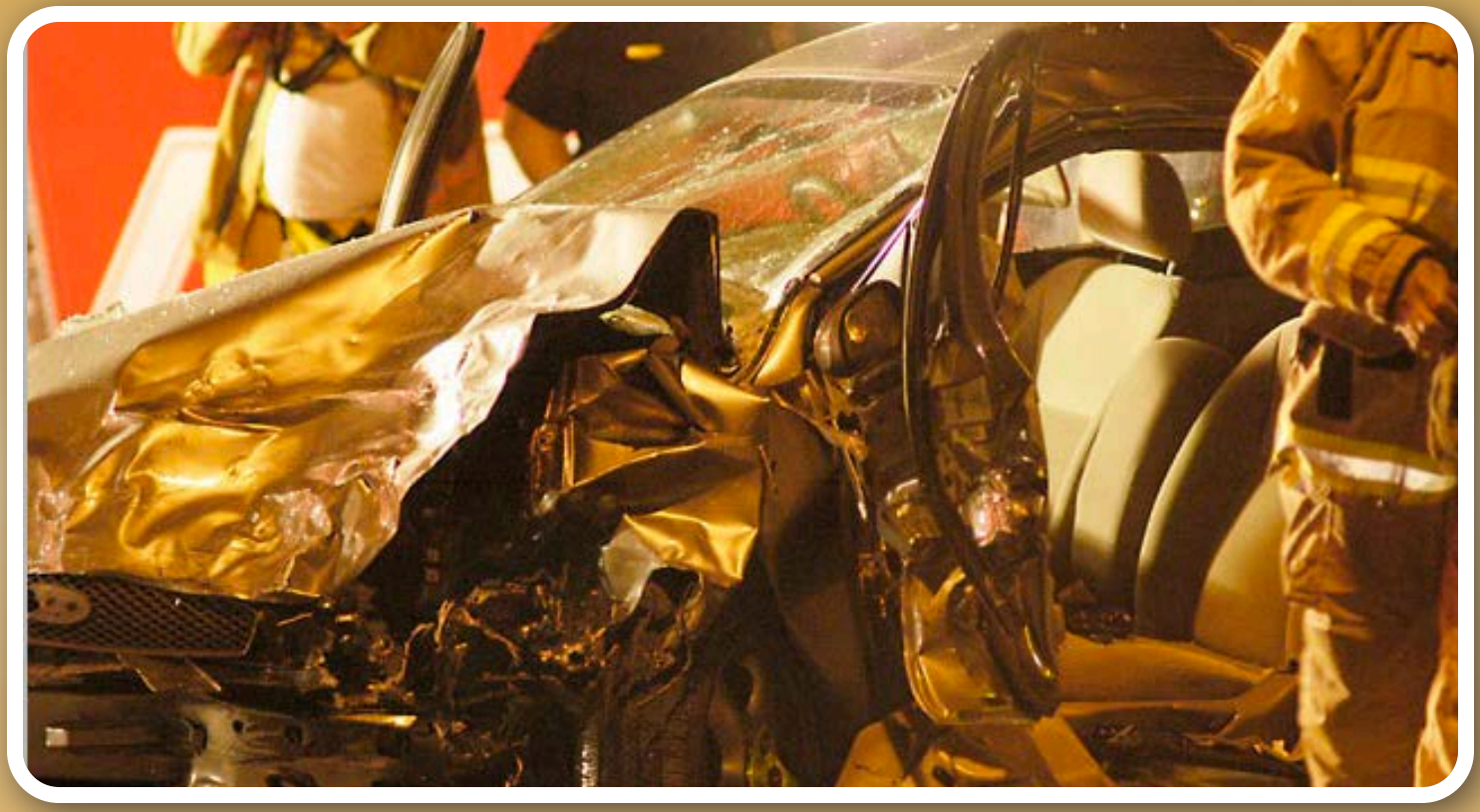
Vehicle Rescue

25

Section III - Truck Company Operations



Vehcile Rescue Fundamentals

Scene Size-Up

Vehicle Stabilization

Securing The Vehicle

Vehicle Extrication

Revised - June 2021

IntentionallyLeft Blank

Chapter 25 Table of Contents

Introduction

Vehicle extrication can be defined as the strategic removal of a wrecked vehicle from an entrapped victim. When a vehicle collision occurs it can create a lethal amount of energy that will transfer from the point of impact to its occupants. The time with which a victim can be extracted from the wreckage and delivered to a trauma facility can mean the difference between life and death. The patient has the most optimal chance for survival if extricated within 15 minutes and delivered to a trauma facility within an hour from the time of injury, a time period called the "Golden Hour." It is the sole responsibility of the fire service to extricate trauma patients from their vehicles in a timely and safe manner, causing no further harm. Therefore, the victims survivability is directly correlated to our preparation, efficiency, and ability to coordinate as a team on scene.

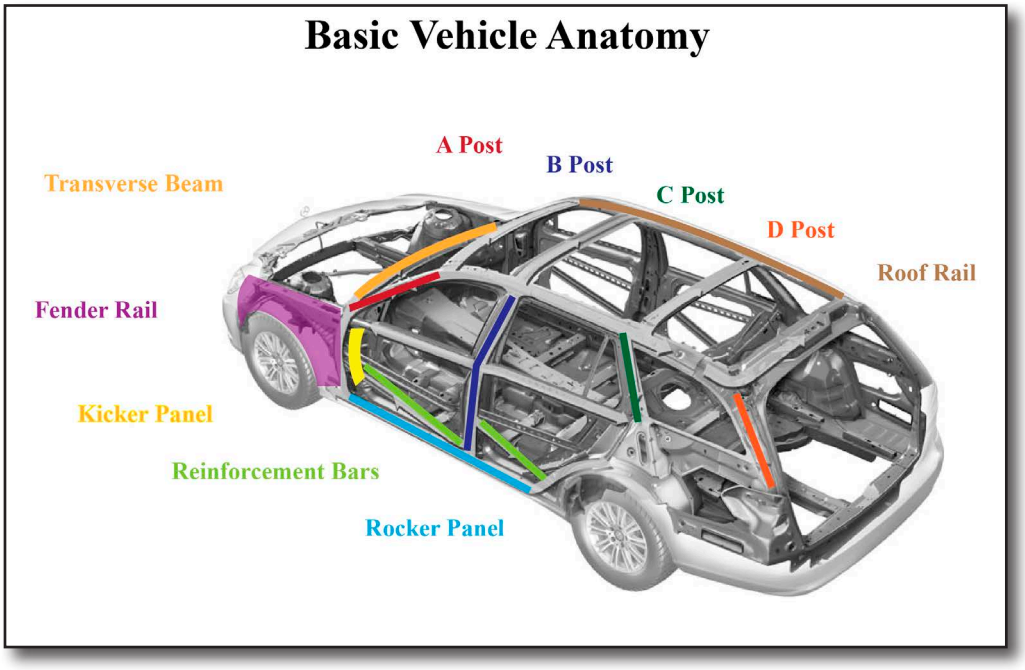
Flow Of The Call

The following chapter is divided into five "phases" that collectively can be titled "The Flow of the Call." Each phase is structured and prioritized to replicate the approach of a real life incident. Learn the fundamentals, size up the scene, stabilize the vehicle, secure the vehicle, and extrication. While vehicle rescue incidents can present themselves to be highly dynamic and complicated, our approach to them should stay the same. When first responders take a systematic approach on scene we can ensure the safety of all personnel involved while also performing an efficient and timely rescue.

Phase I: Vehicle Rescue Fundamentals

In early industry designs, vehicles lacked the high strength steel, safety components, and “crumple zones” in its structure to safely protect its occupants. This lead to a significantly higher mechanism of injury and mortality rates. Facing this problem, vehicle manufactures have engineered stronger and more sophisticated body designs to accomplish two main goals. To absorb an impacts energy and to safely transfer/redistribute it away from the passenger compartment.

This advancement in design has created two critical challenges for us as first responders. Advanced vehicle designs have successfully resulted in less vehicle rescues today; limiting the exposure and experience that first responders require to build proficiency. Simultaneously when us as responders do face these newer model vehicles we can face significantly more challenging obstacles to overcome than in older model vehicles. This creates an even greater importance for first responders to learn the foundational knowledge of vehicle frames and anatomy.



Vehicle Anatomy

To affect a successful vehicle rescue and extricate victims without causing any further injury, a firefighter musthave a working knowledge of vehicle anatomy. The following components are found on most all vehicles.

Basic Vehicle Components

Top

The top of the car is always the roof, even if it is overturned.

A Post

The "A" post is the vertical structural member of the vehicle which frames in the windshield. It is located furthest to the front and extends from the dash to the roof.

B Post

The "B" post is the vertical structural member of the vehicle which extends from the rocker panel to the roof of the car. The "B" post is located one post to the rear of the "A" post and provides the latching point for the front door.

Figure 25-1 "A" through "F" Posts

C Post etc…

The "C" post is the vertical structural member of the vehicle which may frame in the rear window of the vehicle or on larger vehicles may serve the purpose similar to the "B" post. As vehicles get larger, so do the number of vertical posts encountered on the vehicle. A passenger van may have six posts. In these instances, the posts are named by continuing down the alphabet moving from front to rear.

Roof Rail

The beam that runs perpendicular to, and connects the "A," "B" and C" Posts

Fender Rail

This is the area that runs the top outside edge between the front of the vehicle and the "A" post. This area is also referred to as the "quarter panel.

Front Rail (Crumple Zone)

The front rail is placed in the front of the vehicle underneath the fender rail. The front rail is comprised of two separate rails, an Upper and a Lower Rail that are both intended to crush, thereby absorbing an impacts energy and redistributing the absorbed energy before it reaches the passenger

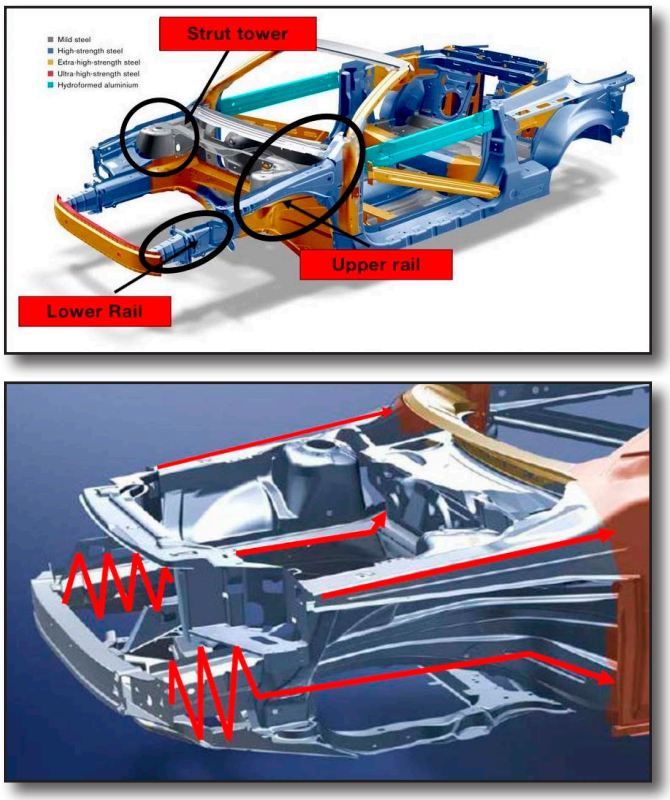


Figure 25-2 Front Rail (top), Crumple Zone (bottom)

Figure 25-3 Kick Panel (top left of image) & Rocker Panel

compartment. As the intended area crumples this material can also become thicker and more difficult to cut.

Kicker Panel

The Kicker Panel is the area of the vehicle just below the "A" post and forms the rear edge of the quarter panel or fender rail.

Nader Pin

The Nader Pin is attached directly to the "B" post and serves as the latching point for the front doors. Depending on the number of doors on the vehicle, a Nader Pin may be found on the "C" posts as well.

Rocker panel

The rocker panel is the rigid area of a vehicle between the bottom of the "A" and "B" posts. Fuel lines run through the rocker panel in some vehicles.

Transverse Beam (Magnesium)

The transverse beam is a solid structure found inside the dash board designed to provide lateral (side-to-side) strength of the passenger compartment. It is also where dashboard components are mounted. The transverse beam is commonly made of magnesium and can thus present additional hazards if fire is involved.

Figure 25-4 Nader Pin

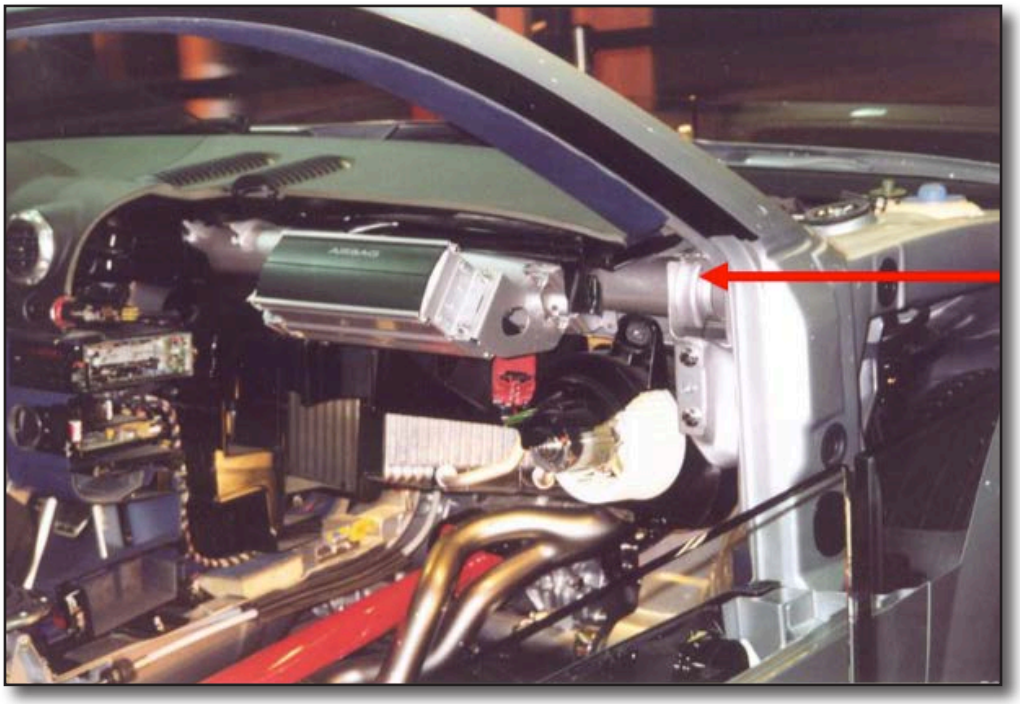


Figure 25-5 Transverse Beam Dash Bar

Vehicle Frames

There are three basic frame designs: "Body Over Frame," "Unibody," and "Space Frame." All three designs were introduced in different time eras and can present different complications when attempting a rescue. The purpose for understanding vehicle frame construction is not to try and identify each individual body construction on scene of a rescue, as that is not only difficult but unrealistic. The purpose is to have a working knowledge of what complications vehicle manufacturing can possibly pose to us and what we can do to overcome them.

"Body Over Frame"

Body over frame design consists of two steel rails that run the length of the vehicle with an attached body on top. This double rail frame is what provides the true structural strength of this design and is the attachment foundation for all other vehicle components. This is still the primary design found in trucks and larger sport utility vehicles today. However, body over frame design began to decline by the 1960s in smaller passenger vehicles in favor of the Unibody Design.

- A body over frame design relies on its bottom frame for its structural strength and rigidity. This leads to less required strength in the attached bodies components other than the necessary protection for a side wall collision. Due to this, the bodies contact points (push points) for our rescue tools can present complications for our Dash Displacement tactics. For example: Without appropriate cribbing support underneath our push points, a "Dash Lift" procedure will likely result in the rocker panel and floor pan to fail prematurely before displacing the dash panel. This design flaw highlights the importance in building a solid support structure underneath our push points.
- This design naturally has a higher center of gravity, thus making it more susceptible to roll over damage.
- Due to the lack of crumple zones in its design, our index of suspicion must be higher in regards to the occupants mechanism of injury and potential for fatal injuries.

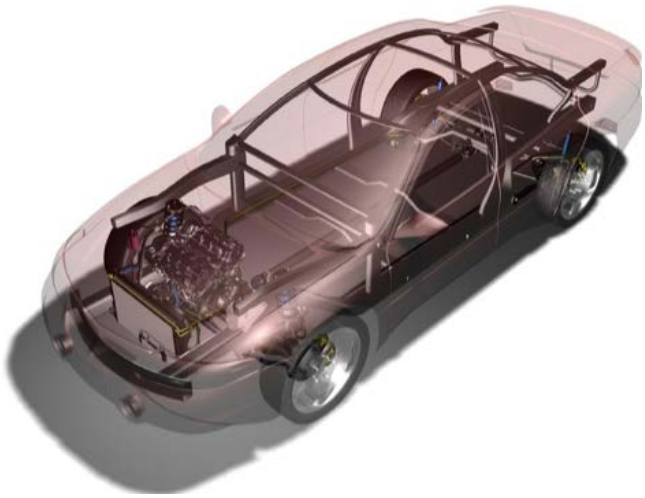
"Unibody Design"

Unibody design began in the 1960s and is the primary design found in most passenger and small sport utility vehicles in production today. Rather than an independent frame with a body attached on top, unibodies design integrates the frame and body into one singular piece of material. Because

it does not have heavy steel rails to rely on for strength like those of a body-on-frame vehicle; Unibody designs strength must rely on each single piece of material in its body working together. If any one piece of this design fails, the structural integrity as a whole begins to compromise.

