FIVE STEP DISCIPLINE FOR OVERTURNS/UNDERRIDES

By: Billy Leach, Jr., Developer and Presenter of BIG RIG RESCUE™

Uprighting a loaded cement mixer, perhaps lifting the rear of a loaded van trailer is an everyday task for heavy recovery operators. Place someone who is injured and trapped in an auto underneath such a vehicle and a challenge begins. While heavy recovery operators may easily overcome this challenge it may prove a formidable challenge for fire/rescue responders. This challenge may critically be a matter of life and death for the victims of the accident, and prove dangerous to emergency responders also.

To provide a guideline for success regarding overturns or underrides, I promote a **5 Step Discipline**. An overview of this discipline is in the information that follows. It is an effort to provide fire/rescue responders a simple list of steps to follow when faced by such an intimidating sight.

Step 1:

Identify the cargos of all vehicles involved. Many training programs offer specific information regarding cargo identification and the responder is urged to complete a hazardous material training program in order to be prepared. Sources of information available on scene are: shipping documents, placards, container shapes/sizes/colors/labeling, the vehicle operator, the vehicle owner, and the shipper. Certainly this affects the safety of all involved and is the first task performed. Hazardous material releases are best handled by appropriately trained and equipped personnel. Also included in this step is mitigation of hazards involved with the vehicles themselves. This is common practice among responders to vehicle collisions and includes: scene assessment, fire/fuel hazards, de-energizing the electrical system, searching for victims, and calling for additional resources. Typically big rigs carry 100-150 gallons of diesel fuel in each tank. Usually there are two tanks mounted alongside the tractor known as 'saddle tanks'. Its commonplace for at least one tank to rupture during a substantial collision, perhaps both. Responders should understand the characteristics of the fuel (s) involved and be prepared to mitigate the associated hazards. Undeployed SRS also present a problem, generally in the smaller vehicle in an overturn/underride situation. Promptly de-energizing the electrical system in all vehicles involved is an important task. Big rigs typically have a bank of batteries parallel wired to offer greater starting amperage. The location of the battery banks varies according to rig itself. There is no definite location of battery banks for each rig. The battery cables of big rigs are larger than that of autos, nearly the size of 00 gauge wire. The cables may be disconnected at the terminal or double cut using a cutting tool. The preferred cutting tool is a hand-held ratcheting cable cutter such as used by industrial electricians. Once an assessment of the scene is completed additional resources are usually requested. Incidents involving big rigs vs. smaller vehicles may require such resources as heavy wreckers; USAR trained responders and their gear, heavy rescue squads, and extended incident traffic control devices. Ideally these resources will be responding on the initial alarm. Preplanning for the dispatch and response of special resources is fundamental when faced with big rig collisions.

Step 2:

Stabilize the larger vehicle. This is critically important to increase safety for responders and prevent further injury to victims. Generally fire/rescue responders attempt to accomplish this using timber cribbing and strut systems. While these tools are very useful they simply may not be able to provide the support needed. This may be due in fact to the construction of the larger vehicle or the damage inflicted upon it during the accident. The optimum in this circumstance is using the heavy wrecker as a stabilizing tool. Typically there is sufficient force and tools needed to perform this task on a heavy wrecker. Moreover it is important that fire/rescue responders realize the limitation of their equipment in this type of collision. Fundamentally they must understand the weight involved, construction methods and materials of various trucks and trailers in order to appreciate these limitations. Without knowing the weight (resistance) imposed upon the stabilization gear the possibility of exceeding the Working Load Limits (WLL) is certainly possible. Responders should be able to calculate the loads (resistances) in order to operate safely. Generally vertical weight is calculated using the industry accepted value of axle weight values: thin profile steering tires of a Class 8 big rig (tractor trailer) carry a front axle weight rating of 12,000 pounds, larger front 'balloon' tires are calculated using a front axle weight of 25,000 pounds, and the drive axles of the tractor and trailer axles are calculated at 20,000 pounds each. If the axles are to be supported vertically as in the case of an underride these axle weight ratings are useful in determining the amount of stabilization needed. When an object is lifted vertically, 100% of the weight is assumed by the lifting gear. Using a Law of Physics, "For every action there is an equal and opposite reaction." or simply 'force pairs' responders can calculate the total amount of stabilization capacity needed. For example, an auto is involved in an underride with the front steering axle of a big rig. The big rig axle weight rating is 12,000# and the auto is trapped underneath which has lifted the front axle vertically. Thus a total of 12,000 pounds of stabilization support is needed. Conversely the lifting force required is also 12,000 pounds. With an overturn of a big rig onto a smaller vehicle the calculations are performed differently. For example, a fully loaded tractor trailer (80,000 pounds) has overturned onto an auto. As responders we will be stabilizing one side of the truck nearest the auto, perhaps allowing the total uprighting prior to performing extrication. If the big rig were at zero degrees from horizontal (flat on the surface with no auto involved) responders would only be lifting half of the overall weight which is 40,000 pounds. Further calculations are made using this figure as it becomes the maximum amount to be lifted. As the horizontal angle of the big rig increases the weight becomes less due to the application of Class 2 lever principle and movement of the Center of Gravity (COG). At 30 degrees from horizontal the lifting/stabilization would require 50% of the maximum of 40,000 pounds equaling 20,000 pounds. These are recovery industry accepted values that are useful during extrication operations. Obviously they could be affected by certain cargos (liquids) and the way in which they are positioned after collision. Once a weight (resistance) is known stabilization gear can be applied. Typically the best tools include timber cribbing and strut supports.

Struts may be used very effectively with big rig incidents due to the vertical stabilization height needed and weights imposed upon them. The use of chain slings with struts is also very effective. A minimum of Grade 80 (or greater) chain should be used during extrication operations. Preferably ½" link diameter chain is used to maximize the support provided by the strut. Generally this requires the use of alloy steel strap shackles used with strut attachments. A basket hitch can be employed using two struts and chain slings which doubles the single leg capacity of the chain sling if the 'legs' of the sling are at 90 degrees to the load. Caution should be exercised so as to not create a sharp bend in the chain. If a chain sling passes around a 90 degree bend in which the bend radius is less than two times the link diameter the WLL of the chain sling is decreased by 50%. This can be avoided by 'padding' the bend using cribbing.

Step 3:

Lower the smaller vehicle. Typically this isn't possible, as the heavier vehicle has crushed the smaller one to some extent. Simply deflating the tires may provide a few inches of lowering. Generally the suspension of the smaller vehicle will compress upon heavy loading, creating an added problem during lifting the larger vehicle. As the big rig is lifted the suspension will relax thus allowing the smaller vehicle to rise. Actually this will decrease the total amount of lift gained nearly 5-6". Suspension compression may be helpful, and can be accomplished using a ratcheting load binder strap (minimum of 2" width). For example when the front of an auto has struck the rear of a tractor trailer, the strap is connected to the front wheels of the auto and the strap tightened. As the larger vehicle is lifted the suspension will remain compressed. The larger vehicle must be lifted high enough to provide clearance for appropriate rescue measures. Alternative extrication techniques may be performed, i.e. trunk tunneling. Perhaps this technique will be of benefit and offer the opportunity to maintain axial spinal alignment. Responders should learn and frequently practice alternative techniques for such incidents involving overturns/underrides.

Step 4:

Lift the larger vehicle. Certainly this is best accomplished with a heavy wrecker and its associated equipment. When lifting such weight it is vitally important that fire/rescue responders understand their limitations when using common extrication equipment. I urge responders to seek out training providing details of lifting physics, timber cribbing capacities, big rig anatomy, rigging, and heavy lifting operations. Only after a thorough knowledge of this information will they understand their capabilities. As the vehicle is lifted, it should be fully supported by equipment that is within its WLL. Herein lays the benefit of timber cribbing, vertical strut systems, and heavy wreckers. Obviously continuous observation must be provided for any lifting or uprighting operation to increase the safety for all involved. The area completely surrounding the vehicles should be under constant surveillance by responders who can sound a command to halt the lift. This command must be established prior to any lifting, and understood by everyone on scene.

Such an operation may be lifting and stabilizing several thousand pounds, thus the **"LCES Concept"** should be employed. **L**ookouts should be established, **C**ommunication among all ensured, **E**scape Routes identified, and **S**afe Areas identified as well.

