VEHICLE EXTRICATION

As adapted from

The Central Virginia Vehicle Rescue School

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Vehicle Rescue
As a
Systematic Approach

The official text for VAVRS Vehicle Rescue Course is Vehicle Rescue by Harvey Grant. This book was written in 1975, and obviously there have been substantial changes in vehicle construction and equipment and rescue techniques since that time.

However, the eleven phase approach to vehicle rescue is as valid today as it was in 1975, and it is essential that you know all eleven phases to plan and implement a strategic and tactical game plan for your extrication problem. The eleven phases of vehicle rescue, in the order they are to be considered and followed, are as follows:

- Preparation
- Response/Arrival
- Size-Up
- Safety
- Establishing Command
- Stabilization
- Patient Access
- Emergency Medical Care
- Extrication
- Removal & Transfer of Patient to Ambulance
- Termination

PREPARATION

PERSONNEL

Physical - turnout gear, which is required for safe operation, can weigh over 20 pounds. Hurst spreaders can weigh 50 - 75 pounds. Obviously you must be physically fit enough to lift and maneuver these tools. With the Americans with Disabilities Act, the National Registry and other organizations that do job functions, analysts are developing criteria for the various EMS positions. It might interest many of you to know that one suggested standard is that the employee be able to lift 150 pounds! It is important for you to maintain physical strength and stamina, for the chance of injury increase as you become more and more tired.

If you are out of shape you should start an exercise program and get in shape.

Mental - You must have training on the vehicle extrication system, on the equipment, and you must practice and get experience in extrication. Every extrication is different. Training itself is perpetual. You must keep on training and practicing and training and practicing. Be wary of the "once-trained/always trained" mentality that rears its ugly head so often in the fire service. There are always new tricks, new pieces of equipment, new vehicle designs, and new problems to learn from. It will not be long before you can tell those who continue to train from those who talk about continuing to train. You must have training and experience to be a good vehicle rescue technician. Neither is sufficient on its own.

TRAINING

Training starts now, with this class. But this class is only an introduction to the principles of vehicle extrication. It takes much practice, as well as additional training to be truly proficient at vehicle rescue. Start by knowing the location of every piece of rescue equipment on your apparatus. Know how it works, its specifications, and how to fix it should it become disabled. Visit your local junkyard regularly to practice those techniques you will learn. Set up scenarios and run through them with other rescue technicians. Limit the number of tools you are able to use so you will learn how to adapt and overcome problems like that in the real world. Respond to as many working extrications as possible to see how the rescue was performed and what worked, (and what did not). Take additional vehicle rescue classes from knowledgeable instructors.

Additional classes that are recommended are:

- Bus Rescue
- Farm Vehicle Extrication
- Hazardous Materials Awareness
- Heavy Truck Rescue
- Rope Rescue I
- BTLS or PHTLS

If your organization has a vehicle rescue competition team, observe how they practice and ask if you can participate. If you do not have a team, organize one. By competing against other rescuers, you will quickly learn a lifetime's worth of information in a very short time. Vehicle rescue teams have to do it safe, fast, smart and right.

EQUIPMENT

It has been said that tools should never limit the rescue effort. In other words, you should never be unable to perform a needed task because you are missing an essential piece of equipment. That is why we are always suggesting new equipment for the squads. We must have the right tools and be proficient in their use. Tools must be maintained in good working order. We use competitions and parades as opportunities to clean, repair and use equipment that otherwise sees little service.

Never, ever be ashamed of homemade equipment. Many of the fancy things we have now started out somewhere as a homemade trick of the trade. Why pay $500.00 for something you can have made for

you for $10.00? Many rescue squads and fire companies that have limited budgets have an amazing array of homemade equipment with which they can put the "store-bought" people to shame.

No ambulance weighs 33,000 pounds. Recent federal legislation has brought equipment weight into question, and in one Virginia locality the insurance carrier has weighed a truck, found it to weigh more than the gross vehicle weight of the chassis and it is having to be replaced after 5 years of service! (Normal life for fire apparatus is 20 years.) Clearly planning in vehicle bidding is required to avoid a $250,000 mistake.

Planning of compartment layouts and for future equipment needs is of vital importance given the service life of the truck. Planning for accessing equipment must take place to avoid having to pull out everything in a compartment to reach a needed item.

ROLES AND RESPONSIBILITIES

Agencies routinely work side by side at an accident benefit by developing assigned responsibilities for each agency to fulfill. The following example illustrates how standardized operating procedures and responsibilities can be established. The time to identify these roles and responsibilities is to sit down and discus which agency will be responsible for which task before the response. Establishing these responsibilities before the response will increase the effectiveness and prevent any confusion how to responsible for what. Listed below are the some of the roles and responsibility of each of the agencies:

Rescue:

- Establish Command
- Make assessment of rescue needs and extrication techniques
- Provide initial and sustained patient access as necessary.
- Initiate disentanglement procedures as necessary.
- Assist EMS as necessary
- Implement necessary safety measures on damaged vehicles to prevent further injuries to patients or operating procedures.

Fire Department:

- Establish and maintain scene safety by control of safety hazards including but not limited to the following:
  - Extinguishing Fires
  - Preventing Fires
  - Handling spill or leaks
- Performing vehicle safety surveys including the following:
  - Energy-absorbing bumpers
  - Electrical system
  - Fuel and fuel system
  - Basic vehicle stabilization
  - Assist law enforcement agency in establishing and maintaining control of traffic and crowds in the immediate vicinity, if requested and assigned.
  - Assist EMS personnel as requested and assigned.

Emergency Medical Services:

- Establish and maintain medical personnel/ patient contact throughout the incident.
- Evaluate condition of patients.
- Prioritize and administer necessary patient medical care.
- Assess need for disentanglement activities to free trapped patient.
- Advise rescue personnel of interior entrapment conditions as necessary.
- Properly package injuries and injured patients.
- Transport patient to medical faculty.

Law Enforcement:

- Investigate the accident
- Establish and maintain crowd and traffic control
- Preserve the accident scene for accident reconstruction and investigation teams

Because the simultaneous arrival of law enforcement, fire, emergency medical services, and rescue rarely happens, each agency must be prepared to deal with the situation alone until additional crews arrive. When a particular response agency is absent from the accident scene, command personnel may have to be assigned from a branch of service temporarily to fulfill of the other services. However, no member of any branch of services should become involved in another agency realm of responsibility without full knowledge, consent and direction of command personnel. For example, if paramedics abandon a patient to direct traffic at the accident scene, the care of the patient is lost. In all cases, every agency must reflect consideration for safety all times.

RESPONSE / ARRIVAL

Proper placement of apparatus on an emergency incident is an important part of site management. The goal is to get the vehicles that will perform the most action as close to the incident scene. Because not all units will arrival on the incident scene at the same time, it is critical that all drivers, officers, police and other responders need to be trained to understand proper placement of their respective vehicles on the incident scene.

Unlike that of a structure fire where a rescue vehicle is parked a block away from the incident scene, since much of the equipment that is used on a fire scene is portable or operates in a support role. In many cases positioning of apparatus is opposite of that of the fire scene. On an accident scene it is critical that placement of the rescue vehicle to be as close as possible to allow the extrication team to have readily access to all it's tools and equipment. Certainly, placement of vehicles on the extrication scene depends on a number of variables. On the extrication scene, the rescue and EMS vehicles should have the spot closest to the scene. The following is a guideline as to placing apparatus on the scene:

- Place the vehicle close enough to the accident scene to make equipment removal easy and to keep carrying distance to a minimum. Some rescue vehicles have tools that operate off the vehicle such as hydraulic and air lines, cranes, A-frames and/or winches. This must be considered.
- Place the vehicle upwind and uphill from the scene, whenever possible. This will prevent exposure to hazardous vapors and keep flammable fuels from running beneath the vehicle.

- Do not place vehicles so close that it will cramp the scene or expose victims to vehicle exhaust or noise.
- If public utilities have been involved in the incident, be cautious of such things as downed power lines, dangling transformers, or escaping natural gas.
- Do not block the scene. Allow for passage of ambulances and other emergency vehicles.

When working in areas of heavy traffic, such as freeways or intestates, the most desirable option is to stop the flow of traffic. Unfortunately, this is not always possible. To provide the most efficient means of protection for the emergency crews, when traffic must be allowed to continue to flow, position emergency vehicles so they provide a barrier between traffic and the emergency scene. If it is possible to close only certain lanes of traffic, the lane the accident is in as well as the lane next to it should be closed.

Driving to the scene is outside the scope of this class. However, you must consider height and weight limitations in determining your route. You must carefully position your truck at the scene and always chock the wheels, (large trucks do not use the transmission to hold the vehicle in place) You should be uphill and upwind from leaks and spills. You should consider placing the truck so that the truck shields the accident scene. Let them hit the truck before they hit you or the accident scene. Place your response unit 50 feet from the accident scene, 100 feet if the vehicle is on fire, 2,000 feet from a hazardous material incident. Always position one unaffected span away from a downed power line.

SIZE UP

Size up begins with the dispatch information and updates en-route.