- Though a Unibody is one singular piece, multiple anatomical components are built separately and hot stamped together using extra layers of sheet metal to connect each component together. This process is what makes each change of direction in its frame stronger and can be used to our advantage when looking for stronger push points with our rescue tools.

"Space Frame"



Space Frame design began mass production in 2011 and is now commonly seen in smaller luxury model vehicles. Space Frame design is similar to Unibody design being that it acts as the body and the frame simultaneously. The difference however is that a space frame vehicle does not depend on any of its outer panels for additional strength. In other words, you can remove all of the fenders, doors, and quarter panels and the space frame design will still have its full structural integrity. Space Frame is a lighter and stronger design and is able to accomplish this by incorporating more reinforcement components and additional layers of advanced steel than ever before.

- Due to the additional layers in this designs body. When there is a need for a spreading operation, it can be more difficult for our spreader tools to defeat its locking mechanisms. Rather than spreading the structural components apart the separate layers of sheet metal will tear and spread apart first. This design highlights the importance in establishing strong tool placement when performing a spreading operation.
- In regards to a cutting operation, rather than having a structural component be cut apart these additional steel layers in its body will tend to bunch together as we close our cutting tools. This further emphasizes our need for more advantageous tool placement, height, and tool pressure build up.

High Strength Steel

As vehicles evolve to become stronger and more durable, High-Strength Steel continues to be the material of choice for automakers. However, what we as rescuers need to be aware of is that the term High-Strength Steel is more often misused by the automative industry as a marketing strategy for the common consumer. While it is true that auto manufacturers are incorporating higher amounts of High-Strength Steel than ever before, there still is only rare occasions that these metals will challenge our rescue tools. This confusion stems from the use of the term "High-Strength Steel" which is an umbrella term used to describe a wide variety of different metal alloys ranging from Mild Strength

Steel to Advanced High Strength Steel, all of which have different levels of strength and thickness. In modern vehicles today, the most common type of metal that can produce challenges for our rescue tools and us as rescuers is Ultra High Strength Steel (UHSS).

Ultra High Strength Steel is a steel metal reinforced with Boron, when manufacturers incorporate multiple layers of UHSS in a vehicles structure it can create challenges for our tools to overcome. Now knowing this, the two things we must consider moving forward is: Where can we commonly find UHSS and when we do face this material, how do we overcome it?

Just as the crumple zones purpose is to protect a driver from a front or rear end impact, UHSS purpose is to protect a driver from a side wall impact. This is why we will most commonly find layers of UHSS in a vehicles B-Post, Rocker Panel, and rarely can find it in the roof rails. In convertible vehicles we can also anticipate finding UHSS in the A-Post, providing rollover protection due to the absence of a roof rail.

Figure 25-6 Multiple layers of a "B" post with a reinforcement bar (above two images)

Overcoming High Strength Steel

When we do face challenges with UHSS there are some key techniques we can apply to increase our chances of success. Tool placement, angle, and tool pressure build up can play a integral role in successfully overcoming this material.

- Tool placement begins by understanding how and where auto manufacturers place UHSS and other reinforcing materials. An entire B-Post changes thickness from its top to its bottom with the thickest portion being placed in its center. Oftentimes a B-Post can also have a reinforcement bar placed in the center of its post for added protection. The main purpose for this protection is to protect the occupant from their hip to shoulder height; where a collision is most common to occur. When having difficulty cutting a B-Post we now know that the closer we cut towards its top or bottom the greater chance we have to avoid these added layers of protection and succeed.
- Another option is to change the angle of our cutters when we approach our B-Post. It is common practice to approach our B-Post with our cutting tool perpendicular to the vehicle, this is a helpful technique as it prevents our cutter tool from rotating into the vehicle. However, when we find ourselves unsuccessful we can then try cutting parallel to our vehicle. This angle cuts the internal folds

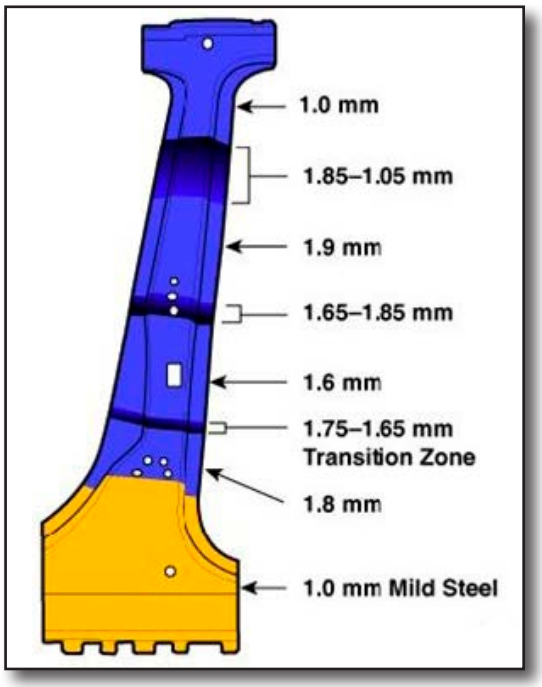


Figure 25-7 "B" post variation in thickness

of the B-Posts material without the tendency for it to bunch together, increasing our chances of defeating it.

Figure 25-8 "B" post reinforcement bar (red)

A key to being successful with UHSS is to allow proper tool pressure build up with our hydraulic line power tools. When we engage our power tools it activates a dual stage pump in our power unit. The first stage begins by drawing hydraulic fluid into our tools which is best described as a fast moving but low pressure stage. This allows our power tools to open and close freely at a relatively fast rate. It is not until our tool comes in contact with its object and no longer moves that the second stage begins, this can be described as a slow moving but high pressure stage. Too often rescuers will begin a spreading or cutting operation and after seeing no progress will prematurely disengage their tool; dumping the tools pressure and having to start from scratch. Manufacturers recommend that we continue to engage our tools for up to 8 seconds after the tool no longer moves. By doing so we allow the tool to build up the appropriate pressure and can defeat the intended object.

Phase II: Scene Size-Up

Arrival at Scene

Upon arrival at scene, stop apparatus uphill and upwind of the incident. If law enforcement is not at scene and is needed, request them through E.C.D.C. When on roadways, particularly on the freeway, it will be important to place the apparatus so that it affords protection to the firefighters, ambulance crew, and victims. Stop far enough back or forward of the incident to allow room for the ambulance, truck company and heavy rescue. If the incident is out of the freeway traffic lanes, place the apparatus off the freeway but still in a position to protect the crews.

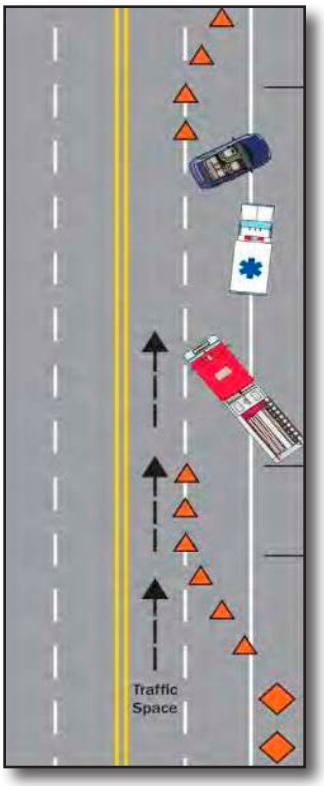


Figure 25-9 Apparatus Positioning At Scene

No two vehicles rescues will be alike. Each incident will require its own size-up and a determination on how the rescue will be effected. With this in mind, there are many common factors which should be considered. These include scene size-up, vehicle stabilization, utilization of vehicle power, disconnecting the 12 Volt battery, patient care, and peeling the interior of the vehicle prior to any cutting. These tasks can all be accomplished simultaneously and in short order by a well trained and coordinated crew.

Size-Up

All firefighters should perform size up of the situation as soon as possible. A thorough size up for a vehicle rescue situation should include the following:

- Report on conditions and request for resources Initiate traffic control
- Identify hazards
  - Downed electrical wires / electrical utility boxes
  - Fire or fuel spill
  - Unstable vehicle
  - Hazardous materials or cargo
- Number of patients
- Equipment & tools needed
- Create a coordinated plan

Scene Protection

Vehicle accidents on roadways and freeways present one of the most dangerous environments for firefighters to work in. Every action taken should be done with safety in mind. When exiting the apparatus, attempt to do so on the non-traffic side, and never turn your back on traffic. In situations where

you are not able to keep an eye contact on the traffic at all times, a look-out or safety officer should be posted to warn the rescuers of danger.

In addition, firefighters should prepare for the possibility of fire by laying a charged hose line with the ability to flow foam. For incidents involving fuel spills, a class B dry chemical extinguisher should be standing by. Use caution in placing traffic flares, keeping them as far away as practical to avoid ignition of fluids or vegetation.

In addition to protecting the overall scene, a 25 foot Hot Zone (Exclusion Zone) around the vehicle should be maintained. This area should only be entered by essential emergency personnel wearing the proper PPE.

Figure 25-10 Safety Zones / Scene Protection

Flammable Liquid Control

Firefighters should attempt to stop or control any leaking flammable liquids and warn all personnel about sparks and fire danger prior to beginning the extrication. In the event of a large spill request Haz Mat.

Remember, when a rescuer first enters a vehicle in a rescue situation involving spilled flammable liquids, the area the rescuer is entering is similar to a bomb. There must be a team at work alleviating the potential of fire and ready to keep a sudden fire away from the rescue team. The “Hot Zone” must be increased to 100 feet when flammable liquids are a factor.

Abate Electrical Hazards

When a vehicle as come in contact with any potential electrical hazard, downed wires, or electrical boxes, it must always be assumed to be energized or “hot.” Do not attempt to make any extrication attempts, or move any downed power lines until it is confirmed that the power has been shut down. As difficult as it may be, no rescue attempt should be made until power is secured. Instead, firefighters should focus their efforts on calming the patient and giving them instructions to stay in the vehicle until it is deemed safe by SDGE or the IC.

In addition to external power sources, the vehicle itself can be an electrical hazard. As part of the initial actions taken by rescue crews to make the scene safe, the vehicle ignition should be turned off and the batteries disconnected starting with the negative terminal (black). Prior to disconnecting the vehicles battery and power system, consider the need for using any of the 12 volt functions in the vehicle to your advantage. Examples may include rolling down windows, adjusting powered seats and the steering wheel.

Bumpter Struts

Most vehicles manufactured after 1974 use bumper struts to create energy absorbing bumpers. These bumper components use a similar design to those found in struts. When the energy absorbing pistons are heated or impinged by fire, they can unexpectedly explode or release, launching the bumper or the individual piston great distances. Based on impact and/or location of the fire, firefighters should always approach vehicles at a 45 to 90 degree angle from the front or back to keep clear of a potential bumper release during vehicle fires or extrication.

Figure 25-11 Bumper Strut Exploding

Coordinated Plan

In order to conduct an effective vehicle rescue, all personal must be briefed on a coordinated plan for their operations. This plan typically starts with a pre-plan of action prior to arrival. Because every rescue is unique and different, an updated and coordinated plan should be communicated to all rescue workers involved during the size-up portion of the incident.

Roles/Responsibilities

As with all other incidents, every vehicle rescue will pose a different set of challenges that cannot be pre-planned. However, what we can do to better prepare ourselves is discuss the individual roles and responsibilities within our Engine and Truck companies. By doing so, we can anticipate what tasks need to be completed and what we must do individually to better serve the incident. The Roles and Responsibilities page must be used only as a template that must be adjusted accordingly based off the acuity and dynamics of the incident.

Engine Company Roles & Responsibilities		
Position	Assignments	Equipment
Captain	• IC • Initial size-up • Additional Resources • Safety	• NA
Engineer	• Spot Apparatus / Traffic Control • ID water supply with Captain • Personal size-up • Protection hose line • Lighting	• 1 3/4” Protection Line • Dry Chem Extinguisher • Tool Cache
FF #3	• Personal size-up • Vehicle stabilization • Battery disconnect • Peel / Peek / Mark	• Cribbing • Battery Pack • Genesis Tool • Recipro Saw
FF #4	• Personal size-up • Patient assessment / treatment	• Medical Aid Equipment

Truck Company Roles & Responsibilities		
Position	Assignments	Equipment
Captain	• Rescue Group Supervisor • Initial size-up • Develop & Communicate Plan • Safety	• NA
Engineer	• Spot Apparatus / Traffic Control • Personal size-up • Assemble Tool Cache • Operate Power Unit • Lighting	• Debris Carrier • Hydraulic Power Unit & Tools • Cribbing • Lighting Equipment
FF #3	• Personal Size-up • Vehicle Stabilization • Glass Removal • Peel / Peek / Mark • Operate Cutter/Recipro Saw	• Rescue 42 Struts • Rope, Come-a-Long • Hydraulic Cutter • Recipro Saw
FF #4	• Personal Size-up • Vehicle Stabilization • Glass Removal • Peel / Peek / Mark • Operate Spreader/Rams	• Rescue 42 Struts • Rope, Come-a-Long • Hydraulic Spreader • Extension Rams

Phase III: Vehicle Stabilization

When on scene, stabilization comes second only to scene size up. The purpose of stabilization is to prevent the movement of a vehicle, preventing any potential injuries to rescuers or victims while performing extrication tactics. When establishing the stabilization of a vehicle we must also use the anticipation of future rescue tactics to dictate our stabilization needs. By doing so, we can avoid undoing any of our work that may no longer serve the rescue.

When sizing up a vehicle, think of them as either bricks or beach balls. Older vehicles more resemble a "brick" with their square shapes and hard exterior shells. Where newer model vehicles have a more round plastic shell and resemble a beach ball, with a higher tendency to roll and deform. Depending on our size up we may need to address our vehicles stabilization needs through Primary, Secondary, or Tertiary stabilization, or a combination of all three.

Figure 25-12 "Beach Ball"

Primary Stabilization
The initial form of stabilization by means of solid objects being wedged against a vehicle.

Secondary Stabilization
Stabilization achieved by means of advanced tools such as rope, come-a-long, chains, and rescue 42 struts and straps.

Tertiary Stabilization
The constant monitoring of a stabilized vehicle, ensuring that rescuers are aware and adapt to the stabilization needs throughout all stages of a vehicle rescue.


Figure 25-13 "Brick"

Primary Stabilization

1. Place transmission in park

2. Set the parking break

3. Stabilize wheels with cribbing or wheel chocks

4. Place step chocks with anticipation of extrication needs

Upright Vehicle

Even when a vehicle is found upright on its wheels, rescuers cannot assume that it is stable or will stay stable. A vehicles distribution of weight, direction of gravity and stability of its ground, are just some of the considerations we must assess when stabilizing a vehicle. Primary stabilization is a quick and effective way to stabilize an upright vehicle. We can accomplish this by placing a solid object (cribbing, wheel chocks) at the base of the wheels; placing it against the direction that gravity will want to pull.

If accessible, we can then set the vehicle's emergency brake and place the transmission in park. To further increase the stabilization of the vehicle, air can be removed from the tires to take the weight off of the suspension and place it on to the cribbing or chocks.

Overturned Vehicle

Finding a vehicle on Its side or on its roof creates an unsafe working environment. The first thing we can do is apply step chocks or wedges for primary stabilization. For overturned vehicles, primary stabilization will not be sufficient and secondary forms of stabilization will be required by means of a truckers hitch, chains, come-a-long, or Rescue 42 Struts and Straps.

Before we can understand Struts and what they can do for us, we need to learn about the physics of stability. An easy way to picture stability is to use a triangle. If you have a triangle with a narrow base sitting on the ground, it is easy to tip over. Widen the base of the triangle and it becomes much more stable. This is similar to how an aerial apparatus uses its outriggers to widen its base.

Now as we imagine a crashed vehicle on its side, sitting on its narrow base, we can then position our struts at an angle between 45-70 degrees and apply tension using a ratcheting strap. By doing so, we dramatically widen the base of our vehicle converting our "beach ball" into a solid triangle. This application of Rescue 42 Struts and Straps is called a Tension Buttress. Below will discuss further on how to apply a Tension Buttress to a vehicle on its side or on its roof.

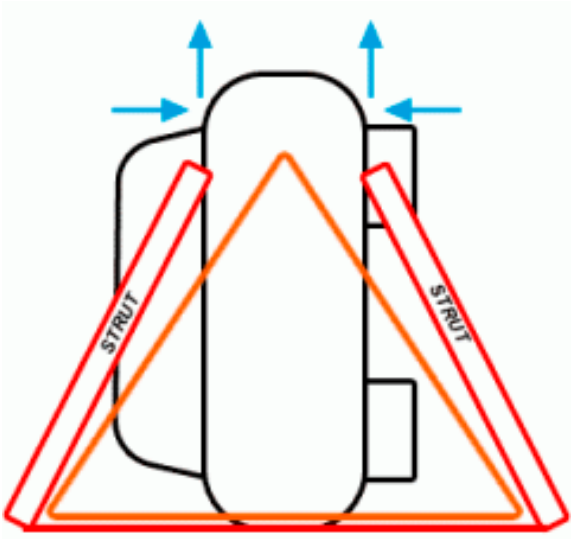


Figure 25-14 Vehicle stabilized as a triangle using the Rescue 42 struts

"Vehicle On Its Side"

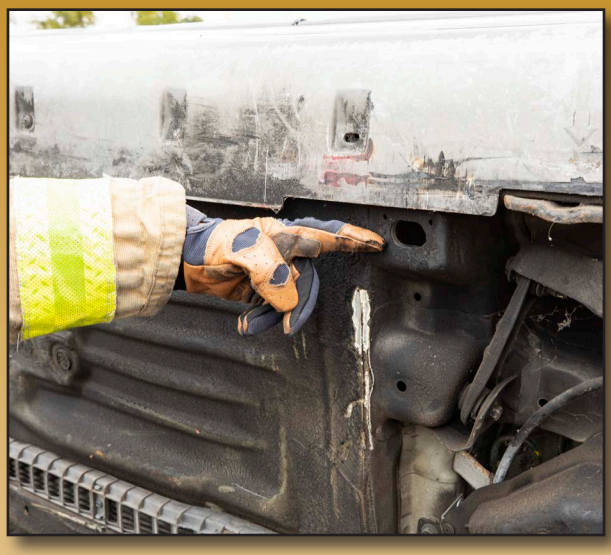
As we approach a vehicle on its side it is important that we first address the areas that have the most potential for movement.