Responders are urged to seek out their local heavy duty towing and recovery operators and train with them prior to any incident. It is important to understand the capabilities and limitations of the heavy wreckers as well. In fact, the ideal circumstance is to arrange for the response of a heavy wrecker on first alarm assignment to an overturn/underride incident. Unless an actual recognized emergency vehicle, the heavy wrecker must obey all traffic laws and regulations without fail. Using today's cell phone camera technology pictures from various angles of the collision can be forwarded to the incoming heavy units. This allows an opportunity to begin assessment prior to arriving for the operators. An area large enough for the heavy wrecker to operate should be provided on scene. A responder should be assigned to accompany the wrecker operator and facilitate the lifting operation. During the actual lifting operation the lifting manager should be in constant voice, visual, or touch contact with the wrecker operator.

Step 5:

Separate the vehicles and extricate victims. Although controversial it provides increased safety for victims and emergency responders. Depending upon the type of big rig it may provide increased safety to upright the rig rather than operate under it. Once the lift has begun it is safer to continue until the overturned big rig is uprighted. After lifting the larger vehicle, the smaller one is attacked similarly to a common extrication problem. It is inadvisable and dangerous for anyone to work beneath a suspended load. A thorough knowledge of timber cribbing, struts, and heavy rigging is paramount to provide safety for all involved.

A restricted path for patient disentanglement and subsequent movement is a potential consideration for moving a vehicle with patient still inside. Simply, it may be better to move the larger vehicle which in turn would provide fewer encumbrances during patient egress. Should extrication be complicated by impalement, or patients trapped beneath or between vehicles/objects it may be better to move a vehicle with patient remaining inside.

Responders should consider the following regarding movement of vehicles during extrication:

1. Weight/resistance of vehicle to be moved
2. Capacity of the lifting device
3. Structural integrity of vehicle to be moved
4. Actual impingement of the vehicles

Advantages may be gained by moving vehicles containing patients. They are:
1. Improved access to patient for emergency medical care
2. Improved egress for packaged patient while maintaining axial spinal alignment
3. Decreased extrication time
4. Safer for all concerned as responders are not working under a suspended load

As with almost any extrication tool/technique there are disadvantages as well. Moving a vehicle during extrication has these as well. Some to be considered are:
1. Increased hazards during the movement, i.e. fuel leaks or spills
2. Providing stabilization of the patient during this movement
3. Providing stabilization of all vehicles during movement

The decision to move any vehicle involved in an overturn or underride should be given very deliberate consideration. There is seemingly no definitive rule or standard that must be followed; simply it is a thoughtful decision of the incident manager based upon the circumstances at hand.

Once the decision to move a vehicle that contains a patient is made, practice the following strategy:
1. When placing stabilization tools initially, consider potential movement of the vehicle
2. Package the patient as securely as possible in position found
3. Move the vehicle slowly and deliberately
4. Once movement is complete, stabilize the vehicle securely and provide extrication

The previous information is simply an overview to the 5 Step Discipline. The **BIG RIG RESCUE ™** program provides much greater information regarding this topic and fosters a cooperative working relationship among heavy recovery operators and fire/rescue responders. For more details please feel free to contact me via email, **billyleach@gmail.com** or surface mail, PO Box 4324, Asheboro, NC 27204.

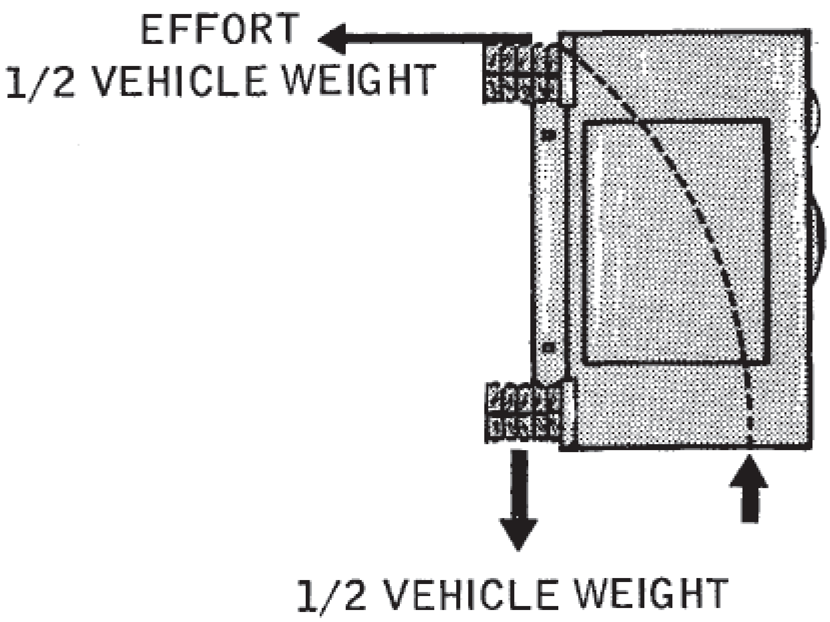
OVERTURN OF A LARGER VEHICLE ONTO SMALLER VEHICLE

To begin uprighting **at 0 degrees**, 50% of the vehicle's weight must be moved (example- a tractor trailer weighing 80,000# requires 40,000# of uprighting force initially)

At 15 degrees, 75% of the initial force is required to continue uprighting (example- a tractor trailer requiring 40,000# uprighting force initially now requires 30,000#)

At 30 degrees, 50% of the initial uprighting force is required (example- a tractor trailer would now require 20,000# of uprighting force)

At 45 degrees, 25% of the initial uprighting force is now required (example-a tractor trailer would now require 10,000# of uprighting force)



Uprighting force is at most, one-half total static weight of the vehicle. To begin uprighting **at 0 degrees,** 50% of the vehicle's weight must be moved.

VAN TRAILER INFORMATION

Questions & *Answers*:

1. What is average weight of a typical empty van trailer?
   13,000-16,000#

2. What are 'strong' points of van trailer to use in rescue/recovery? Conversely, what is weakest area?
   Strongest portion is the floor. Weakest portion is the roof.

3. What is considered to be the actual 'strong' points/parts of the van trailer?
   A van trailer is "frameless" thus; all parts top to bottom provide the strength needed to carry loads. The strongest part of the trailer is the floor. This is similar to 'unibody' type construction.

4. Is the use of air ride suspension for van trailers increasing?
   Yes. Many commodity manufacturers require the use of air ride suspension to prevent transit damage.

5. How do air ride suspensions work?
   Typical air rides use 8" diameter rubber bags located on each axle end that act as a spring. A leveling valve supplies air to the individual bags as needed from a reservoir. Compressed air is supplied from the tractor via 'glad hands' through tubing to the reservoir tank, then to the leveling valve(s), finally reaching the air bag themselves.

6. What is most common side wall material for van trailers?
   Sheet and Post =approx. 60%
   Composite =approx. 35%
   Aluminum Plate & Fiberglas Reinforced Plywood (FRP) = approx. 5%

7. What is the typical 'thickness' of sidewall construction?
   Sheet & Post = 2"
   Composite = 7.5mm
   Aluminum Plate = 5/8"
   FRP = 1"

8. What is the typical material and thickness used for flooring in van trailers?
   Most use 1-3/8" hardwood, remainder use aluminum or wood /aluminum combination Laminated oak is a commonly used material.

9. How is the side wall typically connected to flooring in van trailers?
   They are connected using either 3/8" aluminum rivets or 3/8" steel bolts, depending upon what is required. The fastener shear value varies according to the diameter and alloy used.

10. What is most common material/thickness used for van trailer roofing?
    .040" mill finish aluminum =approx. 90%,
    .075" fiberglass =approx. 10%

11. What is the industry standard for landing gear capacity?
    50,000# static vertical loading for both crank down and telescoping pin type

12. Do refrigeration units add substantial weight to the nose of a trailer?
    Yes. The amount is dependent upon the size of the unit. Generally these units are mounted on a steel framework on the front trailer wall.

COMPOSITE MIXER DRUM INFORMATION

Provided by McNeillus, a major mixer manufacturer

Questions & *Answers*:

1.How much does empty composite drum weigh? Is this drum lighter than steel?

11 yd composite = 2,900 lbs and steel drum = 4,400 lbs. 1,500 lbs less than steel drum.

2. Are there any 'strong' points on the drum to use during recovery? Conversely, are there any 'weak' points on the drum to avoid?

We suggest positioning your straps around the steel roller rack and also around the front pedestal after doing the normal wheel chocking and safety precautions of uprighting.

3. During recovery, should straps be used, or is steel chain & wire rope acceptable?

Straps of comparable capacity are recommended.

4. Can composite drums be retrofitted in place of steel drums?

Yes, if the steel drum was large enough size. You can also replace pedestals if desired which expands what can be retrofitted.

5. Do composite drums increase the cost of a unit?

Yes, they cost more initially. After you operate the truck for a few months or so, the initial cost is mitigated.