INITIAL ASSESSMENT

Once on scene an initial assessment should be performed. This should take about 60 seconds, and you are looking for:

- Fire and safety hazards
  - fire
  - fuel leaks
  - downed power lines not seen earlier
  - hazardous materials
  - unstable vehicles or structures
  - traffic
  - crowds
- Medical needs
  - How many people are involved in the accident?
  - Where are the patients?
    - in car
    - in road/ditches
  - Perform a 300-foot scan for possible ejected patients from roll over.

- Rescue needs
  - Will you need to force entry and disentangle?
  - Do you need additional manpower?
  - Would you benefit from scene lighting at night?

SCENE SURVEY

There are several methods that are acceptable to obtain this information. One such method is generally referred to as the "scene survey". In the scene survey, the IC walks around the incident gathering information from what he/she sees and then decides an appropriate course of action. It is important to remember that an accident scene may change, therefore the IC should be flexible and be ready to change the rescue plan should some unforeseen event occur or if the rescue plan does not work.

During scene survey work, the IC has a close opportunity to observe hazards that exist in, on and around the rescue scene. The IC completes and full circle around all involved vehicles, maintaining about a 10-foot distance from the closest vehicle. This distance identifies the *action circle* and takes on an important significance as the rescue unfolds. (The action circle is where the extrication takes place.) During the scene survey, the unknown becomes the known, and both real and potential scene hazards are identified, as are existing or anticipated rescue and medical problems. Scene survey information should be shared with other emergency personnel and a game plan for the actual rescue should then be formulated.

ESTABLISH CONTROL ZONES

Proper management reduces congestion and confusion around the rescue scene. In order to do this, establish “zones” or areas where only certain personnel are allowed to function. These zones should be circular, their size depending on the size of the rescue scene and what is required. The area closest to the extrication should be labeled the “hot zone” and only those personnel actually performing the extrication work or attending directly to victims should be allowed. The next area, the “warm zone” is where rescuers who are directly aiding the working extrication team should be allowed. This includes personnel who are handling hydraulic tool power plants, fire personnel handling charged hose lines, and personnel providing lighting. The most outer circle is called the “cold zone” and this is where equipment and manpower are staged, as well as the command post and the press information area. The cold zone should be cordoned off with scene tape to prevent the entry of unauthorized people.

SAFETY

"KNOW YOUR PRIORITIES"

You are number one.
Your family is number two.
Your department is number three.
Your community is number four.
Your victim is number five.

"WHAT INJURES OR KILLS MOST WOULD-BE RESCUERS?"

Lack of knowledge.
Stupidity.
Lack of discipline.
Compassion. (Compassion starts in the back of the ambulance, not before!)

PERSONAL PROTECTIVE CLOTHING

Should consist of the following:

- HELMET
- EYE PROTECTION (safety goggles or glasses)
- COAT (with reflective stripes)
- PANTS
- BOOTS (with steel toe) fire-fighter boots do not protect against electrical shock
- GLOVES (not plastic coated) wear plastic gloves underneath

If you are hurt at the accident, then someone must care for you and that takes manpower away. Get into shape and stay that way.

Know your tools and their limitations. (Ex. Knowing that air bags can slip and cause the load to fall may save your life one day). Take breaks and drink lots of water. Stay hydrated.

If you want to be brave, heroic, and professional, then be SAFE. The rest will follow. We do not and cannot trade lives for lives.

SCENE HAZARDS

VEHICLES ON FIRE

A very serious safety threat for everyone, especially us. Hydraulic piston units in the bumper, strut suspension units, hydraulic-pressurized lifting cylinders for hatchback, hood, and trunks are all potential hazards. When they become heated, pressure builds that causes them to become a rocket. You don't want to be around when that happens. Pressurized fuel systems may explode. Plastic gas tanks will melt,

releasing their contents. This usually takes about 30 minutes of fire exposure to cause this to happen. Plastic is far safer than metal tanks since they are less likely to explode. Burning plastics give off hydrogen cyanide gas. This poison is skin absorbed so it doesn't matter if you have a SCBA on or not.

Insurance Companies consider auto fires as a "write off". You should too. Don't fight them unless you are well trained and you have a real need to. If the engine catches fire and the victims are still inside the car, then punch a hole through engine grill and knock fire down using a dry-chemical fire extinguisher. If you use a pressurized water extinguisher, be careful to not to push the fire toward the passenger compartment. Remove the occupants by the "rapid take-down" method of extrication. Isolate the battery only if it represents a danger. This is rare. Cars do not explode when they are on fire; tires will though and will scare you.

VEHICLES LEAKING FUEL

The fire department should handle, unless they are not yet on the scene. If this is the case, kick dirt on the puddle and cover it. Make sure no one is standing around smoking! Try to stem the leak with plugs, gum, etc. Keep all bystanders away. Do not step into the foam blanket the fire department puts down. This eliminates the protection it provides. Forget about working inside foam. It won't offer any protection from ignition unless it covers the spill completely and it is left undisturbed.

Pull a portable fire extinguisher and have someone man it until the fire department arrives. On working extrications have firefighters charge a 1 3/4" line and man it. Do not rush anything, it is only a hazard and is not considered an imminent life threat.

DOWNED WIRES

Did you know that 1/10 of an amp can kill and the average downed electric line has 190 amps, (which is 1,900 times the amount needed to kill!). Back off and call the Power Company. Trying to remove the power line yourself will result in an act of stupidity. The proper distance to position you rescue vehicle is one full span of wires away. Fire boots offer no protection against electricity. They have extra carbon added for strength and this makes them better conductors for shock. Watch for a tingling sensation in feet. If you feel that as you approach a vehicle, what do you think it means?

If someone is inside the vehicle and it catches fire, issue "Jump and Roll" instructions. If they are bleeding, give them instructions on how to control it. Only get them to leave the vehicle as a last resort when their life is in IMMINENT danger.

HAZARDOUS MATERIALS

What is a hazardous material? It is something that when released will harm those things that it touches regardless if it is people or the environment. Park no closer than 2,000' to a hazardous materials incident.

Take hazardous materials awareness classes.

TRAFFIC CONTROL SAFETY

In 1988, 11 rescuers were killed by traffic at MVA's nationwide. Most fatalities occurred in dark or poor weather, but some happened in broad daylight. You want to properly position your rescue vehicles to protect you from traffic. Do not allow the police to put you off the road just to facilitate the movement of traffic. Block the road with your apparatus if you feel the need. Turn off the headlights on your emergency vehicles to prevent blinding oncoming drivers. Do not park any closer than 50' to the accident. This provides a minimum safe working distance and diverts your vehicles exhaust fumes. Enter the accident site uphill and upwind until you know what you have. Never turn your back on traffic.

SAFETY OFFICER

Every working incident should include a safety officer. The role of this person is simple, to monitor and assess hazards and unsafe situations and develop measures for ensuring personnel safety. The safety officer should be someone who is knowledgeable of rescue procedures and techniques and must have the training and background to recognize real and potential hazards. The safety officer should be identified by an ID vest and should not take part in any activity other than the monitoring of the rescue scene.

ESTABLISHING COMMAND

STRATEGIC GOALS AT MOTOR VEHICLE ACCIDENTS

- Preventing further injury or death
- Safely stabilizing the incident
- Making the patient readily accessible
- Treating the patient
- Making the patient readily removable
- Extricating the patient
- Delivering the patient to an appropriate facility within the "golden hour."

COMMAND OF MOTOR VEHICLE ACCIDENTS

Someone MUST take charge. Good commanders have the following:

- Training in extrication.
- Experience in extrication.
- Knowledge of capabilities of personnel and equipment.
- Mental preparation for life and death situations.
- Knowledge about their own strengths and weaknesses.

Essential criteria of good command are:

- Performance of simultaneous functions on scene and quick change by team members to alternate methods if initial efforts fail.
- Anticipation of real and potential needs on scene in order to obtain necessary resources in a timely fashion.

- Good communication between command and team members.

Indications of a poorly managed scene include:

- Lack of a clearly identifiable commander; fragmented efforts by team members who rely on the loudest rather than best person for leadership.
- Lack of simultaneous functions.
- Delays in receiving badly needed equipment or manpower because of unanticipated immediate of potential needs for resources.
- Stressful or argumentative situations resulting from insufficient communication between command and the team.

STANDARD OPERATING PROCEDURES

Primary Concern. The primary concern in all cases of vehicle entrapment is life safety.

Goal. The goal of the vehicle extrication operation is to deliver the patient to an appropriate level trauma center within one hour of the injury.

Tasks to be Accomplished. The Incident Commander must insure that the following tasks are accomplished in an efficient and timely manner:

- Establish command. Maintain communications with dispatch, incoming units, and medical communications center.
- Survey the scene and triage patients.
- Assure that the proper rescue equipment is on scene or en route. Determine the need for additional resources and request the same. The following are to be considered:
Medical personnel, transportation, manpower, hazards, special tools.
- Establish a tool staging area and action circle. Establish a vehicle staging area for additional arriving resources.
- Control hazards.
- Stabilize the vehicle(s).
- Gain access to the patient(s).
- Perform primary patient survey, establishing adequate airway with simultaneous cervical spine immobilization.
- Perform controlled movement and/or removal of all metal and/or obstructions in order to properly package and remove the patient without aggravating the patient's injuries.
- Package the patient for removal. Rapid extrication techniques are indicated for any patient who has an altered level of consciousness.
- Deliver the packaged and removed patient to medical personnel and give patient report. Assist in loading the patient in the ambulance.
- Secure and account for all equipment and personnel. All potentially infectious material is to be secured and properly disposed of to protect public health and safety.

