outlined procedures, firefighters can approach heavy vehicle extrication, including both Trucks and buses, with greater efficiency and preparedness.

Figure 7.3: Bus with Forced Access Points



Appendix C Electric / Hybrid Vehicles

This section briefly discusses the distinct challenges posed by electric and hybrid vehicle extrication.

Electric and Hybrid Vehicles: Essential Safety Precautions

The increasing presence of electric and hybrid vehicles on the road necessitates specific safety considerations during extrication procedures. Here's a breakdown of the key points to remember

High Voltage Hazards

1. **Electric Vehicles (EVs):** These vehicles typically house a high voltage battery pack, usually located in the rear of the car. Never attempt to cut through or tamper with any high voltage components or wires.
2. **Hybrid Vehicles (HVs):** While less prominent, high voltage cables in hybrid vehicles can be identified by their orange insulation and connectors. These cables are typically routed underneath the floor pan reinforcement, generally out of the way for rescue personnel.

High Voltage Disconnect

1. **Electric Vehicles (EVs):** Many EVs come equipped with a high voltage disconnect switch. However, the location and access method will vary depending on the manufacturer and model.

Hybrid Vehicle Considerations

1. **Deceptive "Off" State:** Even when the gasoline Engine isn't running, a hybrid vehicle might still be in "ready state," capable of unexpected movement.
2. **Disabling the System:** To prevent this, emergency responders should not only disconnect the 12-volt battery but also ensure the main ignition switch is turned to the "off" position and the key is removed to fully disable the electronic drive system.
3. **LAMINATED GLASS:** Some EV's are equipped with driver and passenger SIDE WINDOWS made of laminated glass. This may hamper rescue efforts and require reciprocating saws to complete the cuts.

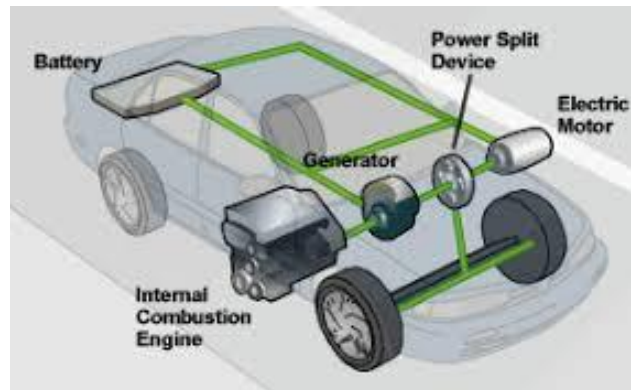
Universal Precautions

1. **Never Cut Orange or Blue Wires:** Generally, avoid cutting or tampering with any high voltage wires or components, regardless of vehicle type.
2. **Standard Procedures (Hybrids Aside):** Except for the heightened awareness of high voltage systems, standard extrication principles and techniques can be applied to most hybrid vehicles.

Manufacturer Information

For more specific details on a particular vehicle model, consult the rescue guides published by the respective car manufacturers.

By adhering to these safety protocols, firefighters can mitigate the risks associated with electric and hybrid vehicle extrication while ensuring their own safety and the safety of trapped occupants.



****DO NOT CUT THROUGH BRIGHT COLORED WIRES****