6. Are the drums entirely composite, or is steel used for reinforcement?

The only steel is the roller track and the mixer drive socket.

7. Is the drum capacity the same as steel?

Yes, and is certified to the standards of the National Ready Mix Concrete Association.

8. Are composite drums gaining in popularity?

Yes, almost in all 50 states.

9. Do temperature extremes affect the drum, i.e. during recovery?

No, part of the pay back is the thermal properties by helping in hot & cold temps to maintain batching temps of the concrete mix.

10. What is the expected life of composite drums?

Better than steel for abrasion resistance.

HYBRID TRUCKS

***Identifying a hybrid truck:**
>exterior badging/emblems
>bright orange cables
>dashboard markings
>larger battery containers

***General Guidelines**
>Assume vehicle is ‘live’
>Don’t cut/handle orange cables
>Don’t cut or open hybrid components

***Emergency Procedures:**
>Secure the vehicle. Stabilize horizontally & vertically using common materials. Place wheel/tire chocks to prevent horizontal movement (upright vehicle). Responders should place tire/wheel chocks in front of, and in rear of a minimum of one tire. Tires should not be deflated. Stabilize vehicles other than upright using buttresses, cribbing, or other appropriate equipment

>Once access into the passenger compartment is gained, ascertain the need for the operation of any electrically powered features of the vehicle and activate such features as deemed appropriate. For example:
-unlock all doors
-lower window glasses

>Isolate the electrical system.
Switch off ignition switch (or stop engine) and remove key a minimum of 50’ away. Maintain the key a minimum of 50’ away at all times.

>Cut seat belts for the seats occupied.

>Determine the location of 12V (low voltage) battery(ies). Begin hazard mitigation activities if physical damage to the battery has occurred, i.e., electrolyte spill, arcing, etc.
Once battery(ies) has been located and exterior responders are prepared to de-energize the electrical system inform the interior responder(s) to coordinate the timing of shutdown.

De-energizing the Electrical System at the Battery:
Cut or *disconnect* the negative (ground) battery cable first using care not to touch any metal part of the vehicle with the cable end or cutting tool. If cutting the battery cable, cut the same cable twice to remove a 2” section. If you choose to disconnect the negative cable at the terminal, bend the loose cable end onto itself. Isolate the bare cable clamps from re-establishing a connection. Tape or two exam gloves may be used.

Ascertain if there is any evidence that electrical power from the battery is still supplying the vehicle. Look for lights remaining on (even if dim), horn working, chimes sounding, etc.

In a severe crash make certain that the battery case hasn’t been penetrated by metal parts that could re-establish an electrical circuit.

To completely de-energize the electrical system, cut or disconnect all positive (hot) battery cables. If cutting the cable, cut the same cable twice to remove a 2” section. Re-check the vehicle again to make certain that electrical power isn’t being supplied to the vehicle.

If the electrical system remains energized after these actions, determine the location of additional batteries and repeat the foregoing procedures. If the battery isn’t accessible, remove all fuses.

>*Extricate victims ‘normally’*. Cab construction doesn’t affect ‘normal’ extrication methods.
Perform the ‘Peek & Pry’ Technique:
1. Responders should peel away or remove trim components to visually inspect for potential hazards hidden from ordinary view.
2. Do not spread against, or cut anything that comes into question after ‘Peek & Pry”.

>*Extricate, not extract!*
Safely perform extrication procedures with undeployed SRS.
The IM shall assure that the three potential hazards with undeployed SRS are avoided. These include:
1. Unintentionally powering the electrical firing circuit causing SRS deployment
2. Causing the SRS propellant to react by mechanical force, heat exposure, spark or static electricity
3. Creating a puncture by crushing, or cutting into a high pressure cylinder used in a SRS

The safest and most efficient technique to open a door with an undeployed side impact system is to open the door at its hinges, beginning with the top hinge.
Once the door is disconnected at its hinges, responders must remain clear of the side impact deployment path for a distance of 5” from the door.
Once wiring to the door is cut and the door is completely free of the vehicle, it should be placed in a designated area with the armrest side (interior) facing upward.
If the roof of the vehicle obstructs access to patients, or prevents their removal, the preferred rescue procedure is total roof removal.

Delay moving or completely cutting through the steering column until the electrical system is de-energized.

Do not place equipment such as spineboards in front of an undeployed SRS airbag attempting to contain it if deployment were to occur.

Do not attempt to cut or puncture the SRS airbag itself to prevent deployment.

Do not place anything over an undeployed SRS airbag in an attempt to contain it.

Should you find a patient in the ‘5-10-20” deployment path’, efforts should be made to safely relocate the person ASAP.
If conditions permit, and you desire to move the patients away from frontal SRS airbag, recline the seat if appropriate for the patient. Removal of the seat back portion should be considered. Moving the entire seat could potentially place it into the correct position for SRS airbag deployment.

When moving a dashboard use caution to avoid direct force against an undeployed SRS airbag inflator unit.

***Emergency FF Procedures:**
>Fight fire 'normally'
>Secure the vehicle
>Isolate the electrical system

Position charged fire hose(s). The fire hose should flow a minimum of 100 gpm and be staffed by two firefighters protected by a complete ensemble of PPE, including SCBA with mask in place.

The fire hose(s) should be positioned between the primary fire hazard and responders/patients. Consider placing a second charged fire hose into position to protect opposite side of the vehicle, large vehicles, or multiple vehicles.

Class B firefighting foam should be considered for use during firefighting.

All patients must be fully protected by fire resistant covering that provides excellent flash fire resistance. This covering must be left in place until actual patient removal is necessary.

***Emergency Submerged Procedures:**
>No risk of shock
>Remove vehicle from water
>Secure the vehicle
>Isolate the electrical system

RESPONSE TO MOTOR VEHICLE COLLISIONS
OVERTURNS and UNDERRIDES

SCOPE

It is the intent of this suggested operating guideline that responders shall operate at motor vehicle collision scenes within recommended safe practices.

AFFECTED PERSONNEL

All responders who may operate at a motor vehicle collision scene involving an overturn or underride.

OBJECTIVES

These suggested procedures are promulgated to maximize safety and efficiency when operating at overturn or underride scenes, and include the following tactical objectives:

I. Identify the cargo of all involved vehicles and mitigate hazards
II. Stabilize the larger vehicle
III. Lower the smaller vehicle
IV. Lift the larger vehicle
V. Separate the involved vehicles and extricate

I. Identify the cargo of all involved vehicles and mitigate vehicle hazards

A. Upon approaching the scene make every effort to identify cargo of all involved vehicles:
   1. Shipping documents
   2. Driver of vehicle
   3. Container shape/color
   4. Placards
   5. Container labels

B. Mitigate/prevent fire/burn hazards:
   1. Ascertain fuel leaks/contain spills/stop leaks while operating at level of responder's training
   2. Prevent flammable/combustible vapor production while operating at level of responder's training. Responders should monitor the atmosphere surrounding the collision using appropriate equipment for flammable/combustible vapor detection.
   3. Place protective hoselines in operation. These hoselines should be capable of flowing a minimum of 100 gpm, and be staffed with firefighters in complete PPE ensemble including SCBA. Consider multiple hoselines on opposite sides of involved vehicles placed between the fire hazard(s) and victims.

4. Once responders have safely gained access to victims they should be covered with a fire retardant covering as completely as possible. This covering should be maintained throughout extrication operations until victims are ready for removal. *Vehicle stabilization should occur concurrently with vehicle hazard mitigation.*

C. Hazardous material involvement:
   1. Responders should never operate at any level above their training or equipment provision.
   2. Responders should summon hazardous material personnel and equipment in order to deal with hazardous materials
   3. Responders should consult the current US DOT ERG for specific information regarding hazardous materials.

D. De-energize the electrical system of all involved vehicles:
   1. Vehicle Interior Rescuer(s)
      a. Once access into the passenger compartment is gained, ascertain the need for the operation of any electrically powered features of the vehicle and activate such features as deemed appropriate. For example:

         -unlock all doors
         -lower window glasses
         -unlock truck/hatch
      b. Turn off ignition switch (or stop engine)
      c. Operate interior hood release mechanism to release hood if accessible
   2. Vehicle Exterior Rescuer(s)
      a. Assess condition of bumper and front of vehicle. Approach if deemed safe to do so. If deemed unsafe, move rescuers to side of vehicle to access engine compartment.
      b. If working from front of vehicle, release exterior hood safety catch and open hood. If hood won't open from the front, or it is safer to work away from the bumper, move to the side of vehicle and open the hood. Once opened, secure the hood in an open position.
   3. Determine the location of battery (ies). If the battery isn't located in the engine compartment, find the alternate location and gain access to the battery. Consider use of available reference materials indicating battery and SRS locations.
   4. Begin hazard mitigation activities if physical damage to the battery has occurred, i.e. electrolyte spill, arcing, etc.
   5. Once battery (ies) has been located and exterior rescuers are prepared to de-energize the electrical system inform the interior rescuer(s) to coordinate the timing of shutdown.