- Obtain and document all pertinent incident details.

SECTORS

The Incident Commander is responsible for all functions unless a particular function is assigned to another individual. The following subdivisions of command may be needed at larger motor vehicle accident scenes:

1. Geographic sectors. In the event the vehicles are not in close proximity, or that there are multiple vehicles, a separate sector may be established for each vehicle or location.
2. Extrication. In the event of multiple patients in addition to the patient(s) needing extrication, a separate extrication sector may be established, whose sector officer controls the extrication operation and reports to the Incident Commander.
3. Triage. In the event there are multiple patients, a separate triage sector may be established to determine the nature and seriousness of the injuries of the patients and to determine the order in which patients are transported.
4. Transportation. In the event there all multiple patients, a separate transportation sector may be established, whose sector officer will:
    a. Contact medical communications to ascertain the ability of the various facilities to receive patients.
    b. Provide preliminary patient reports to medical communications using triage tag numbers when possible.
    c. Receive treated patients and arrange transportation to the facility specified by medical communications.
    d. Maintain a log of patients, the facility to which transported, and the ambulance transporting.
    e. Maintain sufficient transport units to handle the number of injured.

The Incident Commander (IC) will:

- Circle the scene from about 50 feet from the vehicles
- Circle all vehicles about 10 feet from the vehicles
- Look at all sides of involved vehicles
- Designate this 10-foot radius circle as the "action area". All inside the action area should be in full protective clothing and should be actually be performing a task. Those not actually working or dressed should be staged.
- The incident commander should step out of the action area and direct operations from outside the action area.

Obviously each accident scene is different. If you have a one-car accident one person can do the outer and inner circle survey. If you have a two-car accident with both vehicles crushed together or close to each other, one person can probably perform the surveys. If you have a multiple vehicle accident you may have to sector and delegate the surveys, with reports back to the incident commander.

Remember, you are looking for fire/safety hazards, medical needs, and rescue needs during your assessment.

Once your assessment is complete and you have assumed the command position outside the action area, you must establish a plan to deal with the incident. Plans will take one of two forms:

> **OFFENSIVE** (Combat) - you have sufficient resources to handle the incident.
> **DEFENSIVE** (Command) - you have insufficient resources to handle the incident and must call for additional help.

In formulating your plan you must consider actions needed to:

- Prevent further injury or death
- Safely stabilize the vehicle
- Gain access to the patient
- Treat the patient
- Package the patient for removal
- Extricate the patient in the safest and most efficient manner
- Deliver the patient to an appropriate medical facility within the golden hour

Even once you have formed your plan you must continue assessing to see whether your plan is working. Do you need to change your approach? What is your next move going to be? A good vehicle rescue technician will always be thinking ahead.

STABILIZATION

"NO OBJECT IS STABLE UNTIL IT HAS BEEN STABILIZED"

STABILITY

One important concept of extrication is stability. Stability has two components: center of gravity (CG) and base of support. All objects have a center of gravity. The center of gravity is the point in any body at which all the body's weight is said to be concentrated. In other words, the point in a body where all the gravitational forces are equal. Rescuers must also think of the perpendicular line from the center of gravity to any point of force application as lever arms. The longer the lever arms the greater the potential for instability.

The other component of stability is the base of support of the object. Several components contribute to determining the base of support. First is the footprint of the vehicle. The footprint is similar to a dot-to-dot drawing in that it is imaginary figure drawn by straight lines connecting the points of ground contact. For an upright vehicle, the footprint is a rectangle through the four tires. For a row crop tractor, it would be a triangle. The second component of base of support is the surface on which the object is resting: flat or inclined, the composition of the surface, and the condition of the vehicle. The object of stabilizing a vehicle is to prevent any sudden and unnecessary movement. Well-meaning spectators or untrained, ill-equipped rescuers might feel compelled to begin attempting extrication without performing this step. It's true that time is of the essence in vehicle rescue, yet rescuers must realize that even slight movement of an unstable vehicle can aggravate fractures and spinal injuries that haven't yet been detected and

immobilized. We should stabilize the any damaged vehicle as a matter of routine, even when the need isn't obvious. The nature of our work should condition us to expect the unexpected. ***NEVER TEST FOR STABILITY!*** It's human nature to apply a gentle push as a test; one author compares it to reading a sign on a wall that says, "Wet Paint" and then touching the painted object to see if it is true. Resist the urge. Control the hazard. Stabilize the vehicle.

Your first concern should be to make sure the vehicle doesn't leave the scene of the accident in response to the laws of gravity, or fall from a precarious position if the vehicle has come to rest on it's side. The tools and methods you use will depend primarily on the position of the vehicle as you find it. While it's fortunate that the most common position found is upright with the tires in contact with the ground, this does not preclude stabilizing the vehicle since rescue operations may cause it to rock and roll. Here are the three ways a car is most likely to be found after an accident, and the best way to stabilize it.

VEHICLE ON ITS TIRES

The first principle of preventing movement is to support and redistribute the weight of the vehicle. This is done by increasing the amount of contact between the vehicle and the solid ground in a way that redistributes the weight over a greater area and more points. First, set the brakes and place the automatic transmission in park. This should be enough to prevent the car from rolling, but wheel chocks are sometimes used if the grade is steep or the brakes are faulty. Since you may cause the car to tilt when you access the interior or start bending metal, place step chocks under the car behind the front wheel and in front of the rear wheel to prevent this. Remove air from the tires to allow the car to sink down and rest on the cribbing for a solid base. Remove air by removing the valve stem, and keeping it in hand. (Later, the tow truck driver will appreciate it when he can replace the stem and inflate the tire so the car can be moved). Step cribbing should not be used under light sheet metal or plastic body parts, hydraulic bumpers, or lightweight tubing such as exhaust pipes, gas tanks, drive shafts, sway bars, etc.

VEHICLE ON ITS SIDE

This is probably the most dangerous attitude a car can take. More than once, we have pulled up to the scene of an accident and stopped fire personnel from placing ladders on the vehicle and effecting patient care. THIS IS DUMB! Again, don't do anything until the vehicle is stabilized. There is absolutely nothing to prevent this car from rolling onto it's top and crushing you. Start off by working from the ends of the vehicle. Grab 4 personnel and have them push into the car from opposite side on all four corners. This will buy you some time. Crib and wedge around the bottom of the vehicle. Take 2 long (8' or better) 4 x 4 boards and place them against the bottom of the car to the ground. This will give you something to pull against. Find 2 points of attachment on the bottom of the car for chains, and using the winch on your rescue vehicle, pull the car onto the 4 x 4 boards. If you are working on a hard surface, use stakes to secure the boards from moving. This should make the car very secure and give you a strong base from which to work. Now, flap the roof down and there, you have access! Do not use the doors for access since their use will alter the center of gravity of the vehicle and it is nearly impossible to secure the door in the open position properly.

VEHICLE ON ITS TOP

Today's cars are designed to withstand 1.5 times their own weight, (that is, if the doors are in the closed position and the windshield is intact). Your job is to prevent additional collapse of the roof. Crib at each front roof pillar from ground to the vehicle surface using box cribbing. Take a 2 long (8' or better) 4 x 4's and stick them through the back windows across the back seat. Now, using low-pressure air bags, lift the 4 x 4 boards. This should raise the rear of the car off the ground and make a rock hard foundation from which to work. Pop open a door and you have access. Remember, do not open the doors before cribbing is in place. Never remove the windshield if the car is upside down.

Here are some thoughts to keep in mind:

- Assign a safety officer to maintain overview of the entire operation.
- Anticipate movement of the vehicle.
- Keep only those personnel needed to perform the operation in the action circle.
- Constantly evaluate the need for adjustment.
- Stabilization is a continuous process that never ends until the operation is over.
- Don't let your guard down just because the patient has been removed.

PATIENT ACCESS

Get into the car to begin emergency care. The path you use to get in will probably not be the same path you use to get the patient out.

A systematic approach is used to reach the patient:

- Can you get in any door?
- Can you get in any window?
- Must you get in through the body of the car?

Rescuer access should be provided as quickly and safely as possible. Often forgotten, “try before you pry” is usually all that is needed for rescuer access. Once inside, the rescuer should secure vehicle keys, remove or cut seat belts, unlock doors, roll down windows and evaluate the extent of victim injury and entrapment. Coverage and protection for the victim and rescuer should be provided with a blanket, and a wooden/plastic protection board should be placed between the victim and any working extrication tools.

EXTRICATION

Once you have gained access and begun emergency care you must determine if the patient is trapped or pinned, and whether or not the path you used to gain access is large enough to get in with tools and equipment, work, and remove the patient. If the path is not large enough you will have to enlarge the opening or find a better path. If the patient is trapped or pinned, you will have to remove the wreckage from the patient using one or more of the following methods:

- DISASSEMBLY - Take it apart

- DISTORTION - Forcible twisting of a vehicles component parts
- DISPLACEMENT - Moving a component
- SEVERING - Cutting of components

This class will give you hands-on experience in these methods.