Figure 25-15 Safety Zones / Scene Protection

An accident damaged vehicle may have come to rest on its side, on uneven ground, a ditch or incline. The circumstances may exist where any movement may alter the balance, threatening further damage. More commonly however, it takes up a common position where its stability is maintained by its wheels being pinned against the ground. However, almost all passenger vehicles on their side will have a natural lean towards its roof, making it more vulnerable to roll onto its roof than onto its frame. This is due to the roofs profile being narrower than its body. Also factor in the engine compartments weight, thus making the roof side engine compartment the first location to stabilize.

In regards to stabilization, it is good to use the "Good, Better, Best" approach. As mentioned previously, the shape of a triangle is what provides the most stability. The more struts we can have opposing one another the better. However, depending on our environment having four struts deployed may not always be possible as we may be limited with our attachment points or working space. When it's not possible to deploy 4 struts onto a vehicle we can then move onto other variations.

Estimating Strut Angle



1. Pick insertion point

2. Extend Strut 16” above your insertion point

3. Pin Strut

4. Place strut into position

Strut Deployment Methods

4 - Strut Deployment

- 2 struts against the frame of the vehicle, 2 against the roof side with 1 at the hood and 1 at the trunk.
- Attach the ratchet straps from baseplate to baseplate or from baseplate to vehicle framing.
- Thinking ahead, avoid placing stabilization in areas where you are likely to later cut during the extrication.

3 - Strut Deployment

- 1 strut centered against the frame of the vehicle with a single ratchet strap strung though the baseplate attached to the opposite ends of the frame.
- 2 struts on the roof side, 1 strut at the hood and 1 at the trunk with the ratchet straps attached from baseplate to vehicle frame.

2 - Strut Deployment

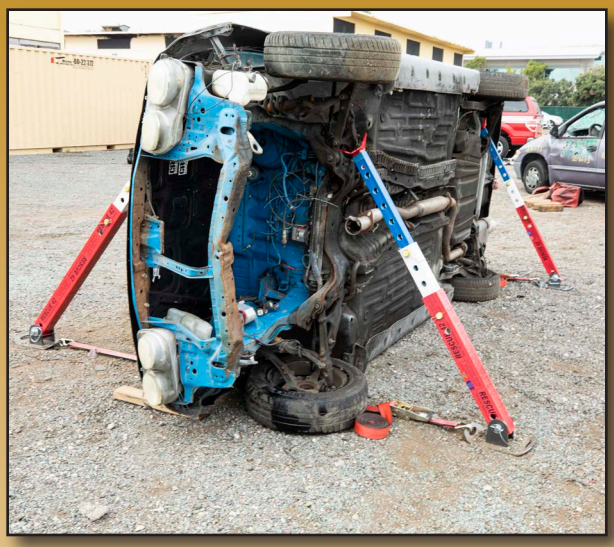
- 2 struts placed in line with one another, placed onto the most vulnerable side of the vehicle.
- Ratchet straps attach from baseplate to baseplate.
- Apply other forms of stabilization onto less vulnerable side (truckers hitch, come-a-long, cribbing)

1 - Strut Deployment

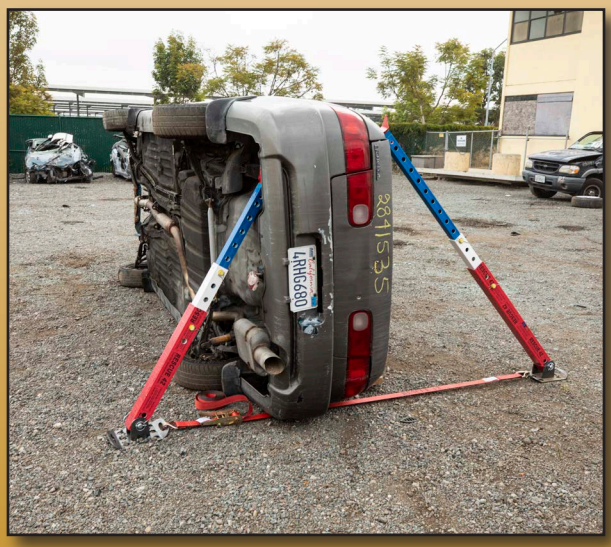
- Single strut is placed against the vehicle.
- Ratchet strap is attached from base plate to body frame.
- With limited frame attachment options, use a hook cluster or cinch ring.

Four Strut Stabilization Deployment

1. Apply struts starting at the roof side engine compartment



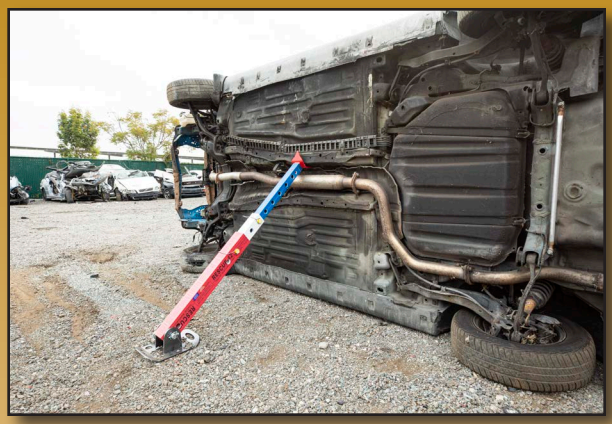
2. Two struts oppose one another with strap attached from base plate to base plate



3. Two struts applied to the trunk side of the vehicle with a strap attached from base plate to base plate

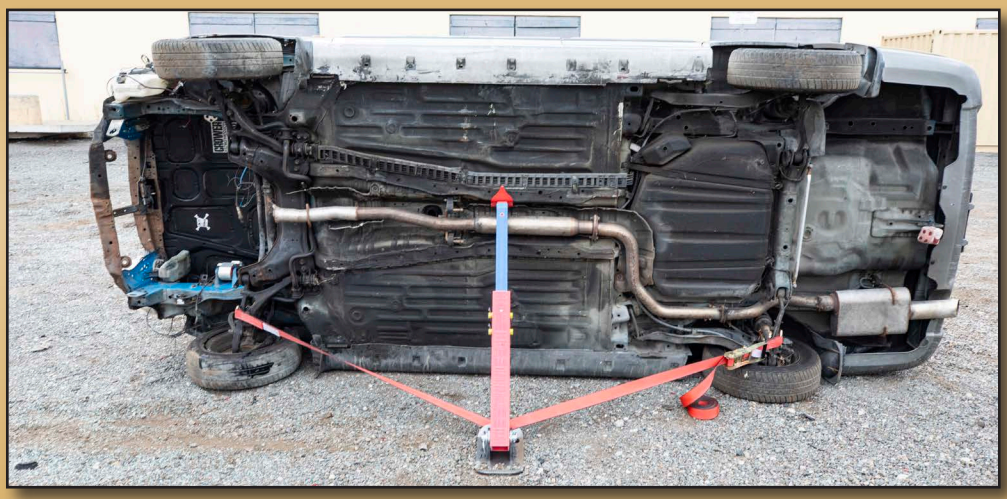
4. Vehicle is stabilized utilitizing a 4 strut tension buttress system

Three Strut Stabilization Deployment



1. A single strut is placed in the center of the frame side of the vehicle another.

2. Strap is ran through the struts base plate

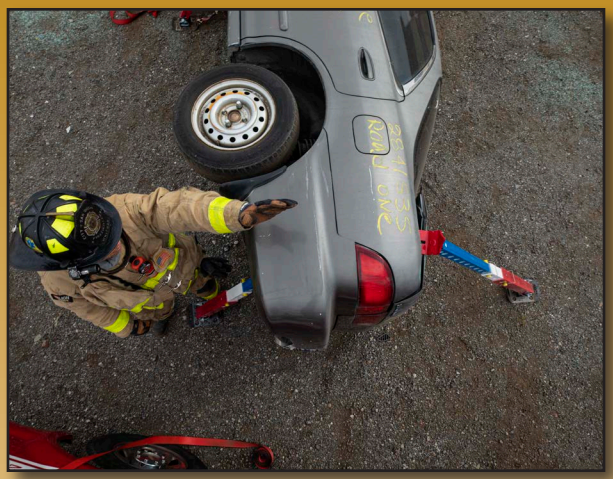


3. Attach strap hooks to the opposite ends of the frame and apply tension

4. Single tension buttress is placed at the roof side engine compartment

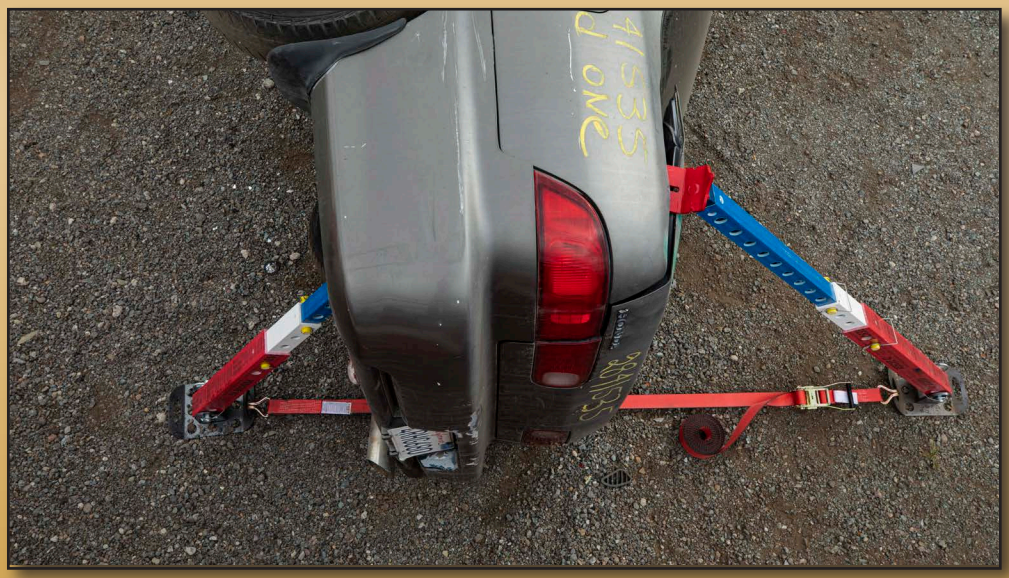
5. Single tension buttress is applied to the roof side trunk compartment

Two Strut Stabilization Deployment



1. Place two struts aligned and opposing one another. Firefighter can raise a hand to signal their insertion point

2. Struts placed at the proper angle (45 Degrees)

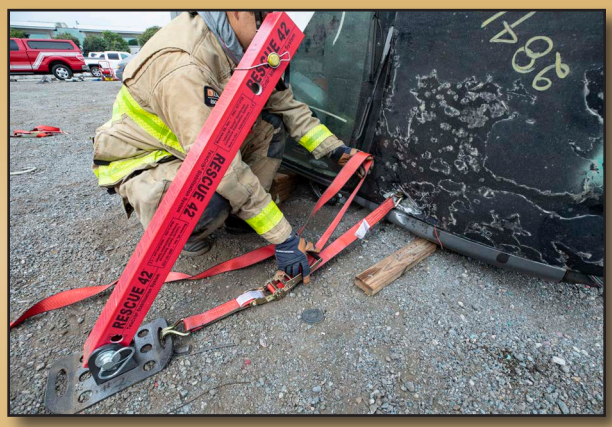


3. Apply strap from base plate to base plate and apply tension

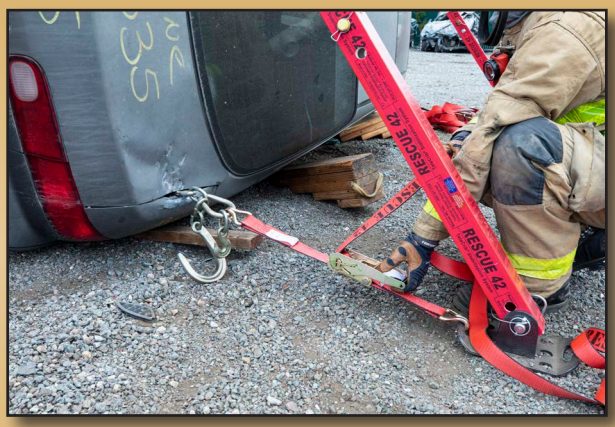
Single Strut Deployment (3 Methods)

1. Locate your insertion point

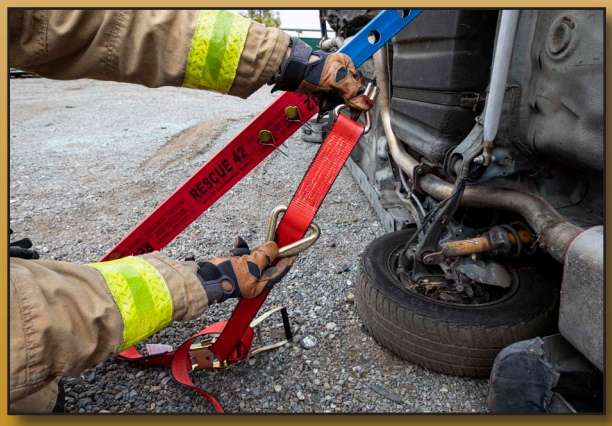
2. Place strut against the vehicle with the desired angle (45 Degrees)



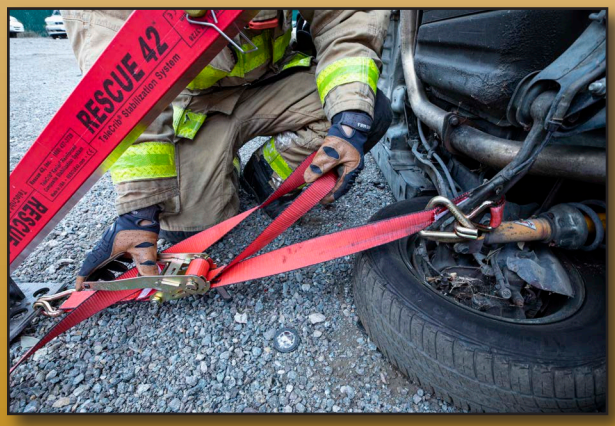
3. Option 1 (Frame) - Apply strap from base plate to vehicle and apply tension



4. Option 2 (Hook Cluster) - When attachment points are limited, apply a Hook Cluster to the vehicle and apply your strap from the base plate to the collection ring



5. Option 3 (Cinch Ring) - Run your strap through the cinch ring



6. Wrap the strap around the desired object and back to the cinch ring. Pull out slack and apply tension.

Vehicle On Its Roof

An overturned vehicle which has come to rest on its roof does not pose a risk of rolling over, more so it poses a risk for the partial or completely compromised roof structures to fail and collapse in on itself. More commonly we can expect to find the vehicle with its trunk suspended off the ground and resting on its hood and windshield pillars. A quick and effective way to provide primary stabilization is to pack cribbing in the void spaces found around the roof members.

Another complication that we can create ourselves is by the use of our rescue tools. Every cutting, spreading, or pushing operation can cause an unexpected vehicle structure to fail, causing further potential for the vehicle to collapse in on itself. This further creates an importance for tertiary stabilization measures to be established before we can progress with any of our rescue tactics.

2 - Strut Deployment

- Struts placed under the trunk or braced against the C-Post (typically the "high side" due to motor weight).
- Deploy a double ratchet strap system to connect base plate to base plate. Have the ratchet assemblies oppose one another. This system enforces stronger tension and ensures safety.

"TeleCrib Chain Saddle Technique"

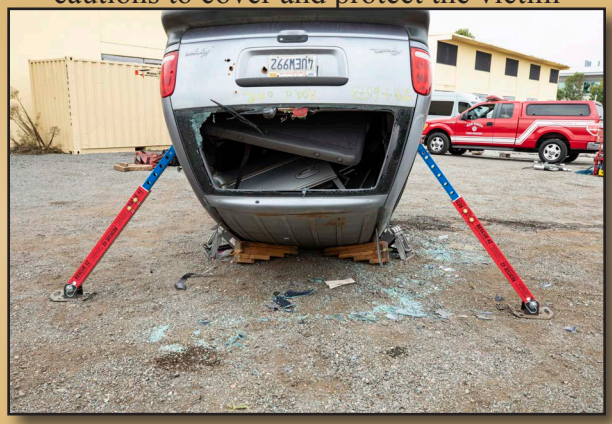
Depending on the wreck, we may not be able to find solid contact points for our strut heads to be placed against the vehicle. In these scenarios we can then incorporate a 3/8" chain to provide surface contact with the vehicle.