E. De-energizing the Electrical System at the Battery

1. *Cut* or *disconnect* the negative (ground) battery cable first using care not to touch any metal part of the chassis with the cable end or cutting tool.
2. If cutting the battery cable, cut the same cable twice to remove a 2" section. If you choose to disconnect the negative cable at the terminal, bend the loose cable end onto itself. Isolate the bare cable clamps from re-establishing a connection. Isolation can be performed with tape or even two exam gloves.
3. Ascertain if there is any evidence that electrical power from the battery is still supplying the vehicle. Look for lights remaining on (even if dim), horn working, chimes sounding, etc.
4. In a severe crash make certain that the battery case hasn't been penetrated by metal parts that could re-establish an electrical circuit.
5. To completely de-energize the electrical system, cut or disconnect all positive (hot) battery cables. If you cutting the cable, cut the same cable twice to Remove a 2" section. Re-check the vehicle again to make certain that electrical power isn't being supplied to the vehicle.
6. If the electrical system remains energized after these actions, determine the location of additional batteries and repeat the foregoing procedures.

II. Stabilize the larger vehicle

A. Determine the weight/resistance to be stabilized

1. Consult the involved vehicle's dataplate for weight ratings
2. Inspect the tire sidewalls for weight rating
3. Use recovery industry calculations
4. *Vehicle stabilization should occur concurrently with vehicle hazard mitigation*

B. Use cribbing for stabilization

1. Ensure cribbing is within WLL

C. Use struts/chain slings for stabilization

1. Ensure struts/chain slings are within WLL

D. Use heavy wrecker for stabilization

1. Ensure all rigging gear is within WLL
2. Constantly communicate with operator prior to, during, and after any movement

III. Lower the smaller vehicle

A. Deflate the tires

1. Ensure a controlled deflation onto stabilization devices

B. Consider alternative extrication techniques

1. Trunk tunneling
2. Others

IV. Lift the larger vehicle

A. Determine the weight/resistance to be stabilized
1. Consult the involved vehicle's dataplate for weight ratings
2. Inspect the tire sidewalls for weight rating
3. Use recovery industry calculations

B. Use a heavy wrecker for lifting
1. Ensure all rigging gear is within WLL
2. Constantly communicate with operator prior to, during, and after any movement
3. Stabilize as the lift occurs

C. Use air bags for lifting
1. Use largest capacity bag that will physically fit into lifting area
2. Consider stacking two high pressure bags prior to lifting
3. Do not consider air bags as stabilization tools
4. Follow accepted training guidelines when using air bag lifting systems
5. Stabilize as the lift occurs

D. Use jacking tools for lifting
1. Follow accepted training guidelines when using jacking tools
2. Stabilize as the lift occurs

V. Separate the involved vehicles and extricate

A. Separate the involved vehicles
1. Calculate resistance of smaller vehicle and rig accordingly
2. Use a wrecker or winch equipped vehicle

B. Extricate victims using accepted tools and techniques
1. Keep victims covered with fire retardant covering throughout extrication

INCIDENT RESPONSE

It is essential that agencies plan for responses involving overturns and underrides. The agencies involved should include:

- Law Enforcement
- Emergency Medical Services
- Rescue Squads
- Fire Departments
- Environmental Conservation/Protection
- Public Works/DOT
- Emergency Management
- Towing/Recovery Services

Consideration for these incidents should include minimizing the number of responders and summoning the *appropriate* resources for initial alarm. Staging areas remote from the scene may be useful until specific needs are determined.

Response Resources

Following is a suggested list of resources summoned for an overturn/underride incident on *initial alarm*:

- 2 ALS ambulances
- 2 Heavy Rescue Squads
- 1 Engine Company plus water tenders to provide 2,000 gallons supply on scene
- 2 Heavy wreckers
- USAR resources
- Law Enforcement

Consider special calling for these resources:

- Air Cushion Recovery unit
- Rehab unit
- Traffic control resources
- Lighting unit
- Support unit with additional/special tools, i.e. cribbing, struts, etc.
- Helicopter ambulance
- Hazmat response

BASIC TRUCK WEIGHTS

Number of axles	***Gross vehicle weight or gross combination weight***
Three or less	55,000#
Four	66,000#
Five or more	80,000#

Special permitting may allow greater weights and greater number of axles on the roadway. Responders should seek local information regarding the common vehicles in their response area.

TRAILER INFORMATION

<u>Dry Freight Van</u>

Likely the most common trailer in use is the dry freight van. A vast array of commodities is transported by these units.

Dry freight van trailer

28’ Pup trailer

Converter dollies are connected to the pup trailers

Generally the maximum length allowed on highways in most states is 53’. It isn’t uncommon to see two joined 28’ foot trailers known as ‘pups’ traveling the roadways. In some areas of the US you may see ‘doubles’ or even ‘triples’. Special permitting may even allow longer or wider units to travel the roadways.

The typical dry freight trailer is known as a ‘frameless’ unit. Thus, each component is interdependent upon another for integrity. This is similar to the well known unibody construction of automobiles.

<u>Side rails:</u>
Generally heavy duty extruded aluminum is used for the top and lower side rail. These rails travel horizontally along the top at roof level, and bottom of the trailer at floor level. They provide substantial integrity for the trailer.

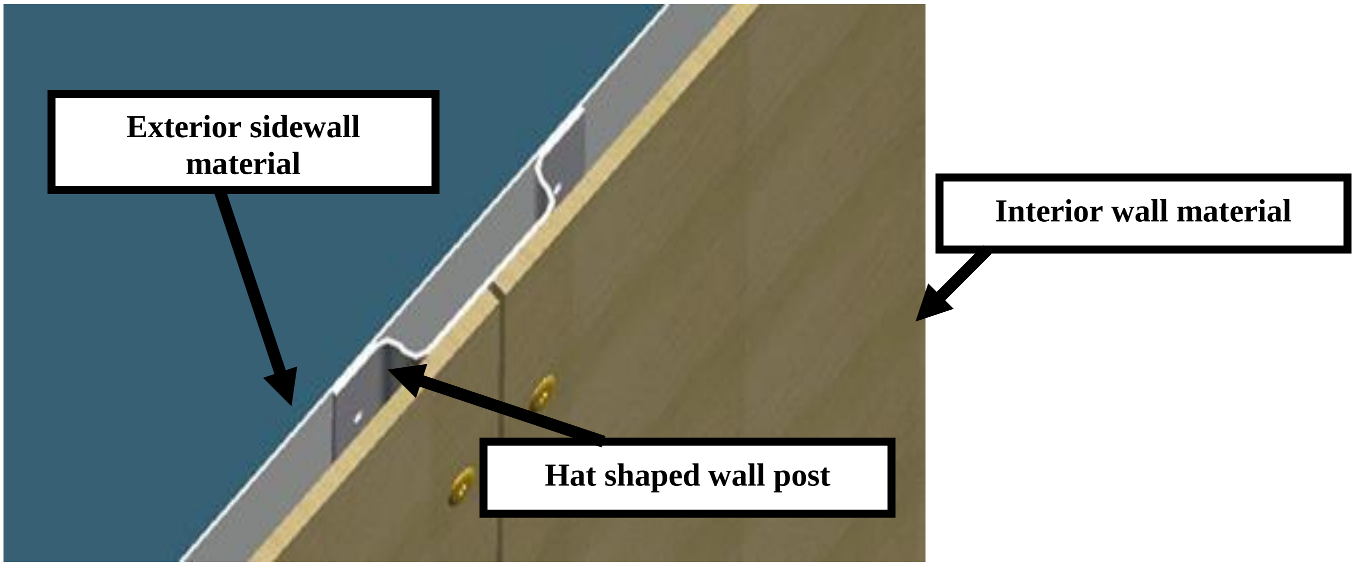
Floor:

The floor of the typical van trailer is constructed of thick boards that are fixed to 'crossmembers'. The thickness of the floors is generally 1-2".