HOW TO REMOVE DOORS

Of all types of automobile accidents that require extrication, 89% involve removing the door(s) of the vehicle in order to gain access and remove patients. There are many reasons for this. Remember the 1990's technology involved in car construction. Unibody construction means that each vehicle component depends on the other for strength. When the car is flexed in an accident, the doors become jammed and cannot be opened. Also, 42% of the extrication accidents are the "T-Bone" type. This causes the door to be pushed into the passenger compartment and therefore cannot be opened. The "T-Bone" accident causes severe injuries, so rapid access is a must.

A little review of the anatomy of a car door will help you understand how to get this quick access. Car doors are held in place by hinges and a latching mechanism. The hinges are weak while the latching mechanism is actually one of the strongest parts of a automobile. The bolt that is attached to the doorframe and connects with the door latching mechanism is known as a "striker bolt" or more commonly the "Nader bolt". This Nader bolt is made of casehardened metal and is very tough. Door skins are now thinner and more likely to tear than cars built 10 years ago, a problem when using power hydraulic tools. Inside the door, a "collision bar" keeps the occupant safe from "parking lot" accidents at low speed but not normal highway speed impacts. Not only does the presence of the collision bar increase the likelihood of the door jamming, but, as it penetrates the passenger compartment, the bar also increases injury to the occupant.

It used to be that if you had no access through one side of a car, then you would have access through the other side. This is no longer true. Modern cars involved in significant accidents usually have both doors jammed because of flexing of the Unibody construction. You also may not have access to the other side due to an immovable object such as a telephone pole or wall and taking a passenger out by pulling them across the car is difficult because of a center console or stick shift. Taking the door off next to the patient is usually the easiest, most efficacious way of access.

Start off by making sure the vehicle is stabilized and safe to work around. Next, make sure the door cannot be opened and that it is indeed unlocked, (you would be surprised at how many EMT's call for a door to be removed when it is only locked).

Removing the glass in the door should be next. Avoid attacking the "Nader Bolt" or latch side of the door since it is very strong and will take excessive time. Is there access to the hinges? Are the hinges bolted? If so, remove the bolts with a socket set and pull the door open. Continue bending the door toward the rear of the car until it snaps off the latching mechanism. (And you thought you always needed hydraulics!)

Most of the time, hinge access has to be made. Take a halligan bar and place the wedge in the door jam about 1/3 of the way down from the hood. Pulling up or pushing down on the halligan should make a larger opening in the jam. Examine the hinge, is it bolted or welded? If bolted then make the opening large enough to access the hinge bolts with a socket and remove them. If they are welded, then use the power hydraulic spreaders and pop the hinges by removing the door. Either way, this evolution should take no longer than 3-4 minutes.

If you already have access to the Nader bolt, cutting it with a sawzall may be the easiest way to gain access. Make sure that you use plenty of soapy water to keep the blade cool and lubricate the cut. Also, forcing the sawzall to cut fast will only take you much longer due to heat build-up and binding of the blade. Even with the bolt cut, you will probably still need to use spreaders to force the door fully open. Another way of removing a car door called "through the window" and at first doesn't look like it will work. This method is excellent for doors that have been pushed inward by a T-Bone accident. Start by stabilizing the vehicle and removing the door glass, (again, the basics must come first). Place a short backboard between the patient and the car door for protection. Place the hydraulic spreaders in the window and spread the arms with one tip on the door and the other on the roof. (The best place to do this is about 2/3 of the way from front to back). When you apply force, the door will push down and away from the patient. Depending on the type of vehicle and it's construction, the door will either break off completely of at the very least expose the hinges for attack. At first glance, this procedure would appear to push the door in towards the victim. The reason it pushes away from the interior is the roof is set in, and the attack angle will always force the door away. With small, light cars this is the quickest way to remove a door. (Of course, if the roof has already been removed this trick doesn't work).

If the Nader bolt is wide open when you get there, that may be the best way to gain access. There is no absolute "right" way when it comes to removing doors. Look at what presents the best and quickest route. When applying force on the Nader side, hold the door handle open. This speeds the process of popping the door since all you need to do is pry the latch off the bolt.

When the door is finally free, the last thing holding it on will be the electrical cable. While you might think that you could pull the cable in half, you will not be able to. Use either the sawzall of a pocketknife to cut through this cable. Many an extrication has gone well until one finds the door held on by a few wires which holds everything up. Think ahead and anticipate, be ready to cut.

A word for ambulance crews. Sometimes you may arrive on the scene to find a patient complaining of neck injuries and a door that appears to be just jammed. Instead of using hand tools, (usually taking 15 minutes minimum), or moving the victim across the seat, (and over the center console which also takes a lot of time and is not good for the patient), call for a squad company to remove the door. Experience shows that this is the quickest way to gain access and is far better for the patient, (and easier on your back).

DASH ROLL-UP

Approximately 80% of all MVA's involve the vehicle running into an object headon. In high-speed head-on collisions, the driver usually winds up being pinned and suffering life-taking injuries. This is due to the force of the collision pushes the dashboard and steering wheel down and into the passenger compartment, thereby squeezing the victim between the dash and the front seat. The old method of

extrication involved removing the windshield and displacing the steering wheel with a hydraulic spreading device and chains. This operation was both dangerous and time consuming, not to mention the fact that it couldn't be done in front wheel drive cars due to the knuckle in the steering column and the fear that it would further injure the patient. Often, this method would not leave ample room for rescuers to work on the victims, and patient care suffered.

A method that is tried and refined involves displacing the entire dash assembly with hydraulic rams. It is quick, easy, and when used in conjunction with roof and door removal offers the maximum amount of room available to EMS personnel. It has been found that with a trained crew of four, the entire evolution can be accomplished in as little as five minutes. The procedure involves these eight steps...

1) Stabilize the vehicle using either cribbing or step-chocks. Have a charged handline standing by.
2) Protect the patient. A half-backboard, small tarp or heavy blanket will do. Never use a sheet since this offers no protection.
3) Remove all glass from the automobile. The best way is to roll down the side windows and break them with a spring loaded center punch. The windshield is best cut out with a sawzall. Keep glass fragments out of the passenger compartment as much as possible.
4) Remove the doors. There are many ways to do this, the least desirable being an attack on the Nader bolt side of the door. If they can be opened, use several people and push the door forward until it touches the front fender. This will usually result in the door popping off the weak hinges. If the door is crushed and cannot be opened then attack it using the through-the-window method. Place the hydraulic spreader in the window approximately 1/3 of the way from the locking mechanism. With the roof line as a purchase point, push the door down and off the attachment points. This procedure is safe since it pushes the door down and away from the victim.
5) Remove the roof. There are two ways in which to do this. Flapping is usually faster and easier while total removal offers the best way to get the most room. If the roof has a sunroof, you will have to remove it. On hatch backs, station wagons, and trucks watch out for lifting pistons since they may contain LP gas.
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6) Roll the dash. Start by making a shallow cut through the connector (and only through the connector) at the base of the "A" pillar as it meets the rocker panel. Place the hydraulic ram butt end down in the corner of the rocker panel and the "B" post on both sides of the car. (Hurst Model 60 rams usually work well). Place the piston end of the ram at the top hinge, or as high on the "A" post as possible. Use 1 ram on each side and fully extend the rams at the same time. This takes coordination and is best accomplished by having each ram operator watching each other.
7) Short, thick wedges are then placed in the area exposed at the base of the "A" pillar and the rocker panel to minimize the return movement of the dash when the rams are released.
8) Finally, the rams are removed and the rescuers are provided with more than adequate space for victim removal, using proper spinal immobilization and providing other appropriate care.

This technique quickly lifts the dashboard off the victim. It also lifts the pedals, which may have entrapped the victim's feet. Also, if the floor pan is creased, this technique returns it to it's original position. Because this technique is quick and very effective, rescuers must use caution and monitor the movement of the dashboard and it's impact on the patient throughout the operation of the rams.

This procedure cannot be done without a lot of practice. Spend some time in your local junk yard refining your skills on the different types of vehicles. What may work for one may not work for another, or may involve some minor changes in your attack.

ROOF REMOVAL

Whenever victims are trapped/pinned inside a vehicle, roof removal is usually a must. Taking the roof off offers the advantage of complete access to the patient and can often speed the extrication process. In the past, it has been taught that “flapping” the roof back, (cutting both A posts and bending the roof back) was the preferred method of gaining access. Experience has taught us that procedure is both time consuming and manpower intensive. Some roofs contain steel rails for sun decks or “T” tops and will prevent you from flapping the roof back. If you want lots of access in the least amount of time, remove the entire roof. Roof removal is best accomplished with 2 teams, one on each side of the car. Moving from the front of the car to the back, each post is cut in succession with either a hydraulic cutter tool or sawzall. Watch the B post since it will probably contain additional support, (therefore strength) for seat belt assemblies. Note where these assemblies are and avoid them. After the roof is completely cut free, one person on each corner should pick the roof assembly up and move it to the rear and out of the work area. Exposed posts should be covered with short fire hose sections to prevent injury.