- Use the slots on the flat side of the Combi-Head to solidly hold a 3/8" chain link.
- To create a chain saddle, place the chain under the suspended section of the vehicle (most cases the trunk)
- Slip a link of chain into the chain slot of one strut head, keeping the chain taught, place a link of chain into the strut head on the other side
- Deploy a double ratchet strap system to connect base plate to base plate. Have the ratchet assemblies oppose one another. This system enforces stronger tension and ensures safety.
- To keep the chain from "riding up" the body, attach a ratchet strap to each side of the chain around the wheel well (or other stationary object).

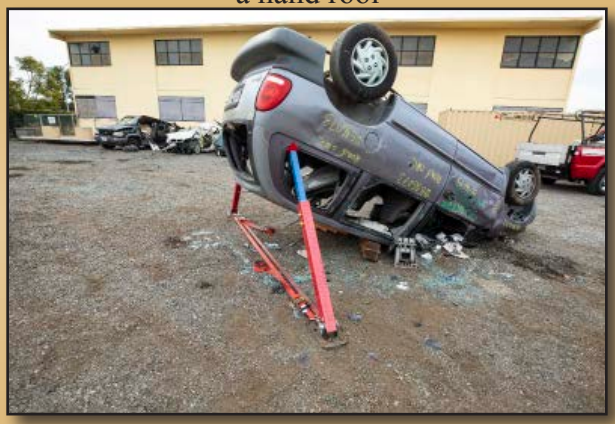
Roof Stabilization (2-Strut Deployment)

1. When taking glass near a victim, take precautions to cover and protect the victim

2. Strike the lower corner of the window with a hand rool

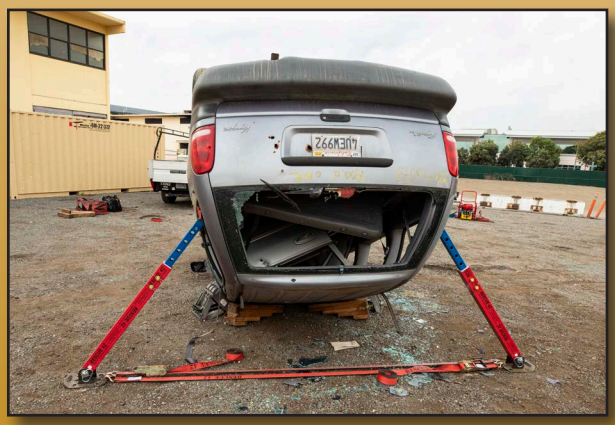


3. Strike the window and remove any remaining glass



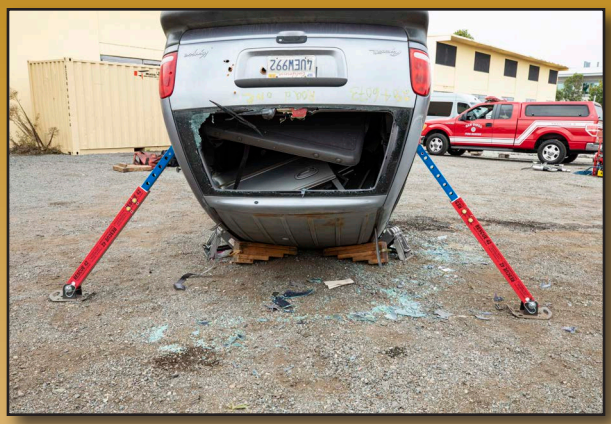
4. An alternative method is to place duct tape on the intended window

5. Strike the window at the lower corner with a hand tool

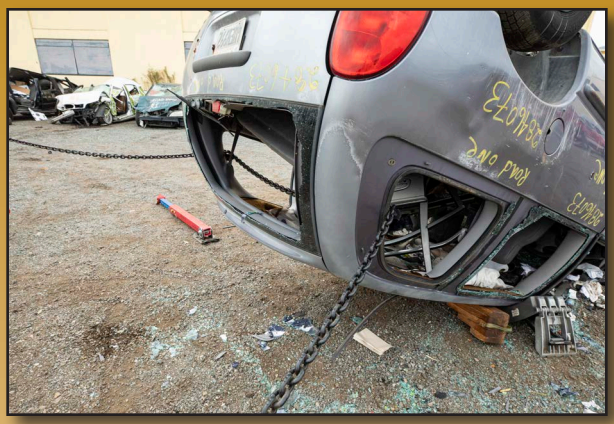


6. Glass remains intact and is peeled off the window frame

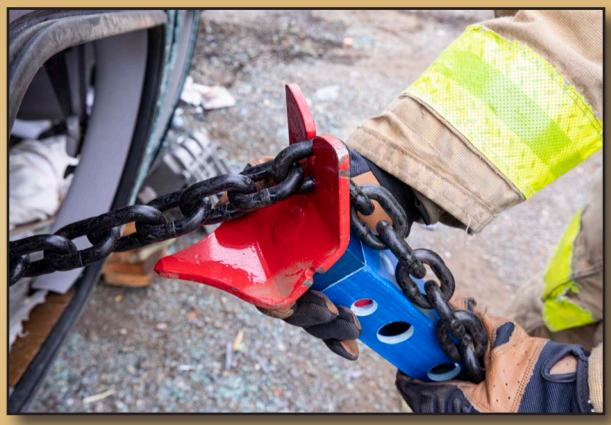
Roof Stabilization (Telecrib Chain Saddle)



1. Place two struts in alignment and opposing one another

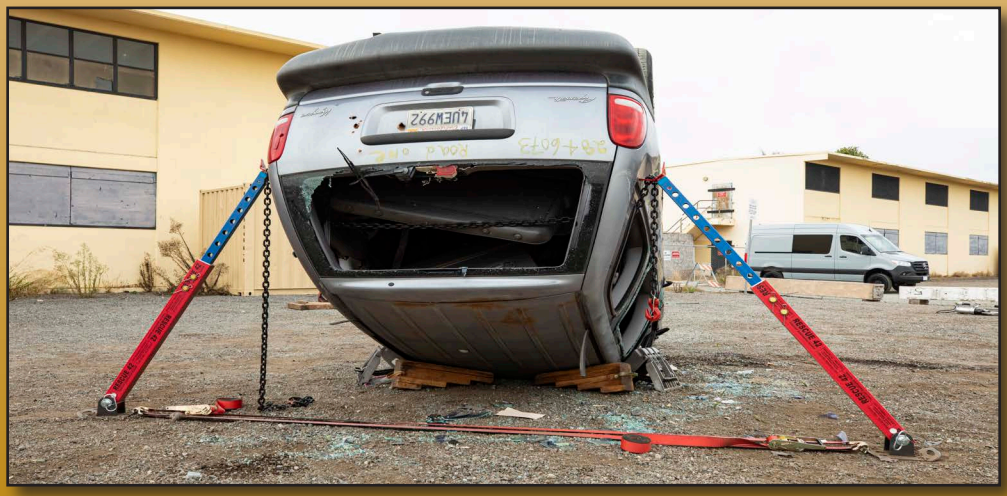


2. Run chain through or under the vehicle with the chain reaching both strut heads



3. Place the chain link into the chain slot of the combi-head with slack taken out

4. Deploy a double ratchet strap system attaching from base plate to base plate



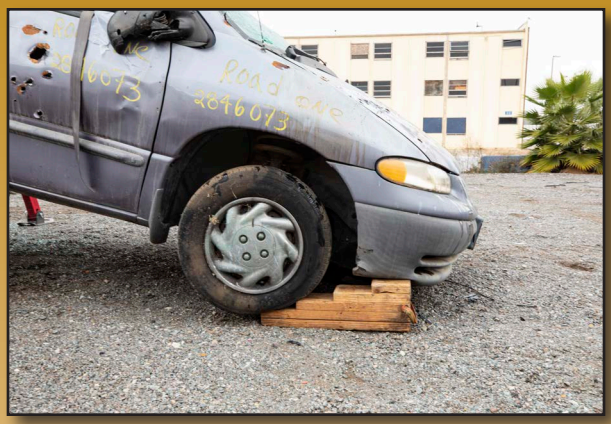
5. Tension both ratchet straps evenly to stabilize the vehicle

Lifting a Vehicle

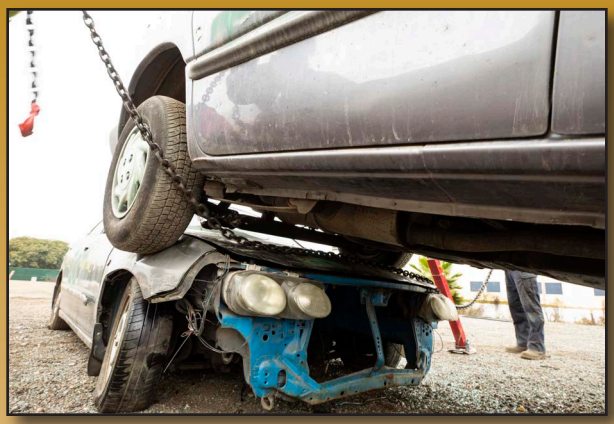
Another incident we can come across is when two vehicles collide causing one vehicle to end up on top of the other. In these situations, victims can be trapped and pinned inside the bottom vehicle. Due to the extra weight of the top vehicle, we can find extricating our victims difficult. Our objective is to physically separate the two vehicles; we can accomplish this by lifting the top vehicle while lowering the bottom vehicle closer to the ground. We do this by building a TeleCrib Chain Saddle to the top vehicle, only now when we tension our bottom straps we will continue to apply tension causing the struts to lift the top vehicle. We can then apply utility straps to both vehicles, ratcheting both suspensions and causing further separation. When lifting a vehicle it is important to have a safety officer observe for the constant need for Tertiary Stabilization. With a suspended vehicle, any cutting, spreading, or pushing operation can change our stabilization needs.

- Use the slots on the flat side of the Combi-Head to solidly hold a 3/8” chain link.
- To create a chain saddle, place the chain under the suspended section of the top vehicle
- Slip a link of chain into the chain slot of one strut head, keeping the chain taught, place a link of chain into the strut head on the other side
- Deploy a double ratchet strap system to connect base plate to base plate. Have the ratchet assemblies oppose one another. This system enforces stronger tension and ensures safety. Having two ratchet systems also allows each ratchet to share the amount of spool build up, eliminating the chance of either spool from becoming full.
- If there is a possibility for the chain to “ride up” the body, attach a ratchet strap to each side of the chain around the vehicle.
- Once the system has become established, begin your insertion point of your struts at a flatter angle than desired, apply tension to each ratchet strap evenly with a safety office observing. Tension the system until the top vehicles weight is now being supported by the Telecrib system at a 45 degree angle.
- Apply a utility strap to the top vehicle, connecting the strap from wheel rim to opposing wheel rim. Ratchet the strap to relieve the suspension causing the top vehicles wheels to elevate into its body frame.
- Apply a utility strap to the bottom vehicle, connecting the strap from wheel rim to opposing wheel rim. Ratchet the strap to relieve the suspension causing the vehicle to sink lower to the ground. You can create further separation by relieving the air in the bottom vehicles tires.

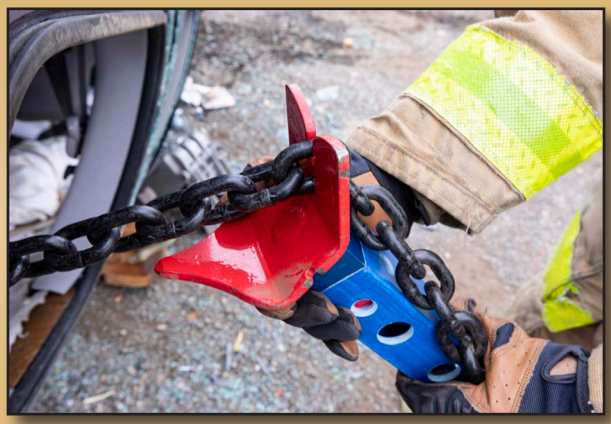
Lifting a Vehicle (Telecrib Chain Saddle)



1. Establish a form of primary stabilization



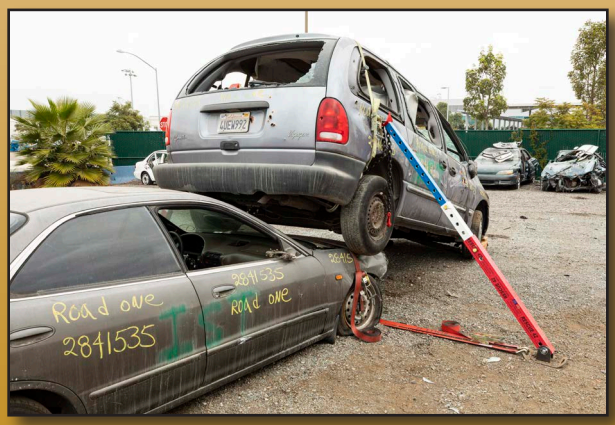
2. Chain is placed underneath the top vehicle with the chain able to reach both strut heads



3. Place the chain link into the chain slot of the combi-head with slack taken out

4. Attach a double ratchet strap system from base plate to base plate

5. Begin with a flatter strut angle. Apply tension evenly until the system supports the top vehicles weight at 45 degrees



6. Place a utility strap to the top vehicle to ratchet the suspension away

Phase IV: Securing The Vehicle

Before we can attempt any form of patient care we must also be cautious of the potential dangers we are exposing ourselves to. Vehicles today are equipped with multiple safety features that; in the right circumstances, can be dangerous to rescuers. Starting from our approach of the vehicle to our "Peel, Peak, and Mark" inspection for airbag cylinders. Firefighters must take the following into consideration when in close proximity of compromised vehicles.

Batteries

Though 12V batteries in themselves do not pose a direct threat, rescuers must be aware of their role in the accidental deployment of airbags. This is due to the pyrotechnics used for deploying air bags being electrically activated. Before we can access the interior of a vehicle, rescuers must first locate and disconnect the vehicles battery in order to make a safer working environment. We also must drain the vehicles capacitors which will hold an electrical charge even after a battery is disconnected. A safe process to locating and disconnecting the batteries goes as follows:

1. Locate the Battery - Due to the advancements in vehicle design we cannot always expect to find batteries located underneath the hood of the vehicle. Batteries can also be found in the trunk, underneath the seats, and underneath the floor boards.

2. Utilize Electrical Components - Before we disconnect the battery we should try and utilize anything electrically powered that can help us and the victim. This can be rolling down windows, pushing the steering wheel out of the way, or pushing the seats back.

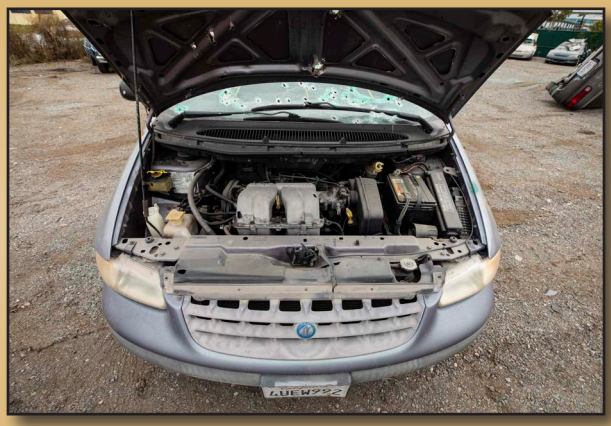
3. 4-Way Flashers - Turning on the 4-way flashers is a way for rescuers on scene to know that the capacitors have been fully drained of their residual charge. Turn on the flashers before disconnecting the battery, once the battery is disconnected and the flashers no longer flash will we know the power has been secured.

4. Disconnecting Batteries - Disconnect both cables, negative terminal first by means of a "Chunk Cut" which is two separate cuts that are 2 inches apart. This leaves a space between the two separate ends of the terminal cable, leaving no chance of the wire recontacting with one another.