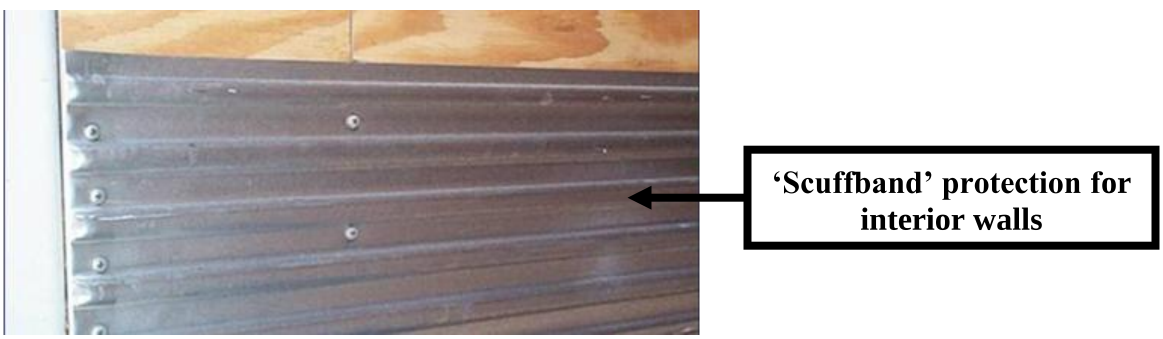
The bottom and sides of these boards are coated with preservation materials to lengthen their life. The joints are sealed to prevent entry of foreign material. Generally the boards are fastened in place with screws.

Sidewall and Front:

Sidewall construction of van trailer differs greatly upon the specific use and specifications of the purchaser. Exterior sidewalls may consist of aluminum, composite material such as Fiberglass Reinforced Plywood (FRP), stainless steel, and others. Stainless steel sidewalls offer greater puncture resistance than other materials. Commonly aluminum is used as a material for the exterior sidewall. The thickness used is near .040". The exterior sidewall covering is attached to posts, similar to studs in a wood frame wall. Rivets are used to fasten the exterior sidewall to the posts.

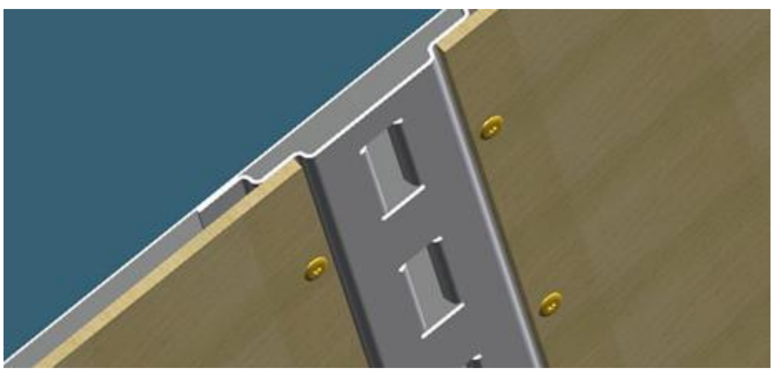


The interior walls are usually ¼" plywood that is screwed or riveted into place against the posts. Generally the interior walls are protected from damage near the floor. Obviously this is to provide an extended life for the interior walls. Protection may be applied to the doors and front of the trailer as well.



The front of the trailer is generally constructed with reinforcement to prevent damage. Heavier gauge steel posts, perhaps aluminum are used along with other formed material to add this strength.

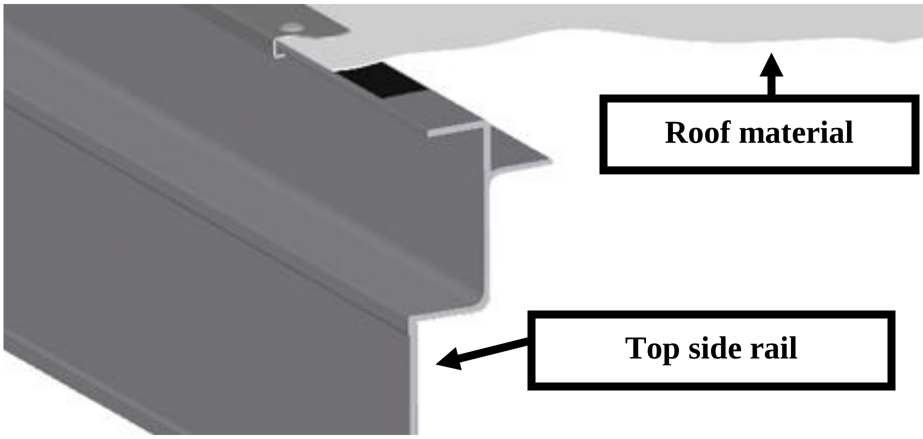
Logistic interior walls may be used as well. Simply this is an attachment point for various types of cargo restraints, i.e. ratchet straps.



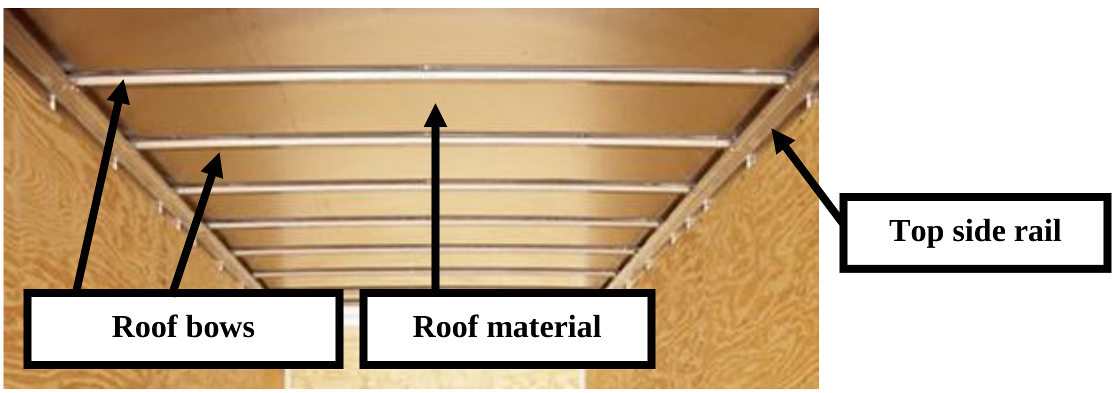
Logistics wall

Roof:

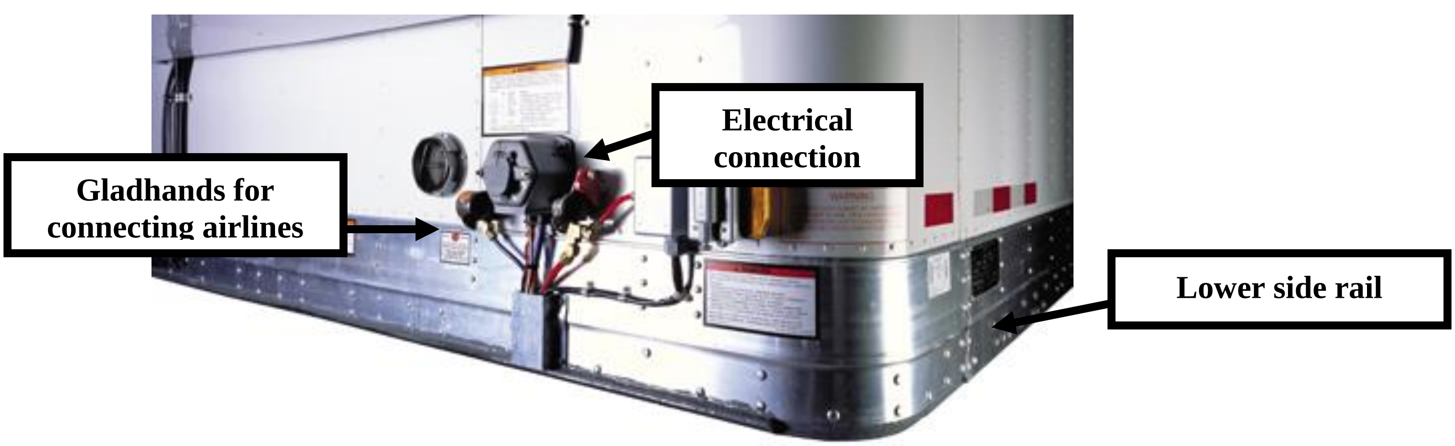
The roof of a van trailer is typically made of .040”aluminum or .075” composite material, i.e. fiberglass. The roof bows may be made of steel or aluminum; riveted to the top side rail. The actual roof material is attached to the top side rail and roof bows. There are many variations of the roof depending upon the purchaser’s desires.