REMOVAL AND TRANSFER OF PATIENT TO THE AMBULANCE

Moving a patient from a wrecked automobile involves two separate operations. In many situations, the movement of a patient can be accomplished in one quick, continuous motion. Rescuers may do no more than lift an injured person from the vehicle, take a few steps, and place him on an ambulance cot. But even in these cases, the movement should be thought of as comprising two steps: removal and transfer.

1. Removal is the movement of a packaged patient from the wreckage to a point outside the involved vehicle.
2. Transfer is the movement of a patient from a point outside the vehicle to a waiting ambulance.

In some off-the-road vehicle accidents, the removal of a disentangled patient may be the easiest part of the rescue while the transferring of the patient may involve a difficult climb up a steep embankment, requiring special techniques and equipment.

TERMINATION

This often neglected or ignored phase consists of:

- Determining need for further support activities
- Collecting all equipment and accounting for personnel
- Returning to quarters
  - Replenishing fuel and supplies
  - Cleaning, testing and replacing tools used
- Documenting the rescue operation
- Critiquing the rescue operation
  - What worked well?
  - What didn't work as well as we expected?
  - What training were we deficient on?
  - What equipment problems did we have?

New Vehicle Technology

BASIS FOR VEHICLE SAFETY

In the 1960's, a researcher named Ralph Nader wrote a book entitled "Unsafe at Any Speed". His book was about the General Motors (GM) Corvair, a then popular rear engine car, and was about the many unsafe design features of the car that eventually drew the attention of the government and subsequent outlawing of the production of the Corvair. GM attacked him in the press and he then sued them in a class action suit, which he won. (His findings in his book so unnerved automakers that they hired private detectives to track his research activities.) He then took the $250,000 he was awarded and formed a consumer advocate group. In 1966, Nader testified before Congress that defective automobile designs were responsible for many auto accidents and injuries and that his research showed head-on and rollover accidents were the worst. This resulted in Congress passing the Motor Vehicle Safety Act, which brought car design under federal control. This is why the government is so heavily involved in automotive design and why cars have so many safety features.

Over the last ten years, tremendous changes have occurred in automobile rescue. The recent radical changes in automobile design and appearance are nothing short of a revolution. The general public has now come to expect the advances in aerodynamic design, space-age plastic materials and passenger safety features that are present on today's new vehicles. The futuristic lightweight automobile body materials and light-duty space-frame construction make vehicles fuel efficient, but at the same time makes them susceptible to receiving irreparable damage in low speed or moderate impact collisions. An automobile is no longer built with a totally rigid structure. Today's car is a hybrid construction that's somewhere between an eggshell and a truss in design. It

resembles truss construction in so far as each member is load bearing and, in normal use, each member bears a tension or compression load. It resembles an eggshell in that the structure is self-supporting, and the body and the chassis are one.

Today's mass-produced, pressed-steel panels are electrically welded to posts and pillars formed so that each curve and indentation are critical to the overall distribution of stress. Extra strength is often derived from the "tunnel" or "hump" running the length of the floor, originally designed to accommodate the drive shaft but retained in many front wheel-drive cars for its structural value. Resistance to twisting comes mainly from a reinforced firewall in front of the passenger compartment and a steel panel behind the back seat.

TRUSS CONSTRUCTION

A load placed on a truss construction (top) creates compression forces that push together on the top horizontal member and tension forces that pull apart at the bottom. Without the diagonal pieces, the top and bottom would have to be much stronger. A modern car (bottom) is similar; Instead of a heavy, box-like foundation, it has a curved shell that distributes stress, so that the roof helps support the engine and strengthen the floor.

By design, vehicles have crushable areas that act as stress and impact failure points. These strategically placed front and rear "crush" zones absorb impact energy as they protect the precious passenger compartment. Any energy that is absorbed by the crush zone will therefore not have to be absorbed by the occupants inside the passenger compartment. (If the car takes a beating, the occupant doesn't) This increases the passenger's chance for survival. In many cases, the same front or rear frame structure that is designed to bend or fold is also designed not to be repairable once bent. (This is why many cheap cars are called "throw away cars" by the insurance industry.)

VEHICLES OF THE 90's

Vehicles of the 90's are designed with the following safety features in mind:

- To prevent intrusion into the passenger compartment.
- Sends energy to crush points that buckle to absorb the force. The crush points are usually fenders & hoods.
- The passenger compartment remains intact, glass does not bust out.

Research into the types of accidents experienced shows that T-bones and highspeed head-on accidents are the ones that generate most extrication problems, (and deaths). Roll-overs and rear-end collisions rarely result in extrications or serious injury. From the standpoint of current safety engineering design, this is to be expected.

FRAMES

FRAME RAIL or PLATFORM CONSTRUCTION - Since the 1970's this type of construction is no longer found on passenger cars, (but is still found on light to heavy trucks). Two longitudinal girders, (rails), set parallel to each other hold the vehicle's

weight. They are bad because body will slide on the frame if involved in accident, but they are good because they have great strength.

UNIBODY or MONOCOQUE CONSTRUCTION- gets its name from the unitized construction principle. Unibody construction uses the principles of a truss to support the vehicle, so the body supports itself without a frame. As in a wooden roof truss, the top cord (the roof) holds up the bottom cord (the floor) by transferring the load to either end while supporting the middle with a center post (the B pillar). The Unibody has no frame, each component depends on the next to make the whole complete. (Example: the vehicle door contributes to overall strength when they are closed, you will feel a release of energy when the first cut in the car is made.) Because there is no frame to give support, all parts of a Unibody car act as a unit to keep the passenger compartment intact during a crash.

The side-guard beams inside the doors help support the dash and firewall in a frontal collision. The roof rails act as columns to keep the front of the car off the passengers. The floor bends to push the motor and transmission down and away from the passenger compartment. And built-in "crumple zones" made of soft metal absorb kinetic energy during the front or rear collision. However, while absorbing impact, the doors jam, the roof buckles and the floor bends upward, often trapping the passenger's legs underneath the dash assembly.

Unibody construction gets it strength from shape. If you look inside a front-wheel drive car, you will see a hump where you think the transmission sits. This hump has nothing inside it, it exists only because the shape serves as longitudinal strength for the car. It is much cheaper for manufacturers to roll sheet metal into columns for strength than it is to build solid steel posts, and it is just as strong. Unlike a frame vehicle, an impact on any part of the vehicle has some type of impact on other parts, that is, the rear hatch may be jammed during a t-bone collision. (Question – why must convertibles have bucket seats? Answer – since there are no "B" post to hold the floor up, the strength comes from a bigger and beefier floor pan and transmission tunnel.) The advantage is that Unibody has reduced weight for better fuel mileage & reduced component costs. An impact on one side of the car usually means the opposite side has best access, but the size of today's compact cars may preclude this access route. Today's entrapment scenario involves the dash, not the steering wheel as it was in past auto designs.

Since the majority of cars on the road today utilize Unibody construction, chances are you run across them quite frequently in performing extrications. Think. These cars are made out of sheet metal that depends on shape for strength. When added strength is necessary, generally at a change of direction or angle, metal connectors are added. Know these areas, because the metal is thicker do not cut it, use it to push against. (Weight savings come at a price, for every pound saved it adds $100 to the price of the vehicle. It is little wonder that some modern vehicles cost as much as a house!)

SPACE FRAME or BIRD CAGE CONSTRUCTION - In 1983, space frame construction was added to the list of design trends with the introduction of the Pontiac Fierro. Space frame is a series of frame or skeletal components fused together on which

body components are placed. The space frame gets its strength from a cage assembly that supports the driveline and all interior components independent of the body. Body panels, many of which are plastic, are attached to the space frame by screws, rivets, and other connectors. This type of construction came from NASCAR racing, where light weight and high strength construction is a must to be competitive. The main advantage of space frame is that it gives adequate strength and protection in a lightweight assembly. All Saturn's, GM mini-vans, Chevrolet Luminas, and the 1996 Ford Taurus/Mercury Sable line use this type of construction. When built, the car is under tension and compression that will be relieved often violently, when you cut a structural component. (For example, when performing a dash roll on the Chevrolet Lumina, cut the "B" post before the "A" post to relieve the tension.) Most space-framed vehicles use plastic body parts. (Plastic bodied cars are a problem because there can be very significant structural damage to the vehicle and they may have no outward signs.)

When extricating people from tangled space frame vehicles, the best approach is to strip away the body panel that covers the area you want to move or cut, and then go to work on the steel frame. (The outer skin of a door is for the paint, the real strength is the inner door.) An air chisel or reciprocal saw will make short work of these panels. You may be able to expose the fasteners and sever them with the air chisel so you can remove the entire body panel. But if not, cutting a "window" is usually good enough to expose the framework. Prying actions may be difficult.

TUNNEL BRACKET SYSTEM - was introduced on the Cadillac Alante in 1990 and now found on nearly all new cars, is designed to strengthen the center of the dash area for mounting dual air bags. It also is to prevent side crushing in t-bone accidents. It is essentially a "roll bar" that connects the "A" pillar to the opposite "A" pillar and the floor pan.