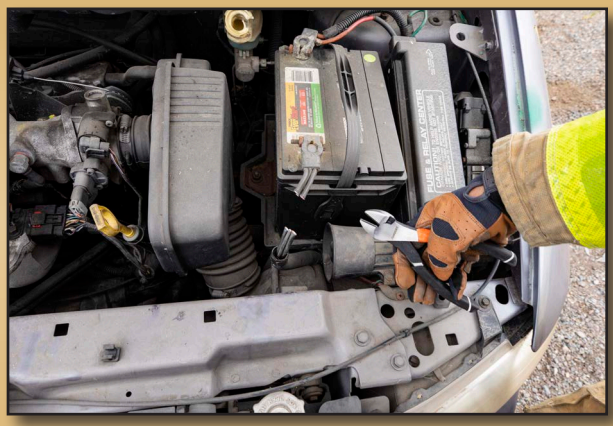
Securing the Battery

1. Utilize the vehicles electrical components as needed

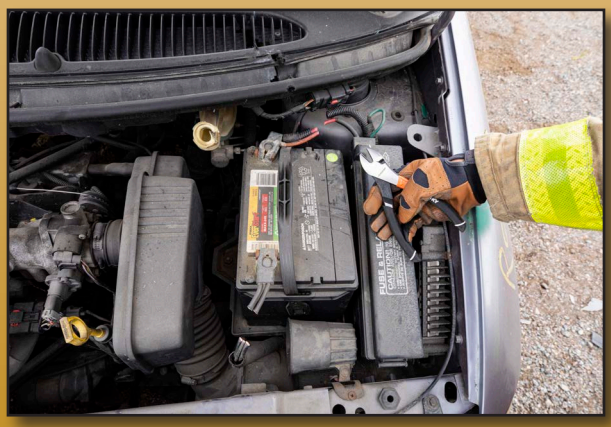
2. Turn vehicles hazard lights ON



3. Locate the vehicles battery



4. Place a chunk cut on the negative terminal first



5. Next place a chunk cut on the positive terminal

6. Confirm that the vehicles hazard lights are OFF

Airbags - Supplemental Restraint Systems (SRS)

In 1988 the first driver side air bags appeared in passenger cars. As of 2011, vehicles can now have up to 16 separate air bags. It is important to recognize vehicles equipped with Supplemental Restraint Systems and the location of each system for both the victim and rescuers safety. In newer vehicles, the words "Supplemental Inflatable Restraint," "SIR," "Air Bag," or "SRS" may be embossed in the following locations:

Figure 25-16 Airbag Deployment Zones "5-10-20" Rule

- Driver's Airbag
- Passenger Airbag
- Rear passenger airbags stored in the back of the front seats
- Side Airbag
- Knee Airbag

"5-10-20" Rule

Because we can never be fully confident that a vehicle contains airbags or that an airbag system has been deactivated, always assume that they are present. When working close to or inside of a vehicle:

Keep all equipment, rescuers, and victims a minimum distance of:

- 5 inches from the door
- 10 inches from the steering wheel
- 20 inches from the passenger side dash board

"Peel, Peek, and Mark"

Figure 25-17 Ajax "Strip and Peek" tool

There is no standard for where auto manufacturers install SRS components in vehicles. Though they're most commonly located in the posts and roof rails we can never truly know their location until we physically find them. Because of this, it is important to employ the "Peel, Peek, and Mark" method. Prior to manipulating the vehicle, firefighters should peel back the plastic and fabric interior, exposing the metal frame, helping to avoid cutting into SRS cylinders such as seatbelt pretensions and airbags. Once we have established where it is safe to cut we can then mark the locations by scoring the outward metal of the vehicle for all personnel to see. We can perform this tactic with any tool but preferably the Ajax Strip-n-Peek tool found in the Battery Pack.

Peel-Peak-Mark

1. Peel and peak the interior molding

2. Remove the interior material searching for pressurized cylinders

3. When cylinders have been located, mark the location on the exterior of the vehicle for all personnel to see

Seat Belt Pretensioners

With the increasing number of occupants colliding with airbags, seat belt pretensions were created. A pyrotechnic cylinder that when engaged, pulls the occupants back into their seats so as not to impact the airbag with such a great force. If we cut or apply enough pressure to this device it can rupture and discharge. The pretensioners can be found at the base of either front seat or in the B-Post. The solution is to remove the victim's seat belt early in the extrication and to "Peel and Peak" before manipulating the vehicle.

Struts

Figure 25-18 Hood, Trunk & Compartment Door Struts

Struts are designed to absorb shock, impact, and assist with lifting and stabilizing heavy components. Struts are typically filled with a compressed gas or liquid. They are most commonly found under the hood, trunk, bumpers, and on hatches or compartment doors. The biggest safety concern with struts is that they are under pressure by design; cutting one may cause a deadly projectile or explosion. They can be under extreme pressure after a vehicle accident as well. When impinged by fire, struts can heat up to the point where they can no longer contain the pressures inside, exploding or propelling themselves great distances.

Passive Roller Systems

Some convertible vehicles are equipped with hidden roll bars. These roll bars will deploy in a fraction of a second when the vehicle senses a roll over. Most bars will either shoot straight out or will hinge up. This is another safety feature to identify and avoid when performing extrication on convertibles.

Phase V: Vehicle Extrication

In general, access to the interior of the vehicle should be considered in the following order:

1. Through the doors.
2. Through the windows.
3. Through the body of the vehicle.

Opening/Removing Doors

The most common obstacle preventing a victim from self extrication is a damaged door that cannot open. In most accidents the vehicles doors will be severely damaged, when we approach the vehicle our first option should be to check the surrounding uninvolved doors and "try before we pry." If unsuccessful we can attempt to pry the jammed doors with what ever tools we first have available. Commonly this can be a hand tool such as a halligan or a hydraulic tool.

Figure 25-19 Creating a purchase point with a Haligan Bar

There are two mechanisms that hold a door intact with its vehicles body, the hinges and its locking mechanism (Nader Pin.) With no option being better than the other, an easy solution is to choose the mechanism that has already been exposed by the wreckage of the accident. When neither options have been exposed we can then use the following techniques to create our own purchase point.

Vertical lift

To create a purchase point the vertical lift technique can be used. Insert the tips of the spreaders between the top and bottom of the window frame, closest to the door handle to expose the Nader pin. Before spreading we must hold our tool with a slight downward angle. With this angle, the spreaders tips will push the bottom window frame down and outwards away from the vehicle. Continue spreading until the throw of the spreader tool is fully extended, by doing so it will create a larger purchase point or can open the door in one single move.

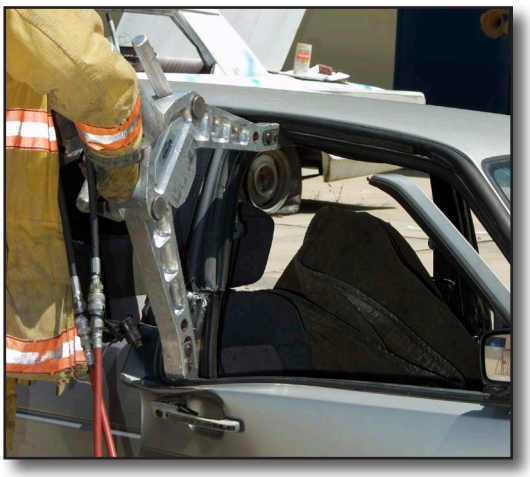
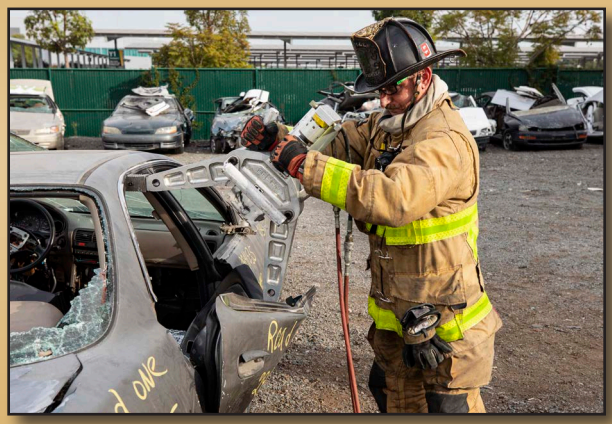


Figure 25-20 Creating a Purchase Point Using the Vertical Lift Method

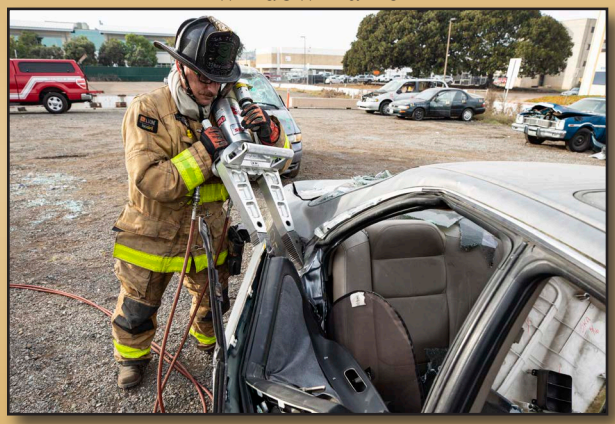
Door Removal - Vertical Lift Technique

1. Place the spreader tool in the window frame closest to the door handle with the tool at a downward angle

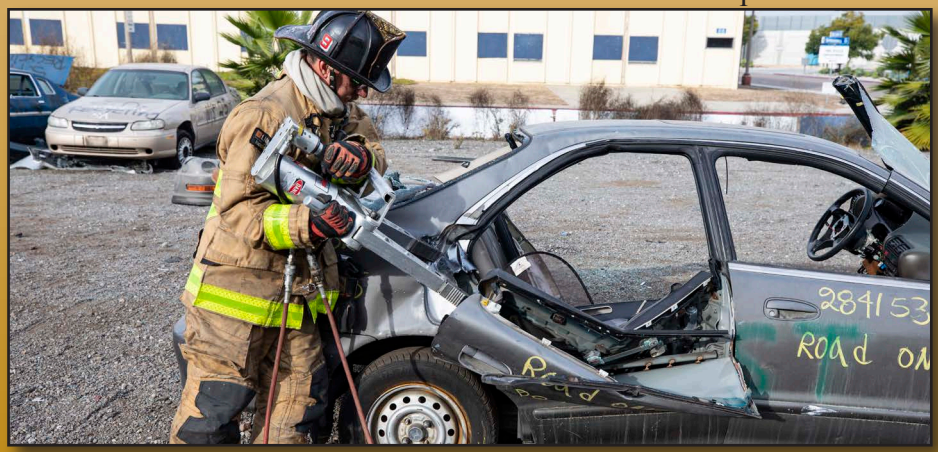
2. With the top spreader tip in contact with the top window frame begin spreading until the bottom spreader tip contacts the bottom window frame



3. Spread the bottom window frame out and away with the maximum spreading distance



4. Place the spread tool in the created purchase point as close to the locking mechanism as possible



5. Spread the door out and away until the lock has been defeated

Fender Crush

The fender crush can be utilized to create a purchase point when attacking the hinges of the front doors. Using the spreaders, pinch the area on the front quarter panel, closest position next to the door hinges. This crushing movement will create a purchase point around the upper door hinge.

Complete Door Removal

Oftentimes complete removal of the door may be necessary. By removing the door completely you will have more room to work and be able to better stabilize and remove your victim. In many cases it is also quicker to remove the door than to force the door out of the way. The hinges can be forced with our spreaders/cutters depending on accessibility. A second rescuer should hold onto the door or attach webbing to prevent any potential injury when the hinges break.

Door Removal - Fender Crush Technique

1. Place the spreader tool on the fender rail closest to the door hinges

2. Clamp down the spreader tool to open up a purchase point at the door hinges

3. Place the spreader tips in the newly created space and spread open enough space for your cutting tools

4. Place your cutter tool in the newly created space and cut both door hinges

5. Door is taken off for a complete door removal

"B" Post Blowout

When there is a need for additional working space or a wider access, we can perform a "B" post blowout. This technique will allow the entire side of the vehicle to be accessible.

Method 1:

1. After the front and rear doors and roof have been removed, simply cut the base of the "B" post to remove it.

Method 2:

This method is useful if you can anticipate the need for removing the "B" post from the beginning of your extrication. This method can save you time by not having to remove the front door first.

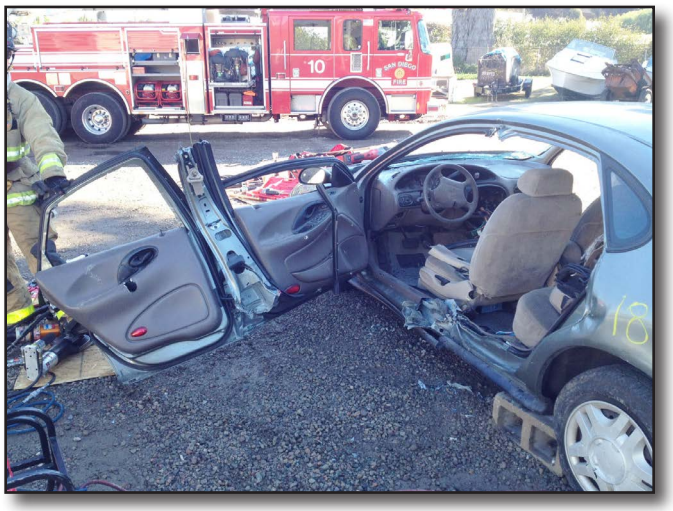


Figure 25-21 "B" Post Blow-Out (method 2)

1. Open the rear door or remove it with the spreaders if necessary.
2. Cut the "B" post low with the front door still attached and closed.
3. Place the spreaders in this relief cut and spread the post up and away from the rocker panel.
4. Cut the "B" post as high as possible. This will now allow you to open the entire side of the car ("B" post, front door, and possibly the rear door) hinging on the front doors hinges.
5. Lean into the door or use a piece of webbing attached to the door to pull it forward.
6. If more space is needed remove the front door hinges as well.

B Post Blowout (Option 1)

1. Begin by removing either of the vehicles doors

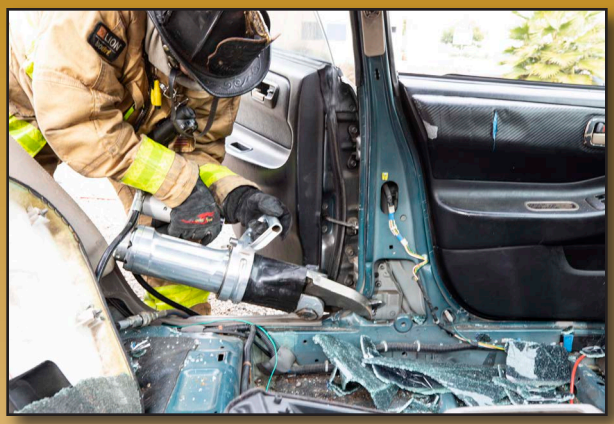
2. Remove the other existing door

3. After the B-Post is openly exposed, cut the post at the top and bottom

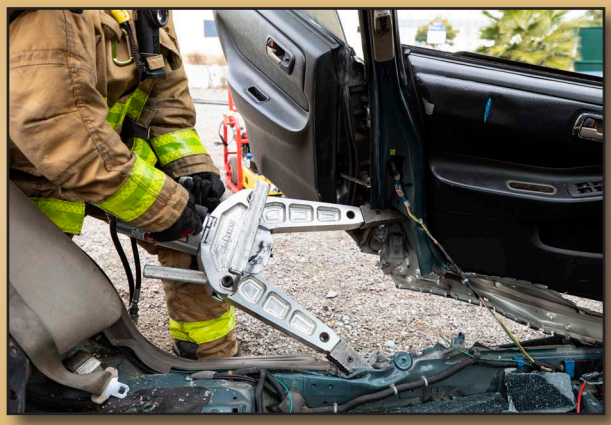
4. With the B-Post now removed, a complete side wall removal is completed

B Post Blowout (Option 2)

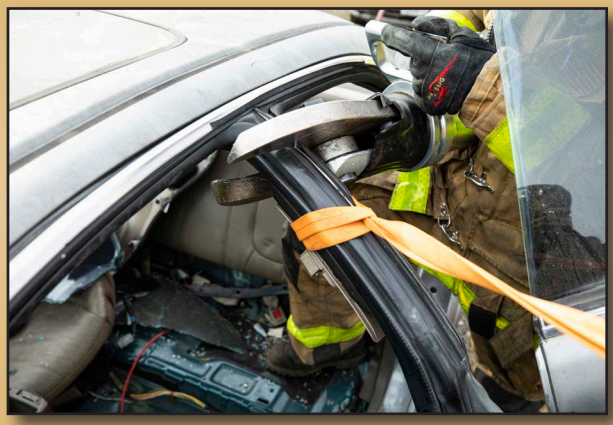
1. Spread open the rear door



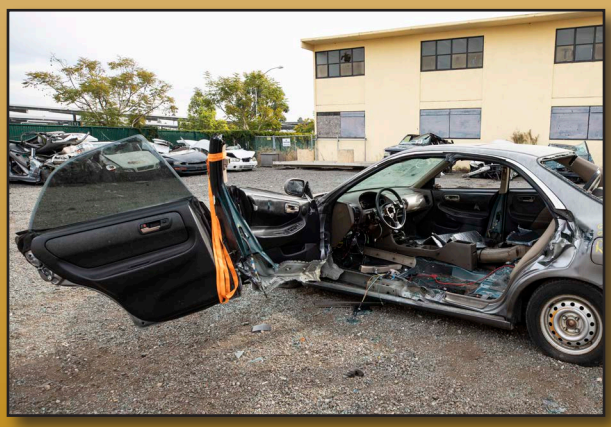
2. Cut a relief cut into the bottom B-Post as deep as possible



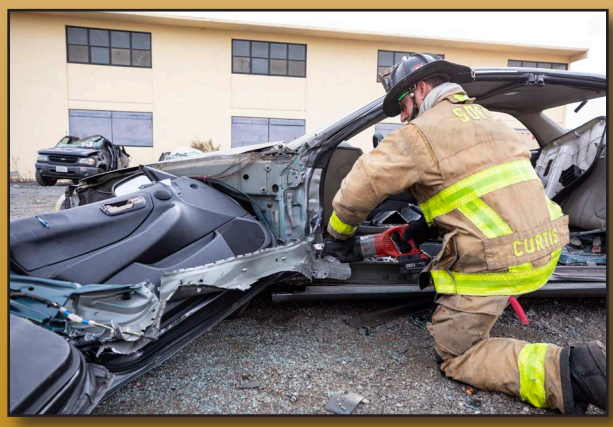
3. Place the spreader tips into the relief cut, spreading out and away from the rocker panel



4. Cut the top B-Post as high as possible



5. Have the entire side wall compartment pulled away from the vehicle



6. If necessary, cut the front door hinges for a complete removal

3rd Door Conversion

In a two door vehicle, if there is a need to access the rear seat from the side of the vehicle you can perform a "3rd door conversion." Cut the "B" post as high as possible, place a horizontal relief cut low on the "B" post at the rocker panel. Next place a vertical relief cut next to the "C" post. You have two options to open this third door. One means is to pinch the material between these cuts and use the leverage to pry the material down opening a 3rd door and access to the rear seats. The alternative is to place the spreaders in the lower "B" post cut and spread the door away and out.