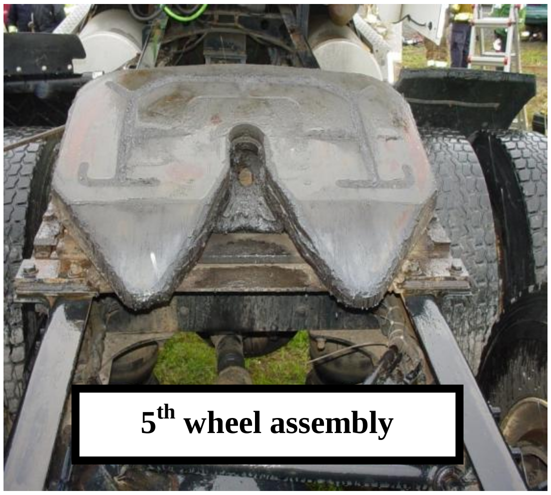


Sealant is used at the joints to prevent entry of foreign material such as moisture.



<u>Exterior Front:</u>
The front or 'nose' of the trailer provides electrical and airline couplers. Also the King Pin is mounted in this area. The King Pin is the moved into the 5th Wheel and locked in place by a high strength 'drawbar'. The upper coupler area provides an optimum location to lift or rig during rescue.





5th wheel assembly

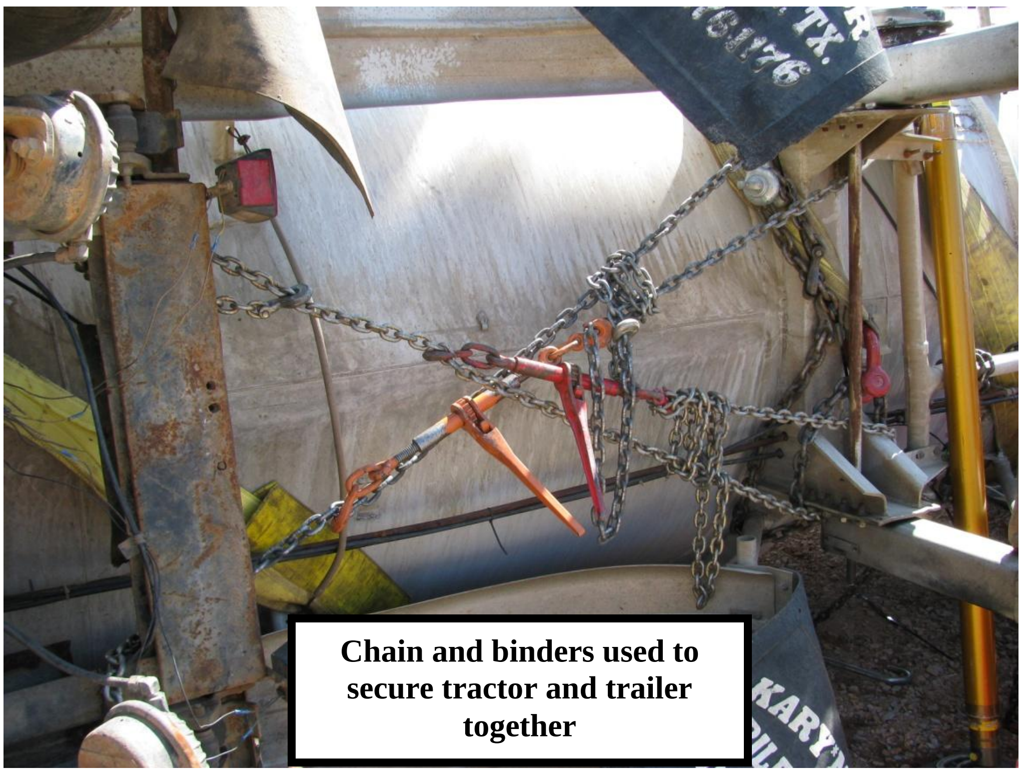
King Pin locked in place by drawbar

Upper coupler and King Pin

It is important for responders to determine if the tractor and trailer are indeed connected. If not, responders must deal with two separate and independent units. In order to determine this, responders should carry a hand light and visually inspect the 5th wheel and king pin area. The drawbar should be in place and secure around the king pin. Also, it is important to inspect the integrity of the 5th wheel mounting assembly and make certain it is indeed securely attached to the tractor frame. Likewise, inspect the upper coupler to determine its integrity and connection to both the trailer and king pin.

If damage is seen responders must manage the stability of the tractor and trailer independently.

If the king pin is in place yet not secure responders may use chain and binders to secure the units together. A minimum of Grade 80, 3/8' diameter chain is used along with ratcheting load binders to secure the units together. The binders should be sized for the chain link diameter and be able to sustain the chain's WLL.



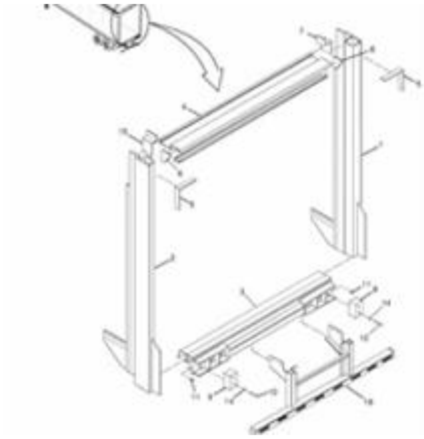
Chain and binders used to secure tractor and trailer together

Rear:

The rear of the trailer is reinforced as well to provide strength for the rear door mounting. Doors may be of differing construction. Two of the most common types used are the swing door and the roll-up door. The doors themselves should offer no significant problem during forced entry.

Typical swing doors

Typical roll up door



Reinforced rear construction of trailer

It isn't uncommon to find doors mounted in the side of the trailer. These will be similar in construction to the rear mounted doors. Surrounding the side door will be reinforcement of the trailer sidewall.

Mounted at the rear of the trailer will be a horizontal impact guard. This is designed to deter impact of a smaller vehicle. Generally the guard shouldn't be used as a rigging or lifting point during rescue operations.

Rear impact guard

During rescue operations it is generally discouraged that rear trailer doors be routinely opened. Opening the rear doors decreases the integrity of the trailer, simply due to removing the potential strength of the doors themselves.

If moving the trailer is necessary during the rescue, responders should cross-strap the rear of the trailer. Using ratcheting binder straps they are crossed to resemble the letter "X". This will improve the integrity of the trailer somewhat.

Cross strapping the rear of the trailer

<u>Landing Gear:</u>

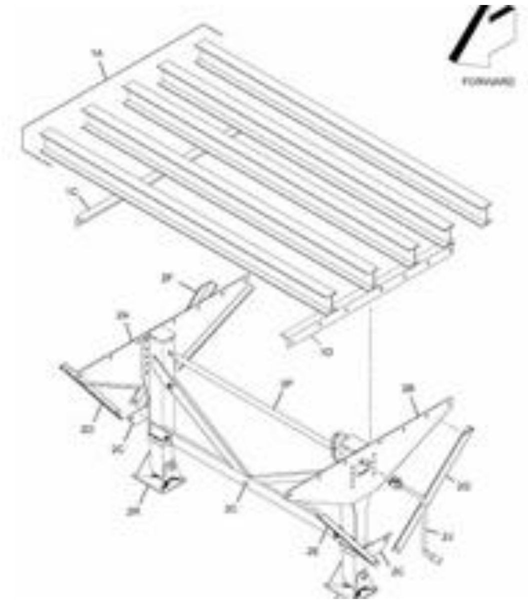
Support for the front of the trailer is provided by the landing gear. This gear is attached behind the king pin, and is typically bolted into place. Some gear may be welded into place.

The gear is lowered for support by manual cranking of a handle. This operates a set of gears that simply allows the gear to descend. Single-speed and two-speed gear sets exist to lower the gear, depending upon the type installed.

Typical landing gear

Lowering the landing gear by cranking

Some landing gear uses telescoping gear. Simply a metal tube slides into a larger tube, held in place by a metal pin. The smaller tube is lowered to desired height, and then the pin is inserted to secure the gear.



Landing gear mounting

During rescue operations landing gear should not be used as a sustained stabilization tool. Other tools such as cribbing or struts should be utilized to provide effective support. Prior to using the landing gear for any reason carefully inspect for cracks in the frame area, any missing, bent, or broken components.

<u>Rear Exterior:</u>
At the trailer rear are the axles, usually tandems although you may see triples. You may even see Super Singles, which are large single tires and wheels that replace the typical two tire/wheel configuration.

Super singles reduce weight and cost

The tandems may be sliding tandems. Simply this means that the rear axles slide as a unit in order to accommodate the weight of the cargo. Generally either spring or air ride suspension is used to offer a smooth ride for the cargo.