Dash roll ups in these vehicles are possible using rams, but impossible using the spreaders due to the strength of the construction. When ramming, you will notice a characteristic "gull wing effect" where the outboard section of the dash lifts and pivots on the center bracket and the "A" pillar folds outward.

PLASTIC BODY CONSTRUCTION – introduced by Chrysler in 1998 for future cars, this type of construction features no frame. The body consists of several large pieces of plastic that are glued together. The advantages of this type of construction are obvious – the body is molded in the color the customer wants (hence no scratches or dents), it is cheaper to build and lighter in weight. It is not yet clear how this type of construction will affect emergency services.

BUMPERS

In 1973, the government required energy absorbing bumper systems on the front end that can absorb a 5-mph hit and sustain no damage. In 1974, the requirement was changed to require absorbing bumpers front and rear. In 1983, the government reduced the standard from 5 mph to 2.5 mph. (The Ford Motor Company continues to go with the

5 mph standard). Currently, the bumper standard ends in 1999 although there is a bill before Congress to reinstate it.

The problem with most energy absorbing bumpers is that in a fire situation they can launch the piston tube up to 300'. They usually do not store energy if they become compressed in an accident and therefore are no problem in most cases. Think of an imaginary "bowling alley" that extends from the front and rear of all automobiles. Stay out of the bowling alley, and you will be out of harms way.

Starting in model year 1997, many manufacturers are building their bumpers out of a type of plastic that makes the bumper very flexible. When this substance burns, it melts into hydrofluoric acid, one of the most damaging & toxic forms of acid. It will eat through almost any type of boot and poison the person wearing them.

FUEL SYSTEMS

In 1975, the Federal Government increased emission control standard to include a vapor recovery system and modified filler neck for unleaded fuels. This means that the fuel system on all modern vehicles are closed and not vented to the open atmosphere. Located in the filler neck is a clapper valve that is designed to slow down fuel leak in a roll-over type accident.

The 1973-87 model year full size General Motors pick-up trucks have a extra fuel tank carried on the outside of the frame rails. In 1993, GM was sued successfully for negligence and fined $105 million for the 1989 death of a 17 year old when the fuel tank exploded in a t-bone DUI crash. Now all manufacturers tend to place the fuel tank between the axles for better protection.

Some manufacturers are using plastic fuel tanks that tend to be safer in an accident, but fail quicker in a fire. (Recent test shows that these tanks will fail within 2 ½ minutes of direct flame contact, but they will not explode.)

In the 1990's nearly all manufacturers are placing the fuel pump in the fuel tank. The pump pumps at 90 psi and is usually operating anytime the ignition is turned on. (Even if the engine is not running). This means that the fuel system is pressurized and will spray gas with force if it is cut.

Alternate fuel vehicles include the following:

LP-GAS VEHICLES (1.5 million on road now) the system operates at 175 psi, and the gas is heavier than air.

NATURAL GAS VEHICLES (1/2 million on road now) the system operates at 2,400 psi and the gas is lighter than air. In 1995 it is now required that the vehicle be placarded on front or back and 1 side.

ELECTRIC VEHICLES - In 1995, many municipalities, (Richmond being one), are converting their vehicles over to battery power. All automotive manufacturers now produce at least one model of electric car. (Ford has an electric pick-up truck that can do 70 MPH with a 1,000 pound load). Electric vehicles pose unique problems. For example, batteries contain potassium hydroxide that is a very powerful corrosive, as well as operating at 600 degrees F.

CATALYTIC CONVERTERS

In 1975, manufacturers for emissions control introduced catalytic converters. The shell gets to about 1,000 degrees F, 2,000 degrees if car is sitting still. A catalytic converter will melt an air bag. Use caution when the vehicle is located off the road since a grass or brush fire may add to the rescue problem.

Just about all cars have at least one. The 1990 Corvette has three! (One on each side of the engine block and one in the exhaust system.)

BATTERIES

Car batteries contain sulfuric acid, and can retain a charge even if the case is broken. (Diesel vehicles usually have 2 batteries). Modern cars have wires that are self extinguishing in case of fire. Leave the battery alone unless you have a very good reason to disconnect it. (Consider electric seats that you may want to operate). If you must disconnect the battery, remove ground wire 1st (Follow the wire that goes to a common part of car), then the hot-wire, (in case the battery is ruptured and the plates are touching ground). Foreign cars have a positive ground.

Starting in 1997, Chrysler cars will have the battery hidden away in the front wheel well making it very difficult (you must turn the tire in-board) to access. It is expected that all manufacturers will eventually place the vehicle battery in a similar location. In the case of 1998 BMW's with a Battery Safe System (BSS), don't be surprised if you arrive and find the battery already disconnected. If the airbags deploy, there is an explosive charge on the battery terminal that will blow the cable off the battery.

GLASS

Today's vehicles have 2 types of glass. The windshield that is made of two sheets of glass with a plastic laminate in the center, and safety or tempered glass that is extremely strong and difficult to break. Safety glass is found everywhere but the windshield.

1927 - First real safety glass was invented, before then people were literally cutting their throats in accidents.

1960's - Laminated glass construction is introduced. Car designers consider the windshield a form of restraint device since it keeps the occupants from being ejected. A "star pattern" found on a windshield after an accident is considered the point of impact of a occupant's head. It is a clear indicator of a significant head injury.

1986 - Ford Tarus and Ford Sable came out with a 70 volt defroster system that theoretically can electrocute. If motor is off or there is a crack in the windshield, then a safety switch cuts power to system.

1987 - Anti-lacerative windshield is introduced on limited models, (mostly Cadillacs). (Look for inspection decal on side glass.) No problem for rescuers.

1995 - Plastic windshields hit the market. They will not yield like present day glass so look for more severe head and neck injuries. Also, plastic glaze will be present on side and back glass that will prevent a center punch from working.

Windshields are considered part of the vehicle structure for roll-over. (Do not mess with the windshield if the vehicle is resting on its top). The best way to gain access is to cut the glass out. We are no longer able to remove intact due to the way it is mounted, (with an epoxy-like material). Be aware that when you cut glass windshields with the sawzall glass dust is produced when can be inhaled. Protect yourself and patient with filter masks.

Controlled breakage of safety glass should take place before the use of any hydraulic tool. Safety glass is easy to remove. Just use a spring-loaded center punch and push against a corner. Beware! If the vehicle has been torqued, the glass may be under tension and will explode with force. Always tape safety glass with duct tape before popping. If you can roll the window down, then do so to save on the amount of glass sprayed. If you are bending metal to perform an extrication, first remove all safety glass to prevent additional problems.

DOORS

Crushed doors still remain the biggest challenge for most rescuers. In a frontal collision, the doors absorb much of the impact and the metal folds together at the latch and hinges, literally welding the door in place. Side impacts force the door inward, usually so the door is directly impinging on the patient.

Doors start with an inner skin of metal that forms the inside, bottom and ends. This inner skin houses the latch assembly, door handle mechanisms, window assembly and collision bar. The outer skin is placed over the surface of the inner skin to hide the mechanism and keep the elements out. The outer skin does nothing for the strength of the door and it is becoming popular to make the outer skin plastic instead of sheet metal.

The outer plastic panel can also get in the way when forcing doors on space frame vehicles. The common complaint is that the plastic tears. Try completely stripping away plastic body panels to expose the metal frame. This metal frame is your pry point for the hydraulic spreader.

With Unibody vehicles, it is a good idea to sever the roof posts and displace or remove the roof early during an extrication. Without the roof, the body of the car loses a great deal of strength. (Remember that you must have an intact roof to perform a "through-the-window" door removal.) It is nearly impossible to effectively displace the dash when both A-posts are intact, or if the opposite side door is still jammed shut. Remember, closed doors are part of the structural integrity of a Unibody vehicle. Door hinges are the weakest part of the door assembly. (Therefore attack them aggressively) Hinges can be:

Bolted - use hand tools to remove.
Welded - pop with hydraulic tools
Bolted & Welded - do both.
Riveted - do not pop, use air chisel to cut through.

Do not tear metal when you are popping a door. It is a waste of energy and will get you nowhere. Instead, think and use the strength of the car to your advantage. The door lock is the strongest part of the door. The reason is simple, if the door should pop open in an accident then the occupant will be thrown out and in all likelihood killed. The bolt in the post that the latch grabs is sometimes called the "Nader Bolt", (the reason is obvious). Nader Bolts first were introduced in 1967 as the result of a federal safety requirement. They are made of hardened steel and therefore should not be cut with conventional hydraulic power tools. The sawzall can cut through this bolt in 30 seconds, but you need access to the bolt first.

Beware of "childproof" and automatically locking door locks. Childproof locks on the rear door prevent the door from being opened from the inside. Automatic door locks activate whenever the transmission is placed in gear. The best way to handle this type of lock is to place the transmission in Park. Also, look for a "lock/unlock" switch. If there is electrical power the locks will unlock.

One thing we will be dealing with in the future is the alignment bolt. These are now being added into doors because the side-impact safety standard has resulted in heavier doors. This means that some model cars will have 2 striker bolts in addition to an alignment bolt.