Window/Glass Removal

In most accident situations entry through a window can generally be made quickly and with little difficulty, especially if the windows have been broken at the time of impact. If possible, avoid breaking or cutting glass to reduce the amount of glass dust. If glass must be broken or cut, rescuers should ensure that victims are adequately protected and are provided respiratory protection from the glass dust. Whenever possible, break the window farthest from the victim. Two kinds of glass are used in motor vehicle windows: Tempered and Laminated glass. Each one having a different characteristic that can influence how they are removed.

"Tempered Glass"

Plate glass subjected to a special hardening process is called Tempered glass. Tempered glass is designed to be impact resistant and to shatter into small pieces when it fails. Tempered glass is commonly used for the side windows and rear windshield of passenger cars. When breaking tempered glass, use a window punch or hand tool to strike the lower window corner closest to the body. If time permits, prior to breaking the window, cover the glass with duct tape, allowing the window and duct tape to be removed in one piece.

"Laminated Glass"

Laminated glass is composed of two sheets of glass bonded to a sheet of transparent plastic at high temperature and pressure. Laminated glass is most commonly located in the front windshields and is now mandated to be in all passenger side windows beginning in 2018. Before attempting to cut the windshield, rescuers should ensure that both the victims and themselves are adequately protected from glass dust.

Removing a Windshield using a Hand Tool

1. Using a hand tool, begin your windshield removal at the top midpoint of the windshield. Use a chopping technique which is efficient for glass removal and limiting glass dust. Use respiratory protection for yourself and the victim.

2. Continue your cuts across the windshield until you reach the A-Post. Repeat this on the opposite side to complete your cut from A-Post to A-Post.

3. The roof removal operation will cut the A-Posts and complete the windshield removal.

Removing a Windshield using a Sawzall

A sawzall can be used to remove a windshield quickly. Start by making a hole on the edge of the top windshield with a hand tool. Insert the saw blade and work your way from one A-Post to another. Use respiratory protection for yourself and the victim as this method creates more glass dust than using a hand tool.

Removing Tempered Glass

1. When taking glass near a victim, take precautions to cover and protect the victim

2. Strike the lower corner of the window with a hand rool

3. Strike the window and remove any remaining glass

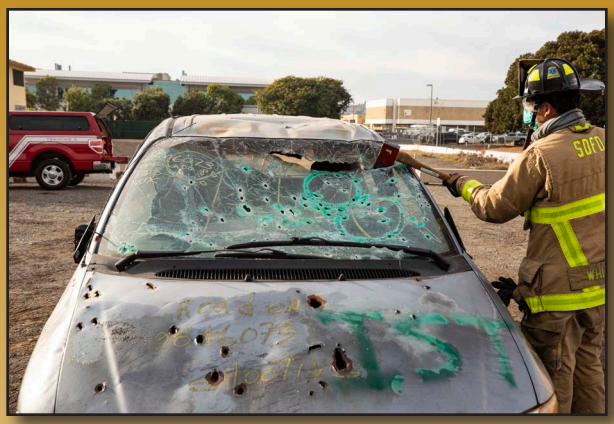
4. An alternative method is to place duct tape on the intended window

5. Strike the window at the lower corner with a hand tool

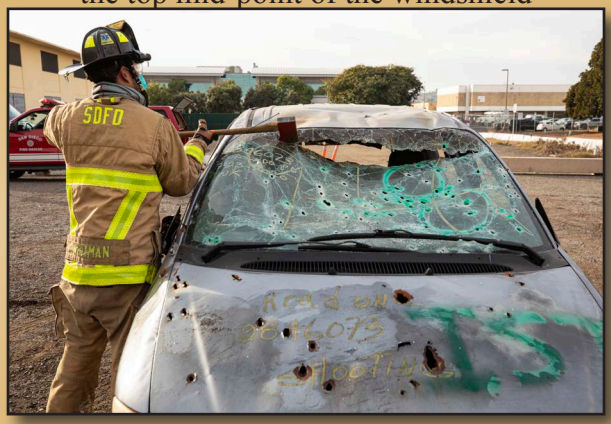
6. Glass remains intact and is peeled off the window frame

Laminate Glass Removal

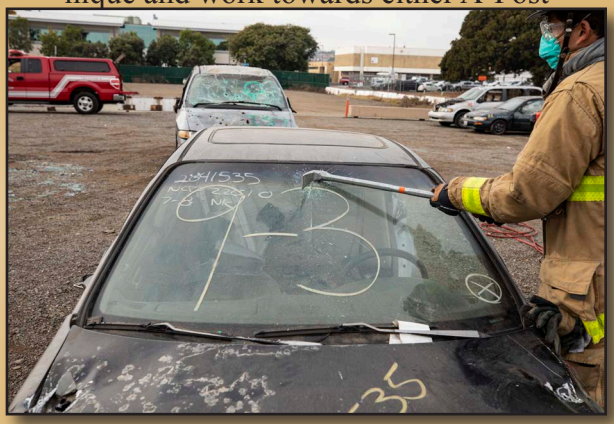
1. With a hand tool, create a purchase point at the top mid-point of the windshield



2. To reduce glass dust, use a chopping technique and work towards either A-Post



3. Work towards the opposite A-Post to complete the cut



4. With a hand tool, create a purchase point at the top mid-point of the windshield

5. Place the Sawzall blade into the purchase point and cut towards and through the A-Post

6. Repeat towards the opposite side to complete the cut

Dash Displacement

Due to the generated force from a front end collision, the dash column can be moved from its original location, landing on top of the occupants. In order to remove the dash off of the occupants we must accomplish two objectives: isolate the dash column and establish a strong base to place our rescue tools.

Displacing a dash can be difficult due to the dashboard physically being attached to its surrounding vehicle components; creating additional strength that reinforces the dashboards position. To overcome this we must strategically place relief cuts to separate and isolate the dashboard. By doing so we can lift or roll the dashboard without the vehicles structures impeding displacement.

In order to successfully displace the dashboard we must place the base of our spreading/pushing tools against structurally sound push points. Without a strong base for our rescue tools, the hydraulic force will cause our tools to slip from their position or cause the base for our tools to fail.

"Dash Size Up"

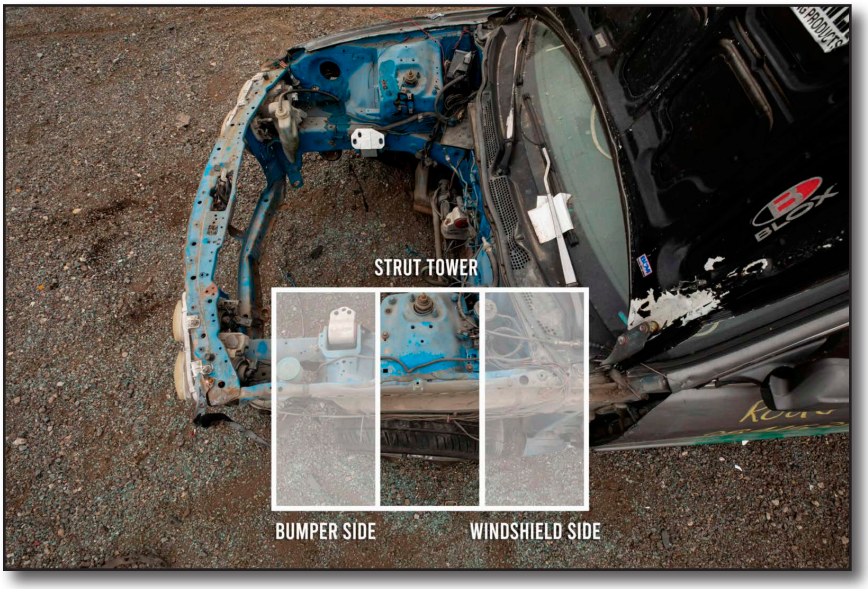


Figure 25-22 Dash Size-up

Choosing whether to perform a Dash Lift vs a Dash Push may be decided based off of the vehicles structural anatomy after its impact. We can do this by means of a dash size up. The first step in our size up is to assess the structural integrity of the Upper Rail which is located underneath the plastic covering of the Fender Rail. Due to the front end impact, the upper rail might already be severely compromised, eliminating the need for a relief cut. However, if the upper rail still has a strong structure we must make a relief cut.

Once we determine that a relief cut is needed we need to assess whether we can make a relief cut that can separate the upper rail from the lower rail. The upper rails purpose is to solely act as a crumple zone where the lower rail is responsible for holding the vehicles engine and suspension components. What connects these two structures together is the strut tower. The objective is to place our relief cut on the upper rail between the strut tower and front windshield. By doing so, we separate the strut tower and lower rail from the upper rail. Now when a dash lift is performed our tools will not have to lift against the engine and suspension.

However, if the strut tower and windshield are smashed closely together leaving no room between the two, we will have to make a relief cut on the bumper side of

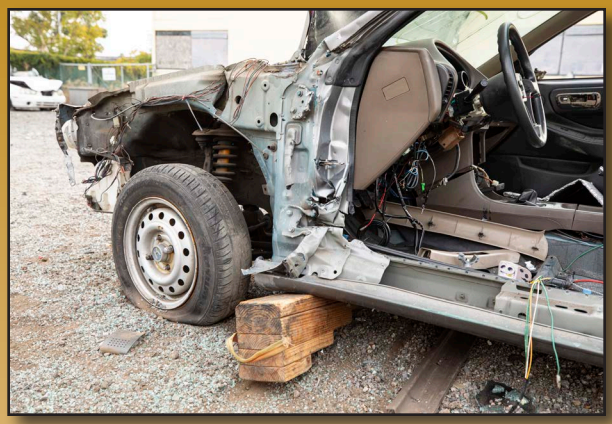
the strut tower. Due to the vehicles suspension and engine still being connected to the upper rail, the vehicle will be a poor candidate for a lifting procedure and better suited for a Dash Push.

"Dash Lift/Dash Jack"

Performing a Dash Lift is when the hydraulic spreaders are used to lift the dash off of a victim. This method is commonly preferred over the "Dash Push" due to the position of our spreaders being placed out of the way from patient access. It is also common practice for our spreader and cutter tool to occupy both hydraulic lines in an incident, this method eliminates the need for removing one of the tools to attach the extension ram.

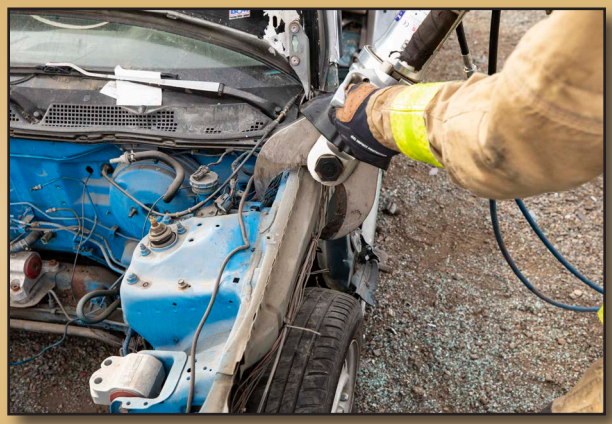
1. If the roof has not been removed, place a relief cut on the top A-Post. Leaving enough material on your A-Post incase the need for a Dash Push.
2. With the front door removed, place two relief cuts to the kicker panel, placing them in line with the door hinges. Placing our cuts as deep as possible into the fire wall.
3. Pinch between both relief cuts with the spreader tool and bend the material back.
4. Place a relief cut in the upper rail, preferably on the windshield side of the strut tower. If the upper rail has not been exposed by the wreck, spread the fender rail covering off to expose the upper rail. Another option is to use the sawzall.
5. Place cribbing under the A-Post, securing a stable platform to lift off of.
6. Place the spreaders in between both relief cuts in the kicker panel and open slowly.

Dash Lift

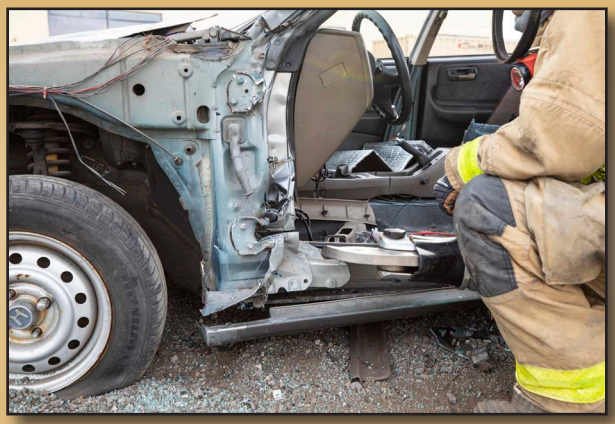


1. Crib and support underneath the A-Post

2. Make a relief cut towards the top A-Post

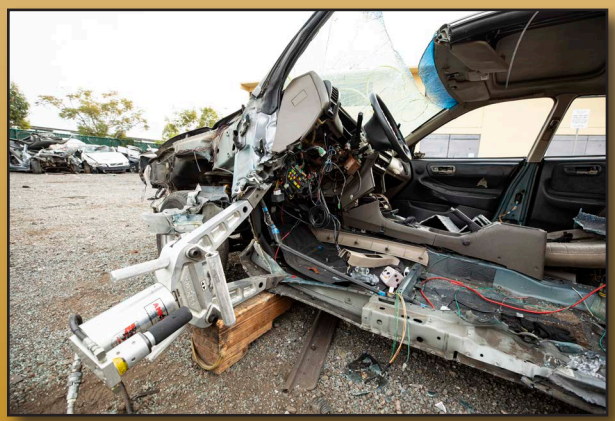


3. Make a relief cut in the fender rail as close to the windshield as possible



4. Place two relief cuts in the kicker panel at the heighth of the door hinges

5. With the spreaders, pinch the metal material between the two relief cuts and bend it outwards. Next, place the spread tool in the created space at a slight downward angle



6. Spread the dash column up and away from the rocker panel

Spreader Tool Angle

When placing our spreader tool, we must insert the spreader at a slight downward angle. This is due to how a spreader tool opens, which is in an arched shape. If we insert the tool parallel to the ground its top spreader tip will come in contact with the kicker panel at an angle, causing its material to bend out and away from the vehicle. This can cause the material to be compromised and no longer viable. By approaching at a downward angle the top spreader tip will extend up in line with the dash column to lift vertically.

"Pushing / Rolling the Dash"

When a victim has become entangled in the dash and/or the steering wheel, it may become necessary to push or "roll" the dash off the victim. The dash push is when the base hydraulic ram is placed on the bottom B-Post and extended to contact the bottom A-Post. If the A-Post has been compromised, another option to push is the Transverse beam.

1. If the roof has not been removed, place a relief cut on the top A-Post. Leaving enough material to push with.
2. Make a relief cut in the kicker panel in line with the door hinges, cut as deep into the fire wall as possible.
3. Place a relief cut in the upper rail. If the upper rail has not been exposed by the wreck, we can remove the fender rail covering by either a spreader or sawzall.
4. Place cribbing under the base of the B-Post securing a stable platform to push off of.
5. Place the bottom end of the ram into the lower rear corner of the B-Post.
6. Extend the ram until the piston pushes against the bottom A-Post, extend slowly.
7. As the dash is being pushed, we can place cribbing in the area of spread to act as a gainsaver.

Locating the Transverse Beam

Transverse beams were widely incorporated in vehicles dashboards after 2011 so they might not be present. However, when attempting to locate it we can look on both sides of the dash column to locate the two attachment bolts which hold the Transverse beam in place.

Figure 25-23 Locating the Transverse Beam

Removing the Roof

When extra working space is needed, it may be necessary to completely remove the roof of the vehicle. A roof can be removed using the hydraulic cutters or a sawzall. To prepare for roof removal:

1. Remove all glass, peel and peek all areas where a cut may be desired.
2. Cut all seat belts so that when all posts are cut the roof will be free and can be removed.
3. If starting at the front of the vehicle cut both the A-Posts first, then work towards the rear posts.
4. Anticipate the need for a dash push, leaving enough of the lower A-Post to push off of.
5. Have other firefighters stationed around the car to support the roof as the posts are being cut.
6. After all the posts are cut, lift the roof off the car.