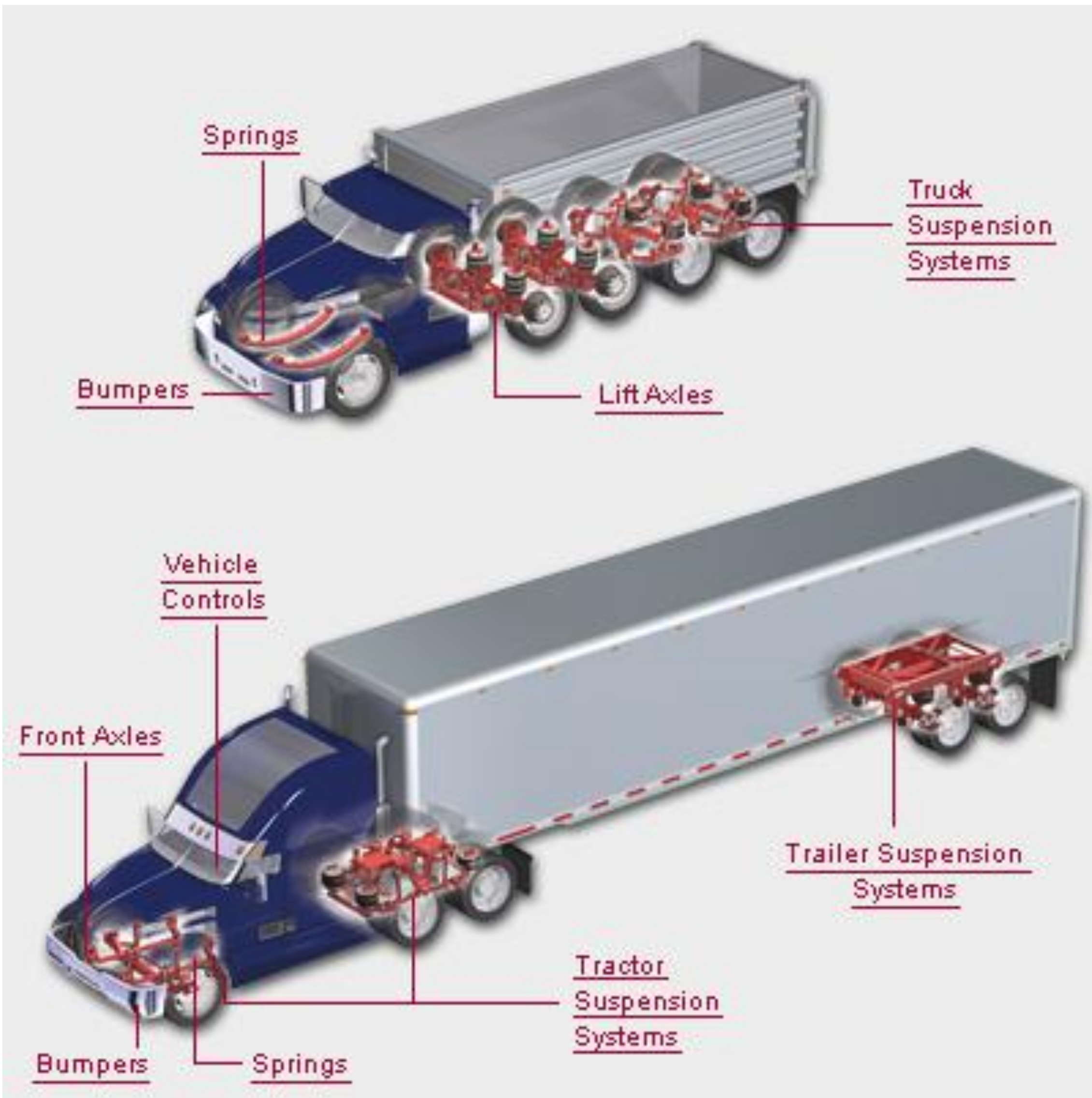
Sliding tandems

Make certain locking pins are in place and secure

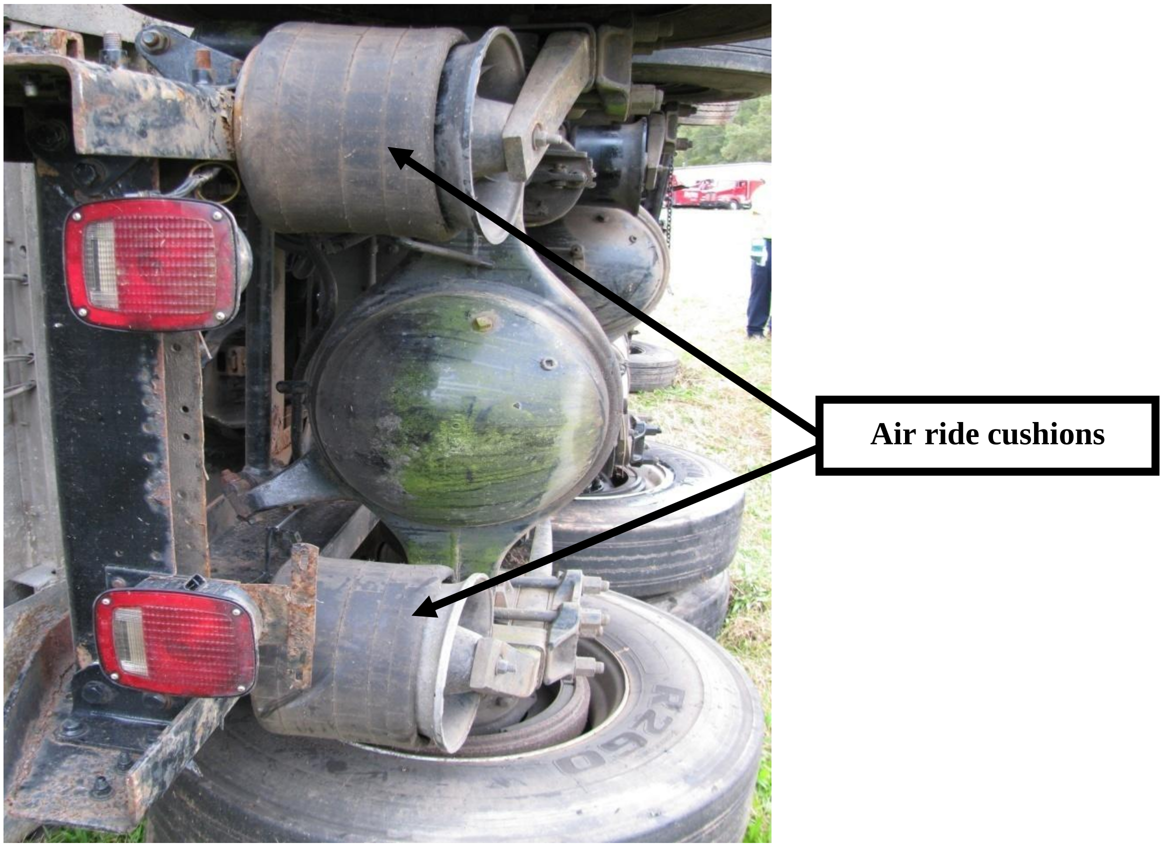
Responders should determine if the sliding tandems are indeed locked into place during rescue operations. Simply visually inspect the assembly to make certain the locking pins are in place and secure. Otherwise responders should not change the position of the axle or alter the locking mechanism.

Generally the rear of the trailer is supported either using spring suspension, or air-ride suspension. Spring suspension is composed of heavy leaf springs to support the weight of trailer and cargo. Air-ride suspension relies upon air pressure to inflate/deflate air bags. The pressure inside the air bags is regulated by a leveling valve. This valve allows air to enter or leave the bags in an effort to offer a smooth ride. Air pressure is supplied to the trailer from the tractor’s onboard air system. The actual connection for the trailer’s air system is made via gladhands. The gladhand connections are located at the trailer’s front end.

Plumbing to air-ride suspension systems varies, thus it is unadvisable for responders to attempt using it to raise or lower a trailer's rear end. With the many variables in plumbing for the air-ride suspension it may not operate as responders intend, creating a danger.