STEERING COLUMNS

In 1967, energy absorbing steering columns were introduced to stem the deaths front head-on collisions. In the old days, rescuers would pull the steering wheel up and off a victim by wrapping chains around the column and pulling toward the front of the car with hydraulic tools. In modern cars, the steering column is connected to a "shear capsule." On impact, the shear capsule allows the column to absorb energy, reducing injury to the driver. After a crash, the column is left hanging loose underneath the dash, and supporting nothing.

It is important to realize that the shear capsule is independent of the dash, and the plastic dash will not move when the column is displaced. "Ramming" the dash with

hydraulic rams is the preferred method for moving the wreckage off the patient after a frontal collision.

CYLINDERS ON HATCH BACKS

Cylinders found on hatch backs are filled with flammable gas, (usually LPG), because it is cheap. Use a key to open or disarm the cylinder by removing it at hinge. Never cut through any cylinder on a vehicle.

COMPOSITION CAR BODY

In 1995, many manufacturers started using composites in roof and hood construction. The problem is that you cannot bend roofs back using the old conventional methods, you must cut using a sawzall. The car will turn into dust when in a MVA, and this dust is toxic. You may have to wear a SCBA for extrication.

SUPPLEMENTAL RESTRAINTS

In 1903, seat belts were first invented. They were not really used until 1920's, and then only on racecars. In 1965 they first appeared in production cars as an option on the Ford Mustang. It was not a safety feature; they wanted to sell a fast car and only racecars had safety belts. In 1968, air bag technology was invented. General Motors had it as a $850 option on the Impala.

Starting 1991, the government stated that either a passive restraint system or air bag must be in place. (A passive system is a seat belt that is located in door and is automatically applied.) Air bags are considered “supplemental” since they work secondary to the seat belt. The device must be automatic and withstand a 30-mph head-on crash test. (Air bags have reduced driver deaths in head-on impacts by 24% since their inception.) In 1995, the Volvo 850 introduced side air bags located in the back seat. Since their inception, over 500,000 devices have deployed and 2,000 lives saved. But this safety comes at a cost. Over 80 deaths have occurred directly as a result of airbag deployment, (44 children, the rest small adults most of whom were unrestrained). Because of the problems with the force behind conventional airbags, in 1998 slower airbags (25-30%) can be used.

Air bags are designed to work in conjunction with seat belts. The designers, (primarily TRW Industries), as well as all the manufacturers, knew there would be injuries and fatalities when the project began. If the driver or passenger is "out of position", (*OOPS occupant*) e.g., not sitting in the seat as the seats were designed; injury or worse is a possibility. In 1994, a small female driver of a vehicle was "out of position" when the bag deployed. She had slumped or been thrown forward before the necessary impact to deploy the system. The engineers later decided the force the air bag exerted against her would be somewhat like trying to catch a basketball thrown at 200 mph. If the occupants are sitting in the seat, secured by seat belts and shoulder harness, there is a significantly reduced possibility that the body would be "out of position". However, recent research has shown that the OOPS occupant may be someone who is seated properly and seat belted, but has the seat moved forward so they may

reach the foot pedals. Indeed, should an air bag deploy check for a red dot in the middle, this is blood from the broken nose the driver usually receives.

Automotive engineers are considering several answer to the many problems air bags have presented. On answer is the "*smart seat*". This device is the occupant seat and has sensors that determine the weight of the occupant and deploys the air bag accordingly.

Another answer is an on/off switch that the driver may activate according to their prerogative. What dangers these devices will present to the rescuer remains to be seen. Air bags will deploy when any 2 of many sensors are started as a result of a 14- mph deceleration within a 12-degree arc from the front of the car. (Extrication should not activate the system, but always disconnect the car battery to be sure). The entire sequence takes about 1/40 of a second, and sounds like a shotgun blast. Air bags are designed to protect occupants from frontal impacts up to 30 mph. The speed of a deploying air bag is somewhere between 150 - 240 mph. Keep in mind that an air bag punches out with the same force regardless if the car is moving at 70 mph or sitting still.

When air bag's first came out, there was great concern about the airborne particles that were released. As it turns out, the dust is nothing more than corn starch that is used to lubricate the bag. A test was performed with volunteer asthmatics and it was found that the dust did not cause any respiratory problems. Now that many new vehicles are equipped with 2 air bags you will find the quantity of particulate has doubled. It will appear the car is on fire. You have nothing to worry about.

On August 21st, 1995, several firefighters in Dayton, Ohio were injured when an airbag deployed unexpectantly during a rescue operation. Evidently, the firefighters were in the process of pushing a steering post when their hydraulic tool shorted-out the airbag connector and the airbag deployed. One tip of the spreader came into contact with the supplemental restraint system (SRS) diagnostic unit, which contained contact points that complete the circuit during a crash to deploy the vehicle's air bag system. The dual air bags deployed, ejecting the rescuers out of the car. With this in mind, the following procedures should be followed in any vehicle extrication operation where the air bag has not deployed:

- Stabilize the vehicle and disconnect or cut the negative battery cable.
- Disconnect the airbag connector at the base of the steering column of General Motor's vehicles.
- **DO NOT CUT THROUGH THE STEERING COLUMN UNTIL YOU HAVE DISCONNECTED EITHER THE BATTERY OR THE AIR BAG CONNECTOR**; do this only as a last resort and make sure the ignition is turned off.
- If you cannot disconnect the airbag connector, wait 10 minutes after the battery is disconnected before putting your body or objects against the airbag module in the steering wheel, EXCEPT for essential patient care and rescue maneuvers.
- Minimize exposure to the inflation zone of each air bag if it were to deploy. Electrical storage capacitors present in an air bag system may allow the system to

remain energized with reserve power even though the battery has been disconnected.

- Do not cut or drill into the airbag module.
- In the unlikely event that the airbag module is ruptured, do not touch or ingest any exposed chemicals.
- Otherwise, use normal rescue procedures. Keep in mind that air bags are pyrotechnic devices and deserve great respect.
- Ford manufacturing is advertising to disconnect the battery cables and touch them together, shorting out any residual electrical energy. This will reduce the drain time from 10 minutes to 1 second.

Volvo uses a pressure sensor to deploy side air bags. Volvo suggests that rescuers take steps to protect the sensor unit mounted on the outside seat rail during extrication efforts and sever the igniter cable in the seat back to make the side bags safe, (you must dig down to find the cable). Be very careful when removing the door, any force placed on the igniter switch will activate the side air bag. BMW is placing their side-impact bag in the roof seam, as in adding another in the door. This means that when you open the door to access the patient, there is an air bag behind you.

1996 - Dynamic side impact protection will be required. (30 mph impact protection). It was expected to prevent 500 fatalities yearly. Mercedes-Benz started selling its most elegant autos with 17 airbags, (that is correct - 17!).

1996 - The "Bag Buster" is introduced to rescuers. This device consists of a metal plate with hooks that attaches to the steering wheel in front of a loaded air bag and is designed to burst the air bag instantly should it unexpectantly deploy. Most nationally recognized rescuers do not recommend the use of the device, especially since the inventor has no supporting research data that shows its worth. Another device, invented and marketed by the Holmatro Rescue Tool Company is called the "Secunet". The Secunet consists of a durable bag that is wrapped around the steering wheel and secured with a nylon strap. Holmatro has done extensive testing with this device and they are confident of its worthiness.

1999 - Light trucks will be required to have front-seat bags.

Proposed - The Federal Government is looking at a problem that has surfaced with passenger air bags. Children secured in child seats are carried facing rear-ward in the passenger seat. When the air bag on that side of the car is deployed, the force breaks the child's neck very effectively.

FYI - An estimated 1 million air bag equipped cars are being built every month. In 1996, a driver spilled his soft drink on the floor, which seeped into the air bag modulator and activated his air bags! Engineers call this the "law of unintended consequence". There is no way they can predict all the different ways people can accidentally activate the air bags system.

AIR CONDITIONER SYSTEMS

Since 1994, it is against Federal Law to use R-12 (freon) in the air conditioner system of new vehicles. Freon has now been replaced by OZ-12 that is a mix of propane and butane. You will find 2-5 lbs. in the A/C system. Expect a big bang in a fire.

SUSPENSION SYSTEMS

The latest and hottest thing in luxury cars is air ride suspensions. The driver can now choose the type of ride, (soft, medium, firm), with the flick of a switch. The more elaborate cars have their suspensions controlled by a computer, (called "Load-Leveling"). This will be a problem when you attempt to raise the car with rescue air bags. The computer will sense one side of the car raising and will attempt to adjust the level of the car by raising the opposite side. This will also happen when you attempt to roll the dash, the car will try to raise up. This is all taken care of by shutting off the motor since there is no reserve supply of air. Remember that the bags can deflate unexpectantly, so establish your cribbing early and liberally.

INDIVIDUAL CAR DANGERS

There are some cars out there you need to pay particularly close attention to. Not to be picking on any one car manufacturer, but some cars are just plain dangerous to rescuers. Here are a few examples and the dangers involved:

YUGO: The Yugo is a mini-subcompact that is made as cheaply as possible, for the lowend buyer. What makes it cheap is its construction; its metal is as thin as possible and if anything can be plastic then it is. This car is bad for the occupants because there is nothing substantial in its construction. The wheel base is just 85" and its weight is a mere
1,832 pounds.