Vehicle on its Side

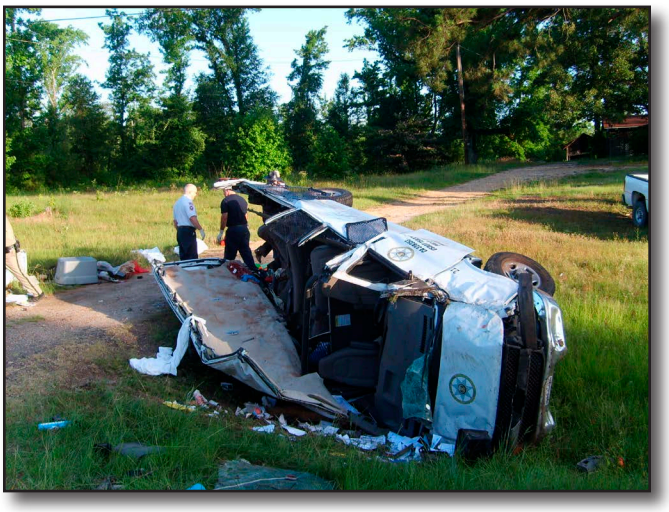


Figure 25-24 Vehicle on its Side

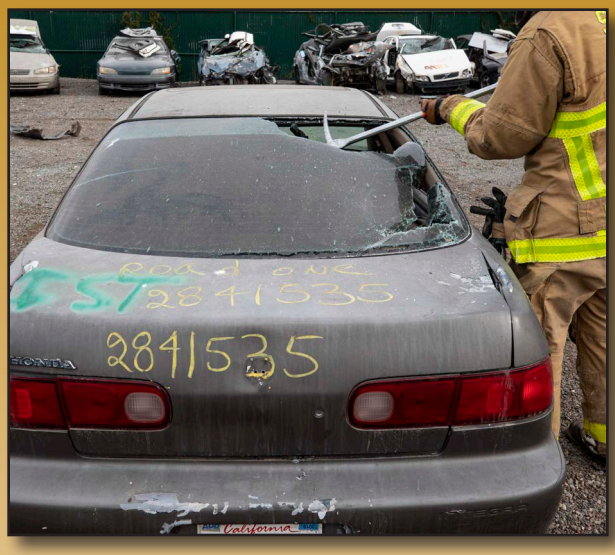
If the vehicle is on its side, access may be made through the roof. Roofing sheet metal is fairly weak and can be opened with the Sawzall or Hydraulic Cutters. The posts on the high side can be cut and the roof may be folded down, or all posts can be cut and the roof can be completely removed. After the roof has been removed, rescuers must use caution and cover the freshly cut metal, as the edges can be sharp.

Using the reciprocating saw or hydraulic cutters

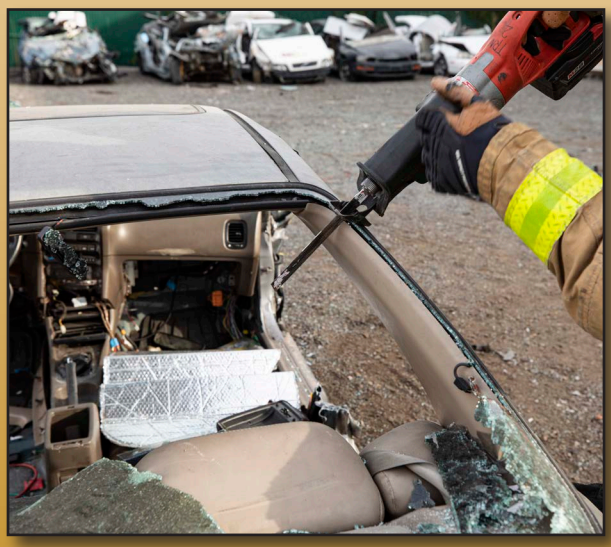
The posts on the high side can be cut and the roof may be folded down, or all posts can be cut and the roof can be completely removed, using either the reciprocating saw, the hydraulic cutters, or both. Rescuers must use caution when working around the freshly cut metal, as the edges are very sharp. A debris carrier can be laid over the sharp edges, a traffic cone may be placed over cut posts, or duck tape may be used to pad the hazards.

Roof Removal

1. Remove the front windshields connection to the vehicles roof



2. Remove the rear windshields connection to the vehicles roof



3. Cut all surrounding posts using either a sawzall or hydraulic cutter

4. With enough personnel; lift and remove the roof off of the vehicle

Removal/Pulling of a Steering Wheel

Often in vehicle rescues, the victim is found to be pinned behind the steering wheel. In these situations, rescuers need to evaluate whether a victim may be extricated by simply pulling or removing the steering wheel. Prior to pulling or removing a steering wheel, you must consider if enough space will be provided by simply pulling the steering wheel away from the victim and what is the potential for failure. Caution must be used in vehicles which have adjustable steering columns and U-joints in-line with the steering column. When pulling this type of steering wheel, you must be aware of the potential that the joint may break under stress and strike back on the victim sitting in the driver's seat. To prevent this kick-back effect, wrap the chains as low as possible on the steering column.

Figure 25-26 Cutting Steering Wheel

Hydraulic spreaders or rams, come-a-longs, the high-lift jack, or the scissor jack, can all be used to pull the steering wheel clear of a victim. Regardless of the equipment or tools you have available to you, the basic principle behind pulling a steering wheel remains the same:

Figure 25-25 Complete Steering Wheel Removal

1. Start by removing the windshield or make a hole in the windshield to pass the chains through

2. Wrap one set of chains 3 times around the steering column.

3. Wrap the second set of chains 3 times around the front bumper or some other structural member under the front of the vehicle (frame, front axle etc.)

4. Placethe tool over the hood between the two lengths of chain and attached to both ends.

5. Depending on the tool, either push, pull, or squeeze to initiate movement of the steering column.

6. A piece of 4"x 4" cribbing can be placed against the dashboard and hood to prevent the chain from cutting into and binding

Cutting a Steering Wheel

A hacksaw, reciprocating saw, or bolt cutter can be used to cut the steering wheel ring on both sides of the "T" bar to gain more room. Another technique is to cut the neck of the steering wheel off, completely severing the steering wheel form the steering column. Only use this technique if you are confident the air bag system has been deactivated.

Miscellaneous Extrication Information

Lifting Vehicles

Occasionally, rescuers will encounter victims trapped beneath a vehicle . In this situation, the vehicle should not be moved, but stabilized in place. Before a lifting operation can begin, crib beds must be assembled to prevent the vehicle from further trapping or crushing the victim.

Once the load or vehicle has been supported by a crib bed, the load can be lifted or raised to free the victim. There are several methods and tools that can be used to lift a vehicle, such as the hydraulic spreader, air bags or standard car jack. In any case, a solid point on the vehicle must be identified to use as the lifting point, such as the frame or rocker panel.

Cribbing

Cribbing is used to construct crib beds, which provide a protected area for the victim underneath a vehicle or heavy object . Crib beds expand or grow taller as the object or vehicle is raised, thereby increasing the protected area for the victim. The crib beds also create a "gain saving" mechanism should the load slip or fall while being raised.

There are several different types of crib bed configurations used in the fire service:

- 2 x 2 Crib Bed - Standard crib bed configuration
- 3 x 3 Crib Bed - Used in place of the 2 x 2 crib bed when a higher load capacity is needed.
- Solid Crib Bed - Used to crib on soft surfaces such as dirt or asphalt or to support an airbag during lifting procedures
- Triangle Crib Bed (less stable) - Used to crib in a narrow or tight space.
- Parallelogram Crib Bed (less stable) - Used to crib in a narrow or tight space.
- Sloped Surface Crib Bed - Used when the load that needs to be supported has a sloped surface or is not parallel to the ground

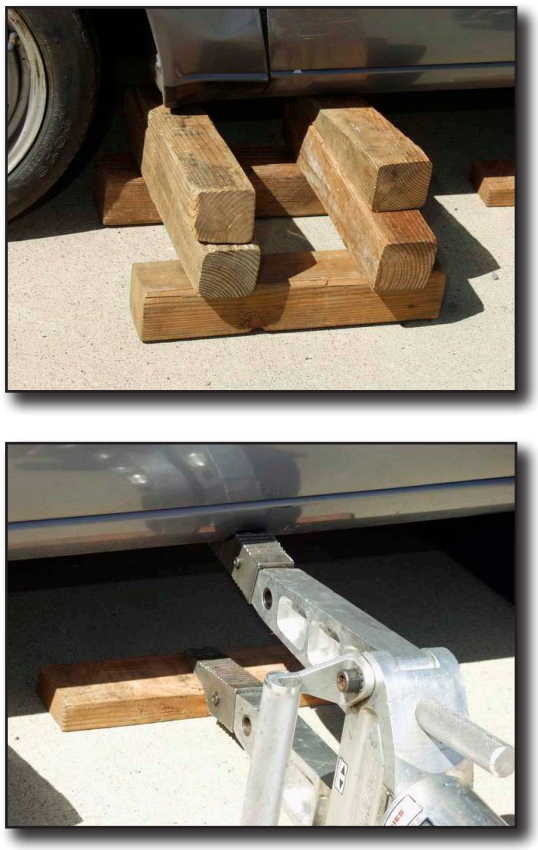
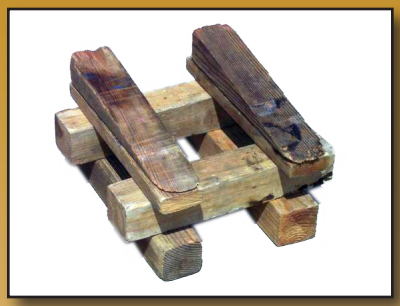


Figure 25-27 2 x 2 Crib Bed (top) and Lifting with the Amkus Spreaders (bottom)

Cribbing Capacities & Layouts



2 x 2 Crib Bed
(Max 3:1 Height to Width)

3 x 3 Crib Bed
(Max 3:1 Height to Width)

Solid Crib Bed
(Max 3:1 Height to Width)

Parrallelogram Crib Bed
(Max 1:1 Height to Width)

Triangle Crib Bed
(Max 1:1 Height to Width)

Sloped Surface Crib Bed

- 4” x 4” dimensional cribbing has a load capacity of 6000 lbs at each load point
- 6” x 6” dimensional cribbing has a load capacity of 15,000 lbs at each load point
- Crib height is based on the number of contact points of the crib bed
  - 4 contact points = 3 times the width of the crib base or 3:1
  - 2 contact points = 1.5 times the width of the crib base or 1.5 : 1
  - 1 contact points = 1 times the width of the crib base or 1:1
- Cribbing corners or load points should overlap by 4” to assure a slow crush type failure
- Bottom layer of crib should be solid when used on soil or asphalt paving to spread the load evenly

Standard dimension cribbing is 4" x 4" x 18". 6" x 6" cribbing may be found on Heavy Rescue and USAR. 4" x 4" wood cribbing can support 6000 lbs of weight at each crossing. Therefore, a standard 2 x 2 crib bed supporting a load equally on all four load points can support up to 24,000 lbs (12 tons). A crib bed becomes more unstable the taller it is. For this reason, square crib beds are limited in height to three times the width of the crib base. Additionally, a properly constructed crib bed should have overlapping corners by 4 inches.

Lifting a Load - Hydraulic Spreaders

To lift a vehicle with the hydraulic spreaders , place a piece of cribbing on the ground directly below the lift point. Turn the spreaders vertically, and open the tool so that one tip is in contact with the cribbing on the ground and the other tip is contacting the lift point. Slowly begin lifting the vehicle, allowing time for the person building the crib bed to shore as you go. As a general rule of thumb, you should lift an inch, then crib an inch so as to never leave more than one inch of space between the object and the crib.bed Once the desired height is achieved, the crib bed must be "stuck," meaning a wedge placed between the load and the crib bed to assure maximum stabilization.

Lifting a Load - Air bags

Air bags can be used to lift a vehicle or heavy object in a combination of ways: single bag lift, stacked two bag lift, or side-by-side two bag lift.

Single Bag Lift

1. Center bag under object to be lifted.
2. Ensure that there are no sharp edges contacting bag.
3. Inflate bag slowly checking for possible load shift.
4. Always crib as object is being raised. (Rule of thumb: Lift and inch, crib an inch.)

Stacked Two Bag Lift

1. The larger bag is always on the bottom.
2. Stacked bags must be centered one on top of the other directly under object to be moved.
3. Air hoses should be connected to the bags so that the connection points are facing different directions. This prevents air hoses from getting tangled and confusing supply lines.
4. Ensure that there are no sharp edges contacting bag.
5. Inflate one bag at a time as follows:
6. Partially inflate bottom bag first.
7. Then partially inflate top bag.

8. Continue this sequence until desired height or safe maximum inflation is achieved.

9. Always crib as object is being raised.

Figure 25-28 Side-By-Side Two Bag Lift

Side-By-Side Two Bag Lift

1. Ensure that there are no sharp edges contacting bag.

2. Inflate one bag at a time as follows:

2.1. Partially inflate one bag.

2.2. Partially inflate second bag.

2.3. Continue this sequence until desired height or safe maximum inflation is achieved.

3. Always add cribbing as object is being raised.

Airbag Safety Considerations

- All personnel involved in the rescue must wear full protective clothing.
- All non-essential personnel must be kept clear of the operating area.
- A minimum of three rescuers are required to conduct an airbag operation
  - Safety Observer/Leader
  - Airbag Operator
  - Cribber
- Before raising an object, careful evaluation should be made to predetermine the desired height or load movement. This allows rescuers to obtain, in advance, all the necessary cribbing before committing the bags.
- Always crib and secure the load as it is being lifted. Never let more than an inch of space exist between the top of the crib and the object. "Lift an inch, crib an inch"
- Never work under a load that is supported only by air bags.
- Personnel should work in a squatting position on the balls of their feet to enable a quick escape, never sitting down.
- Do not reach under the object or vehicle during lifting operation. If necessary, use cribbing as an extension of your hands.
- Never inflate the air bags against sharp objects or on a surface in excess of 220°F. When necessary, protect the surface of the bag from damage by using cribbing or protective materials.
- Use cribbing large enough to assume the load.
- Make sure all valves are in a closed position before turning on the air source. This will reduce the risk of an uncontrolled lift.
- Ensure that the load is spread over the airbag and that potential for the air-

bag to wrap around the object is minimized. Plywood or cribbing can be used to spread the weight of the load.

- Always open high pressure air bottles slowly.
- Always inflate under load. Do not overinflate.
- Uneven surfaces should always be cribbed until parallel.
- Always crib up to the surface until you can just get the bag in, so as to retain the maximum lift of the bag. When shoring using box cribbing, make sure the bag is placed on solid crib bed. Do not leave a hollow center as any movement of the load may cause the cribbing to shift and collapse.
- Always inflate bags slowly to minimize the chance of load shifting.

Figure 25-29 Solid Crib Bed for Achieving Maximum Airbag Lift

Large Vehicle Incidents

It is not uncommon to have a vehicle extrication involving large vehicles (tractor trailers) and passenger vehicles. As with every vehicle accident the priorities are size-up, hazard control, stabilization, and rescue. If the tractor trailer is on top of the passenger vehicle the most important concern is the potential of further collapse and entrapment. It is imperative to prevent any further movement through the use of cribbing or tension buttresses (Rescue 42 Struts) to assist with stabilization. Stabilization of both vehicles is paramount.

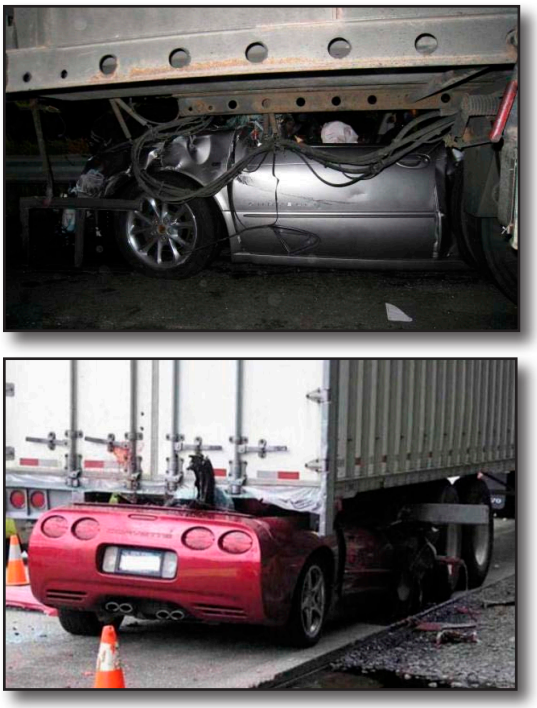


Figure 25-30 Rescues Involving Tractor Trailers

Engine and Truck company level operations can make an attempt at squeezing the suspension of the smaller vehicle with ratchet straps and removing tire air to gain space for extrication to be performed. Air bags or rams can be used to raise the tractor trailer as well. Rescue operations should then be performed using the described door/roof removal and dash roll techniques.

Alternative Fuel Vehicles

An alternative fuel vehicle is a vehicle that runs on a fuel other than "traditional" petroleum fuels (gasoline or diesel). Alternative fuel/ energy vehicles can be used for any number of purposes, such as buses, personal cars, and SUV's to name just a few. These vehicles pose a whole new set of challenges for firefighters.

Auto-Stop Feature

If you encounter a hybrid vehicle in a rescue situation exhibiting no outward signs of power, be cautious, these vehicles function with virtually no noise. This is due to the "Auto Stop" function which shuts down the combustion motor when there is no demand applied to it. When one of these vehicles is stopped, the words "Auto Stop" should be illuminated on the dashboard. Be aware that there will be no running motor, no exhaust and no noise. Any inadvertent push on the gas pedal will result in the vehicle's motor engaging and movement. To prevent this, hybrid vehicles must be properly shut-down prior to patient care or extrication.

Shutting Down a Hybrid Vehicle:

1. Stabilize the vehicle, chock tires.
2. Identify vehicle as potential hybrid.
3. Place transmission into PARK, set parking brake.
4. Turn off and remove key (remove Smart Keys at least 20 feet from vehicle.)
5. Check that "Ready" light or "Auto Stop" light is OFF on the dashboard.
6. Disconnect 12 volt battery, negative terminal first by means of a chunk cut.
7. Remove the 20 amp HEV fuse (yellow) in engine compartment, when in doubt, pull all fuses in the fuse block.
8. After disabling the vehicle, power can be maintained for 5 minutes in the high voltage electrical system and 90 seconds in the SRS system.
9. NEVER should you consider cutting the high voltage harnesses, these cables will be marked with an ORANGE color.
10. 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 are disabled.