PONTIAC FIERRO: A once very popular sports car first introduced in 1983. Production ceased in 1988 due to safety concerns about occupant's survivability in accidents. (It was the most popular American car in 1984 and 1985). Its construction was unique. It had the engine located in the back seat while the car battery was behind the driver's seat. The gas tank was a 14-gallon tank located in the transmission hump next to the driver. (The "Nader's Raiders" complained to the government about its poor location so it was moved in subsequent models, to underneath the driver's seat!). In older models the catalytic converter was under the driver's seat. **ALL THIS WITHIN A 24' CIRCLE!** The outer skin of the car was a plastic shell called Enduraflex, which gives off HCN gas, (the same stuff used in gas chambers and is skin absorbed), when it burns. Because of its flimsy construction, (light means fast), the Fierro will blow apart in an accident. Access should be no problem.

MINI-VANS: Chrysler Corporation pioneered the development of the mini-van, a vehicle representing a cross between a truck, station wagon and car. Their Plymouth Voyager and the Dodge Caravan are classified as "first-generation" minivans and have been imitated by many competitors. General Motors

entered the market with it's plastic-bodied All Purpose Vehicle (APV) in the fall of 1989. GM's Lumina, Silhouette and Transport APV's represent the "second generation" of minivans. These vehicles can carry up to 9 people at a time, making it a moving mass casualty incident. Because of the light construction employed, there will be many injuries, mostly head in nature. You cannot pull the steering wheel (lack of hood) and hydraulic tools will have a fit because there is really nothing substantial to push against. The best way to gain access is with a sawzall or your bare hands. The side sliding door has 2 safety pins, which is hard to force. (You may want to consider doing a 4th door on the opposite side).

The new mini-vans are even more of a problem for rescue technicians because the outer body panels are made of plastic and it is very hard to find any purchase points for tools. One nice thing is that the bucket seats are easily removed for patient access & removal. Since the introduction of the 1992 model Chrysler minivans, medical personnel must rethink their patient packaging procedures for children riding in the new Voyagers and Caravans. New van buyers can order the middle bench seat with Chrysler's integrated Child Seat feature. This middle seat is located at the sliding side door, can serve as a standard bench seat or can be converted to one or two child safety seats for younger passengers.

This design appears to be functioning well. The concern is for medical crews who have become used to packaging children in their individual car seat and removing them together. When this crew arrives and encounters the new design, it is unrealistic to consider removing the child and seat as one unit. The medical crews must again become proficient in packaging and extricating a pediatric patient without the safety seat.

Minivan vehicle collisions call for accurate assessment of patients to possible head injuries, (which carries a very high incidence in minivans), prior knowledge of the vehicle's special features, and an available arsenal of primary and alternate disentanglement techniques to achieve the safest and most efficient possible rescues.

TOTALED vs. TOTALLY DESTROYED

Many rescuers make the mistake of not doing enough to get a victim from a wrecked vehicle properly. Consider again that cars are not made like they used to be. Due to modern lightweight construction techniques, cars that look like they have sustained light to moderate damage may in fact be totally written off by the insurance company.

Keep in mind following the following facts:

- If 70% of the VALUE (miles, year, NADA book value, etc.) of a car is damaged, then the car is considered totaled.
- If 2 airbags deploy, it will add $2,000 to $2,500 to the repair bill and the seat belts must be replaced as well.
- If the car is > 3 years old, insurance companies will normally appraise it for repair. Cars are disposable, they are worth nothing. Do yourself and the victims a favor, bend metal!

THE FUTURE

What does the future hold for car design and problems for us rescuers? Here is a partial list of things to watch for...

NEW DESIGN - For years, automobile manufacturers and the Federal Government have used destructive testing to check the effectiveness of new designs. This testing usually is conducted by running the test car into a wall at a 90-degree angle, (head-on testing). The problem with this test is that few autos hit an object square, (license plate to license plate).

Pressure by the insurance industry will be changing the test method to a more realistic approach. This new type of testing, (offset testing), involves running the test car into an object at an angle. Since most modern cars fail this type of test easily, expect to see radical design changes as well as increased strength in cars. (An example will be steel rods placed in the "A" post to prevent crushing.)

MICRO-ALLOY STEEL - AKA "high strength low alloy (HSLA) will be added to strengthen certain parts of autos as composites become more widely used. This metal, (which has 100,000-psi strength, about 3x the strength of steel) will be almost impossible to cut with modern tools. This steel is already found in the horizontal beams found in doors and in parts of the roof for additional lateral strength.

ASSISTED SEAT BELT RETRACTORS - These devices will be attached to the seat belt retractor and will fire if there is a crash. The purpose is to tighten the seat belt substantially to prevent the occupant from moving forward. If the occupant is out of position or a rescuer accidentally fires one off, the seat belt can then strangle. These devices will be operated by the same mechanism as dash air bags and will contain an exposed tube of sodium azide. If rescuers accidentally cut this tube then the sodium azide will be immediately toxic to anyone in the passenger compartment.

SIDE-IMPACT - It was no surprise to the rescue community when side-impact testing revealed that great numbers of injuries occur when the occupant's head strikes the roof rails or post. In the past, cars were only crash tested to meet safety standards for front or rear collisions. But recent changes require cars to meet new side-impact standards. To reduce side-impact injuries, most automakers will be adding thick padding to the roof rails, over the front windshield and down the "A" and "B" posts. Rescuers will notice this change when attempting to cut the posts or roof rails with hand tools. Before cutting, it will be necessary to strip away more plastic and padding to prevent binding of hacksaw blades. However, if you are using a reciprocal saw or hydraulic cutters, you shouldn't notice a big difference.

In 1997, BMW introduced the Inflatable Tubular Structure (ITS). ITS is a hermetically sealed tube that inflates in a fraction of a second in t-bone collisions. It emerges from the roof lining above the door to shield the driver's head against impact and also any flying objects and glass splinters from the side window. ITS will be available in the 7 series now and in the 5 series later on. Probably the best way to deal with this

system is to completely remove the roof at the posts. Using a through-the-window method of pushing the door away from the car may activate the system with disastrous results.

Additional lateral strength will be added to cars in an attempt to prevent intrusion by side-impacting cars. This will prevent roof flaps and dash rolls as we perform them today. The answer will be to totally remove the roof and perform a different type of dash roll.

INCREASING SAFETY THROUGH RESEARCH - Another thing we will have to contend with are beefier hinges. Engineers examining wrecked vehicles looking for ways to improve safety in their design were surprised to find broken hinges with the door hanging by its striker bolt in a lot of cars. They designed the hinges to be bigger and stronger to combat the problem. As is always the case, they did not do their research well. The broken hinges were the direct result of rescuers using new techniques to allow patient access!

SIDE WINDOWS - Laminating plastic will be added to the inside of side windows to absorb some of the impact when the occupant's head strikes the glass and keep the window intact. The current method of using a spring punch to shatter tempered side glass will still work, but only as a first step. You will also have to either cut the plastic or pull the entire sheet of glass away from the patient area, which will actually be beneficial since it will reduce the amount of shattered glass at the scene.

In 1999, unbreakable side glass will be required in automobiles. This is an attempt to prevent a victim's arms and head from extending from the passenger compartment in roll-over type accidents.

INCREASED PILLAR CONSTRUCTION – Foam is now being added to the A & B posts to deaden sound and add rigidity. This foam will tend to bind up a sawzall blade so be aware of it. Also, B pillars are now coming with a channel to slide the seat belt holder up and down for occupant comfort and safety. This means an increase in steel where you would least expect it.

HIDDEN AIRBAGS – Surprisingly, airbags are the #1 theft item. To combat this problem, auto manufacturers are hiding the airbags. Chrysler products have no seams or labels that alert a rescuer to the fact that the vehicle they are working on may contain airbags. No longer will you be able to look at the dash and tell.

ITS – Inflatable Tubular Structure is coming in BMW series 5 & 7 by the middle of 1997. Originally developed to prevent head injuries in military helicopters, it is now on its way to the automotive world. The information source for this is Automobile Magazine for May 1997 in the FOB section page 27. According to the magazine, the inflator is located under the dash. These units will deploy electronically with their conventional door mounted side airbags. ITS stays inflated for a period of several seconds unlike conventional airbags to protect against secondary impact.

FMVSS – Federal Motor Vehicle Safety Standards have been published by the Federal Government for years. These standards affect how vehicles are designed and built, hence how we as rescuers work to get people who are trapped out. The rules are changing and this is what to expect:

FMVSS 216 – all passenger cars must be able to carry 1.5 times its weight on the roof applied at a 30 degree angle to the roof supports without deforming > 5" the pillars. In 2000, all light trucks must conform to this standard. Expect pillar and roof construction to be beefed up.
FMVSS 208 – occupant safety. Effective 1997 all passenger cars, (1998 all light trucks) must have a supplemental restraint system for both the driver and the front seat passenger.
FMVSS 214D – side impact safety. Effective 1997 all passenger cars (1998 all light trucks) must be able to sustain a 15 mph hit broadside by another vehicle traveling 30 mph and protect both the driver and passenger from fatal injuries.