Tesla Vehicles

Tesla vehicles present a unique set of challenges to a rescue incident. Being an all-electric vehicle manufacturer; its design features and high voltage components are specific to Tesla vehicles only. Requiring first responders to adjust accordingly in order to safely disable, stabilize, and perform our rescue tactics. In order to operate safely around Tesla vehicles, it is important to have an understanding of its high voltage components.

High Voltage Battery

Tesla vehicles are equipped with a floor-mounted 400 volt lithium-ion high voltage battery. This battery is located on the bottom side of the vehicle and directly underneath the vehicles floor pan. Never breach the high voltage battery when lifting from under the vehicle. When using rescue tools, we must pay close attention to ensure that we do not breach the floor pan.

DC-DC Converter

In most Tesla vehicles, the DC-DC converter is located in the front right wheel well, on the passenger side of the firewall. It transforms from a high voltage current to a low voltage to charge the 12 volt battery. High voltage is present at the DC-DC converter. Use caution when placing relief cuts in this area during a dash lift or dash roll procedure. If possible, we can choose to work on the opposite driver side compartment for our dash displacement tactics or use work-around techniques.

High Voltage Cabling

High voltage cabling is always marked with an orange color and is routed under the rear seats and inside the rocker panel on the passenger side front. Avoid any procedures that can deform or cut into these areas.

12V Battery

In addition to the high voltage system, Tesla vehicles have a low voltage system, powered by a traditional 12 volt battery located underneath the hood. The low voltage system operates the same electrical components found in conventional vehicles, including the supplementary restraint system (SRS), airbags, and ignition.

High Voltage Shutdown - First Responder Cut Loop

Figure 25-31 Cut Loop label

The first responder cut loop is a designated set of low voltage wires produced by the manufacturer for first responders. It can be located by opening the hood of the vehicle, from that point you will find an orange label protruding from under the plastic access panel on the passenger side. After opening the access panel you will find the orange colored cut loop which displays a fire helmet insignia. Cutting this loop shuts down the high voltage system and disables the SRS and airbag

components. When cutting the loop, double cut to remove an entire section. This eliminates the risk of the cut wires accidentally reconnecting.

Chock All Four Wheels

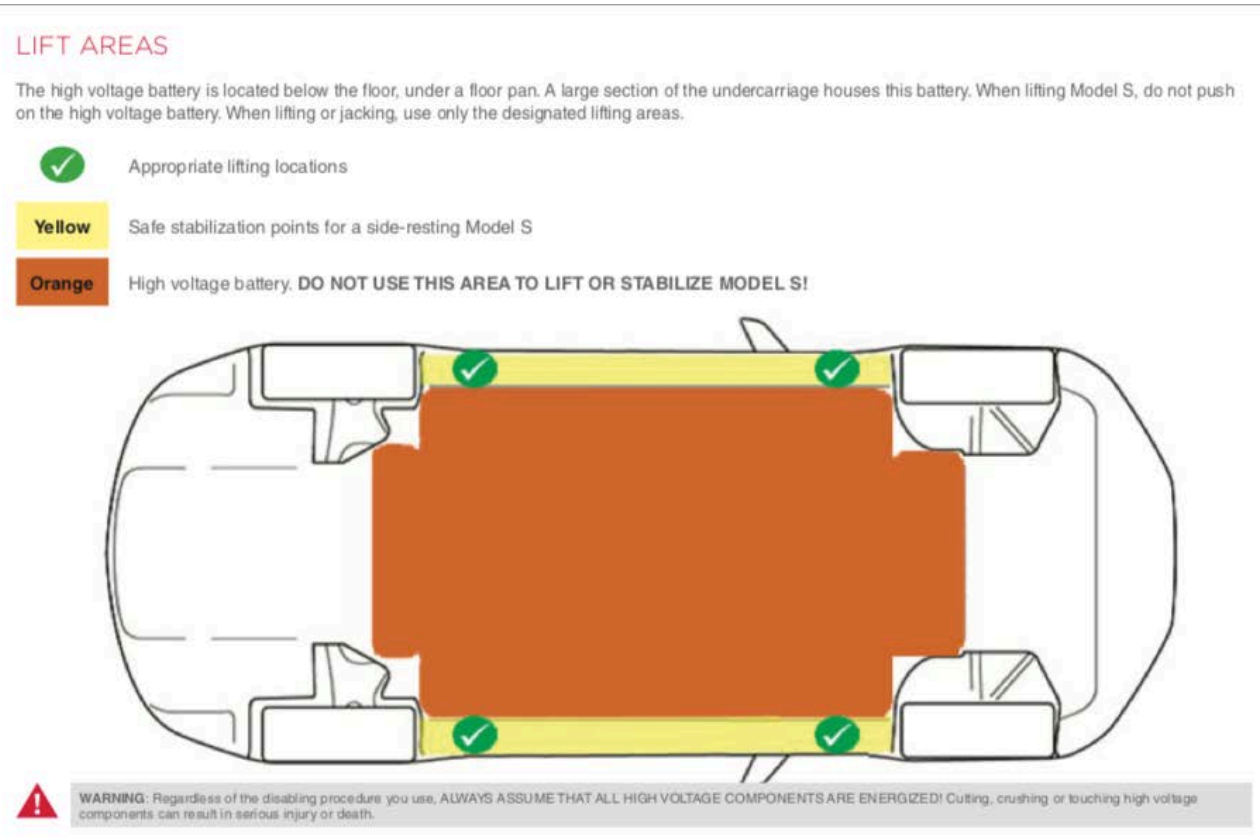
Drivers can choose a setting that determines whether or not their vehicle will "creep" when a driving gear is selected. If this setting is off, Tesla vehicles will not move unless the accelerator is pressed, even if shifted into Drive or Reverse. Therefore, never assume that it will not move and always place chocks on the outward side of all four wheels.

Set In Park

Tesla vehicles are silent so never assume they are powered off. Pressing the accelerator pedal even slightly can cause a Tesla vehicle to move quickly if the currently active gear is in Drive or Reverse. To ensure that the parking brake is engaged, press the button on the end of the gear selector to shift into Park. Whenever Tesla vehicles are in Park, the parking brake is automatically engaged.

Vehicle On Its Side

Due to the high voltage battery being located on the bottom side of the vehicle, it can be difficult when searching for our stabilization tools attachment points. At no point should we make contact with the high voltage battery. Stabilization tools such as the Rescue 42 Struts must be placed around the high voltage battery.



Tesla Extrication Tactics

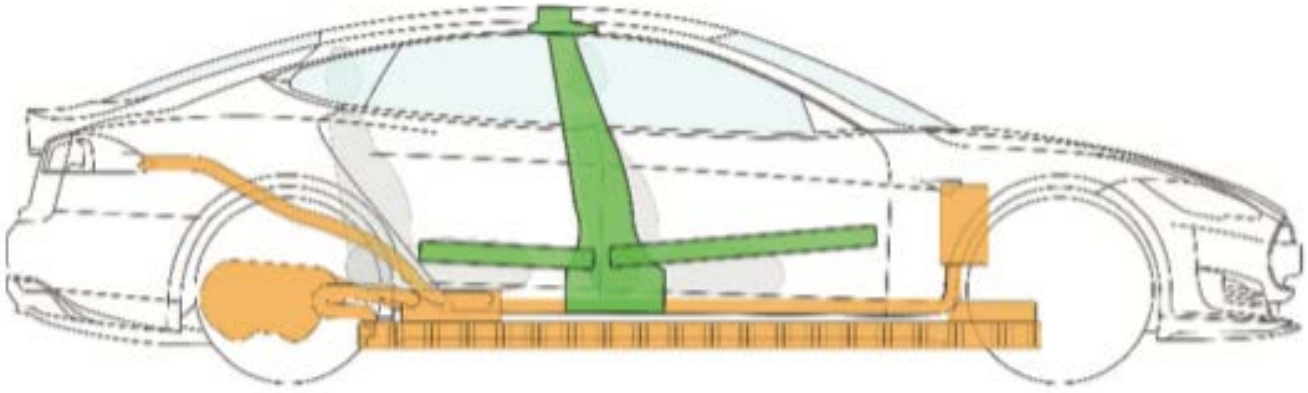
Due to Tesla's advance safety features and manufacturing techniques, additional extrication tactics should be considered.

Ultra High Strength Steel

Tesla vehicles are reinforced in their B-Posts with Ultra High Strength Steel. Depending on the tools used, UHSS can be challenging or impossible to cut. As with all other vehicles, we must adapt by choosing more advantageous cutting angles, tool placement, and proper tool pressure buildup to increase the likelihood of defeating this material. However, If these techniques are not successful we must use workaround techniques, such as making pie cuts at the top and bottom of the B-Post where they connect with the roof rail and rocker panel.

Pushing On The Floor Pan

Due to the high voltage battery being located directly underneath the floor pan. When attempting a dash displacement technique, we must never push down or push against the floor pan, doing so can breach the high voltage battery, causing either serious injury or death. All push points for our rescue tools should be placed against the rocker panel.



Only the B-pillars are reinforced with high strength steel

Trolley Emergencies

The Metropolitan Transit System (MTS) operates 3 different electrically driven Light Rail Vehicles (LRV's). These trolleys can seat up to 64 passengers each and transport between 100,000 to 2000,000 passengers daily. These LRV traverse over 50 miles of San Diego County, most of which are in San Diego City and at speeds over 50 mph. Several miles of track in downtown share the roadway with vehicles.

Figure 25-32 Vehicle vs. Trolley

Electrical Hazards

The following is a brief description of the different electrical components of the Trolley system.

Substations

The Trolley's electrical supply is transmitted through various substations located at points along the track. Firefighters should not attempt to access or operate in or around these substations. The substations have a blue beacon light on the top to indicate trouble. In all rescue and fire situations, firefighters are to remain outside until a representative from MTS arrives at scene and determines it safe.

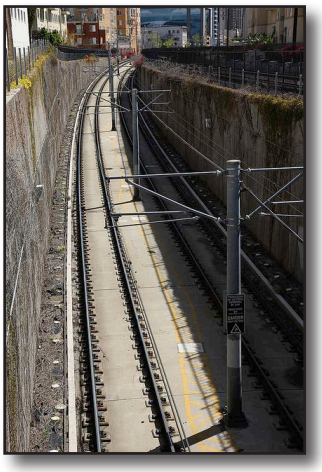


Figure 25-33 Catenary

Catenary

The electrically powered LRV receives its electricity through a series of power lines strung above the tracks. These power lines are called the "Catenary" and transport 600 volts DC power to the LRV.

Pantograph

Atop each trolley car is a "Pantograph" which captures the electricity from the power lines and directs it to the electric motors. The circuit is completed when the energy returns to the substation via the railway. One of the primary considerations when dealing with Trolley emergencies is to lower the pantograph completely from the Catenary. This can be accomplished by pressing an electronic switch in the operators cab. If the batteries of the trolley have been shut down already, then the pantograph cannot be lowered this way, . and must then be lowered manually from the inside the trolley car through a compartment on the ceiling below the pantograph. The crank for this operation is typically in a nearby compartment or under a seat. Firefighters need to be aware that if the trolley cars are connected, then all pantographs in the train must be lowered in order to completely disconnect the power supply from the centenary.

Figure 25-35 Powered Track Switch

Batteries

Each trolley car has a 24-volt battery which is used to supply power to accommodate the lights, doors, and the raising and lowering of the pantograph. These batteries are located in a compartment on either side of the car. Once the trolley doors have been opened, the isolation/battery disconnect switch in the operators cab should be turned to OFF. It is important to note that the trolley doors require electrical power to open and close. If the batteries have

been disconnected, then the doors must be opened manually by pressing the buttons on either side of the door and physically pulling the doors apart. Even though the pantograph has been lowered and the batteries have been isolated to the trolley, electrical power can be held in capacitors for up to 10 minutes.

Railway Hazards

In addition to electrical hazards, two other primary concerns with safety on the railway are the "Powered Switches" and railway traffic. Powered switches are the intersections on the railways where trolleys can be diverted to another track. A trolley can request action from one of these switches over one mile away. Because you cannot anticipate when the tracks may switch, all personnel must stay clear of any track transitions or switches. The rail has more than enough force to easily crush a foot if it were to adjust while being stepped on.

Figure 25-36 Operations on Trolley Tracks

Some situations may arise that require rescue workers to cross or work on the tracks. MTS should be contacted via FCC to advise of any activity on the tracks. Regardless, one can never be sure that oncoming railway traffic has been stopped. A look out should be posted and all personnel must stay aware of the surroundings. If resources permit, a flare may be placed in the middle of the tracks in both directions of the incident far enough ahead for the trolley to stop. Another option is to have a firefighter waving a lit flare back and forth while standing on the side of the tracks.

Trolley Rescue Procedures

- Size Up
- Notify MTS via FCC
- Access Trolley / Open All Doors
- Parking brakes are automatically applied when the trolley comes to a stop.
- De-energize Trolley by lowering pantograph
    - Electric switch – or
    - Manual Crank
- Shut-down Batteries - Isolation switch in operators cab

Contact can be made to MTS Operations Control Center Supervisor at (619) 595-4975 to answer any questions and ensure personnel safety. When an incident does occur on the MTS system, MTS personnel will also be dispatched to the scene. These personnel should be utilized by the IC as they are knowledgeable about the electricity, powered switches, oncoming traffic, how to gain entry to the cars and control the interior of the trolleys.

Summary

Vehicle rescue incidents requires an individual evaluation and decision on strategy and tactics. No two events will be alike. You have been given tools with which you will be expected to utilize when the situation requires.

Consider the incident under control when all victims requiring medical aid have been transported to the hospital. Tow trucks are responsible for the removal of debris and vehicles, but it is the fire department's responsibility to ensure the vehicles can be towed without presenting a hazard; that is, to ensure that flammable liquids are safely contained, and that hidden or remaining fire is out. Clean up of an accident scene is not our number one concern. This incident may very well be a crime scene and it is imperative that we disrupt as little as possible. In extrication the experience and training of the crew at hand will determine what can be done. If no one has ever pried a door, removed a window, or cut open a roof it is doubtful that they will be able to do it at an actual incident. There are many wrecking yards in the city, and several of them are very cooperative in allowing firefighters to train on their wrecks. While training, try to perform various extrications first with only the tools available on an engine company. Finally, the rescue rigs are always available for training exercises and familiarity with their equipment may help the decision to extricate now or to await the arrival of Heavy Rescueh

Media & Link Index

- Vehicle Rescue 1 -Hydraulic Tool Pressure Build Up Demonstration
- Vehicle Rescue 2 - Cutting Angle: Perpendicular vs Parallel
- Vehicle Rescue 3 - B-Post Blowout
- Vehicle Rescue 4 - Extrication Minutes – Inflation Cylinders
- Vehicle Rescue 5 - Extrication Minutes- Lower A-Post Failure
- Vehicle Rescue 6 - Extrication Minutes – Overcoming UHSS
- Vehicle Rescue 7 - Extrication Minutes – Dash Displacement
- Vehicle Rescue 8 - Extrication Minutes – Dash Size-Up
- Vehicle Rescue 9 - Extrication Minutes – Dash Relief Cuts
- Vehicle Rescue 10 - Extrication Minutes – Hybrid Vehicle HV Service Disconnect
- Vehicle Rescue 11 - Emergency Response for Tesla Vehicles
- Vehicle Rescue 12 - Advanced Extrication Training – Tesla Vehicles

References

1. San Diego Fire-Rescue Department, Vehicle Rescue Power Point, Capt. R. Edrozo
2. San Diego Fire-Rescue Department, Truck Company Spiel Guide, SOG's
3. California State Fire Training, Course Information and Required Materials
4. California State Fire Training, Fire Fighter I Instructor Guide
5. California State Fire Training, The Emergency Response Guide To Alternative Fuel Vehicles, Rodney Slaughter
6. FIRESCOPE, Field Operations Guide, ICS publication, Multi-Casualty
7. San Diego Metropolitan Transit
8. http://www.daleandsharyn.com System, Rail Emergency Response Training
9. http://www.howtobuyyonger.com, unibody cars
10. http://en.wikipedia.org/wiki/San_Diego_Trolley
11. http://www.alternative.fuels.about.com
12. http://www.houston.cars.org
13. http://www.daily.driver.blog.com
14. http://www.zodiac.automotive.com
15. http://www.perfect.car.insurance.com
16. http://www.rdl.army.mil
17. http://www.trailer.life.com
18. http://www.alabama.clean.fuels.org
19. http://www.auto.how.stuff.works.com
20. http://www.metro.jacksonville.com
21. http://www.ca.trolley.com

Credits

Writers:

Rich Vigil

Jim Gaboury

Brad Whitman - 2021 Revision

Media, Layout & Editing:

Jim Gaboury, Justin Herzog, John Brubaker, Brad Whitman

Grammatical Editing:

Piper Denlinger, Justin Herzog

NOTE: If you have any additional information or content that you feel would be appropriate to contribute to this Chapter or would like to report any errors or misrepresentations, please contact the SDFD Training Division or email the Drill Manual Revision Staff at

SDFDDrillManualTeam@SanDiego.gov

Revisions/Updates

Date	*Revision/Update Description*
June 2014	Trolley Voltage corrected from 700V to 600V DC
March 2021	Significan revision of entire chapter.
June 2021	All previous video links removed and new updated video links added
June 2021	“Vehicle extrication can be defined as the strategic removal of a wrecked vehicle from an entrapped victim” Page 25-1