Both the tractor and trailer may have air ride suspension



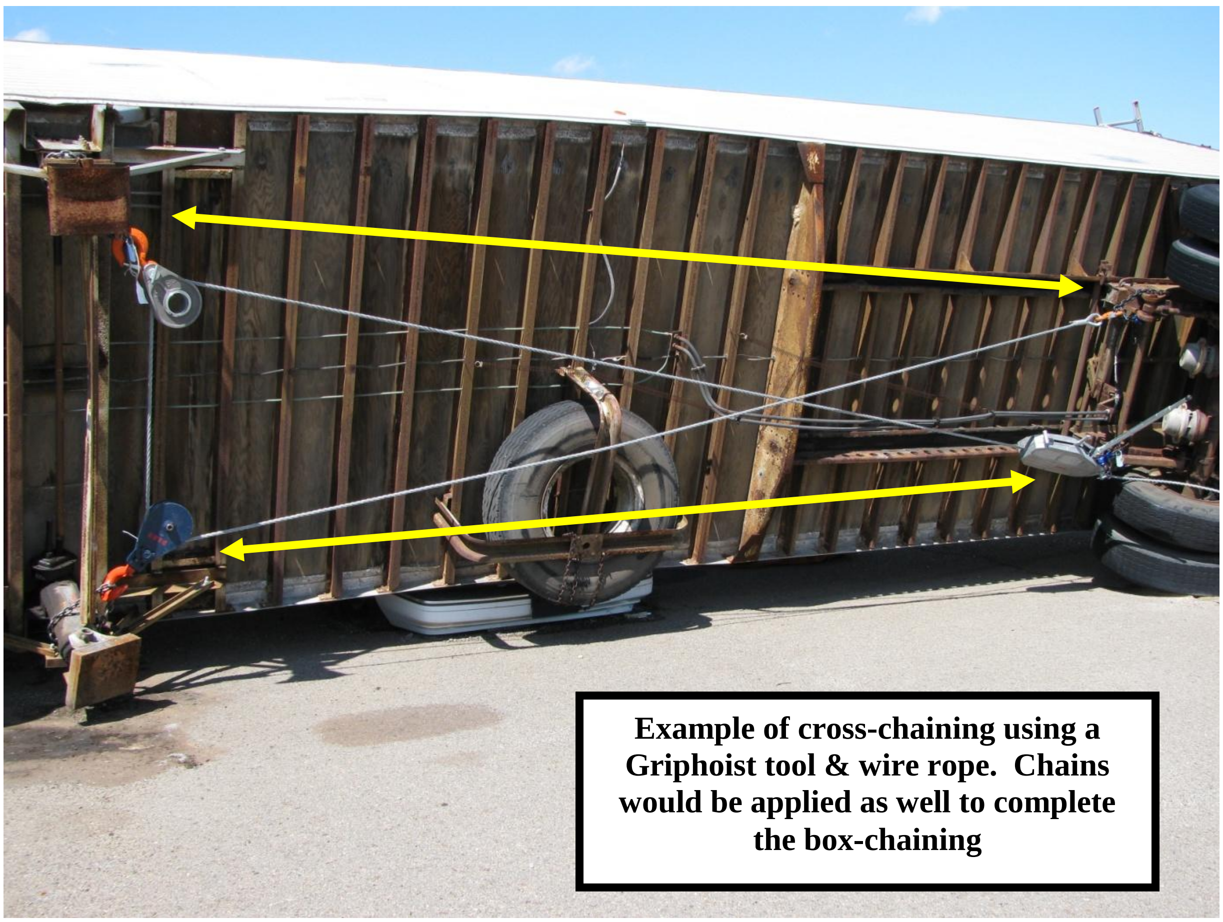
<u>Cross-Chaining and Box-Chaining Dry Freight Van Trailers:</u>
During an overturn of a dry freight van trailer onto a smaller vehicle the integrity of the trailer is often compromised. Responders must carefully inspect the entire trailer for signs of damage.

The signs of damage include:
Broken or bent side rails
Torn, bent, or open sidewalls
Broken crossmembers
Missing rivets along the sidewall
Bent roof components

If any of these signs are seen, the integrity of the trailer is diminished. If moving the trailer is needed during the rescue operation responders should be prepared to provide support for the trailer.

If the side rails are damaged responders should be prepared to cross-chain and box-chain the trailer. Generally this is performed using chains and ratcheting load binders along the underside of the trailer. This technique is accepted and used by towing operators as a means of providing support for the trailer during towing. The chain used should be a minimum of 3/8" diameter Grade 80 with ratcheting load binders that match the chain's WLL.

The chain is attached to the upper part of the landing gear and to the axle assembly at the trailer's rear. A ratcheting load binder is then applied to tighten the chain securely. Cross-chaining resembles the letter 'X' and minimizes the torsional bending of the trailer. Box-chaining is used to support broken side rails. A minimum 3/8" diameter Grade 80 chain is attached at the same location as cross-chaining, then brought parallel to the trailer's underside. A ratcheting load binder is used to tighten the chain at this point. Box-chaining requires two chains be used, each parallel to the side rail (indicated by arrows). Both cross-chaining and box-chaining should be in place and secure prior to moving the trailer.



Example of cross-chaining using a Griphoist tool & wire rope. Chains would be applied as well to complete the box-chaining

Sidewall Support Operations:

During an overturn it is likely that the sidewalls of a dry freight van trailer will suffer damage. Cargo may shift, impact may cause damage, and even deterioration of the trailer itself will contribute to damage.

Operating on the smaller vehicle under the trailer places the responders in danger. The responders may mitigate the hazard by uprighting the trailer. This will expose the smaller vehicle and facilitate extrication.

Another option is to create a safer working environment for responders by supporting the trailer's sidewall. This support operation should progress from the outside the trailer's footprint into the unsafe area, similar to shoring operations in USAR. All unnecessary responders and equipment must be kept clear of the trailer's footprint at all times.

Building support for the sidewall can be performed by using struts, a header and footer, and cross-bracing. This is similar to sloped floor support in USAR. Support can be increased by using Finnform shoring panels against the trailer sidewall being supported with the struts, header, footer, and cross bracing. This support system is built outside of the trailer's footprint and then moved into place using ropes. The struts are pressurized minimally to expand them without creating further damage to the sidewall.

Of concern is that the struts must be tightened once in place. This generally requires that a responder enter the footprint. Air pressure must be maintained in the struts while they are tightened. Cross bracing between struts is important to prevent movement.

Once the support system is in place, responders must frequently check the security and stability of the system. It is critical to frequently inspect the trailer's sidewall even while it is being supported.

Finnform panel in use to support the trailer's sidewall

Cribbing may be used with a Finnform panel as well. Primary support for the sidewall is being supplied by the panel with an upright attached. A box crib and wedges are used to support the panel in place against the trailer sidewall.

Timber cribbing being used with a Finnform panel to provide support

<u>Refrigerated Trailers</u>

Reefers are prevalent among trailers, used to maintain an environment suitable for the cargo. The trailers are insulated and have a refrigeration unit mounted at the trailer's front end.

The refrigeration unit has its own electrical and fuel system allowing self-contained operation when disconnected from the tractor. The electrical system generally consists of a 12 volt negative ground battery and charging system. The battery is usually mounted in a compartment on the unit itself, and can be accessed without difficulty.

The fuel used to power the refrigeration unit is likely diesel fuel. The fuel is contained in a tank under the trailer floor, typically containing 40 +/- gallons. Flexible fuel lines transport the fuel to the unit.

Fuel tank for refrigeration unit

The fuel tank will have a shutoff valve to control the flow of fuel to the refrigeration unit. This valve is typically easily located on the tank itself.

Mounted on the refrigeration unit is a console containing a start/run/stop switch. This switch controls the unit itself. Also, a thermostat is generally found that serves to adjust the trailer's environment. The refrigeration unit will start and stop automatically to control the interior environment. The front of the trailer is generally strengthened to support the weight of the refrigeration unit.

During extrication operations, the refrigeration unit should be left to function normally. This is true unless its operation actually interferes with the extrication. Then it is a simple matter to operate the switch and turn the refrigeration unit off. At that time responders should de-energize the refrigeration unit's electrical system by disconnecting the battery from the circuit. This can easily be done once the battery itself is located. Usually the battery is found inside a compartment on the refrigeration unit itself. Begin by either disconnecting or double-cutting the negative cable first, followed by the same procedure for the positive cable.

The trailers walls themselves contain insulation. The insulation found is generally polystyrene near 3-4" thick. Also the floor, doors, and roof are insulated as well.

The landing gear for refrigerated trailers will not differ greatly from that of dry freight van trailers. Also, the rear tandem axles including air ride suspension will be essentially the same as their dry freight van counterparts.

Specialized Trailers

There are multiple types of trailers, and many are specialized according to their purpose. Responders should research the common types of trailers encountered in their response area and gain as much knowledge as possible regarding them and their cargos.

This knowledge will be critical if a tractor-trailer combination unit is involved in a crash in their area. Of primary interest will be the weight involved and how to calculate the amount in order to operate safely.

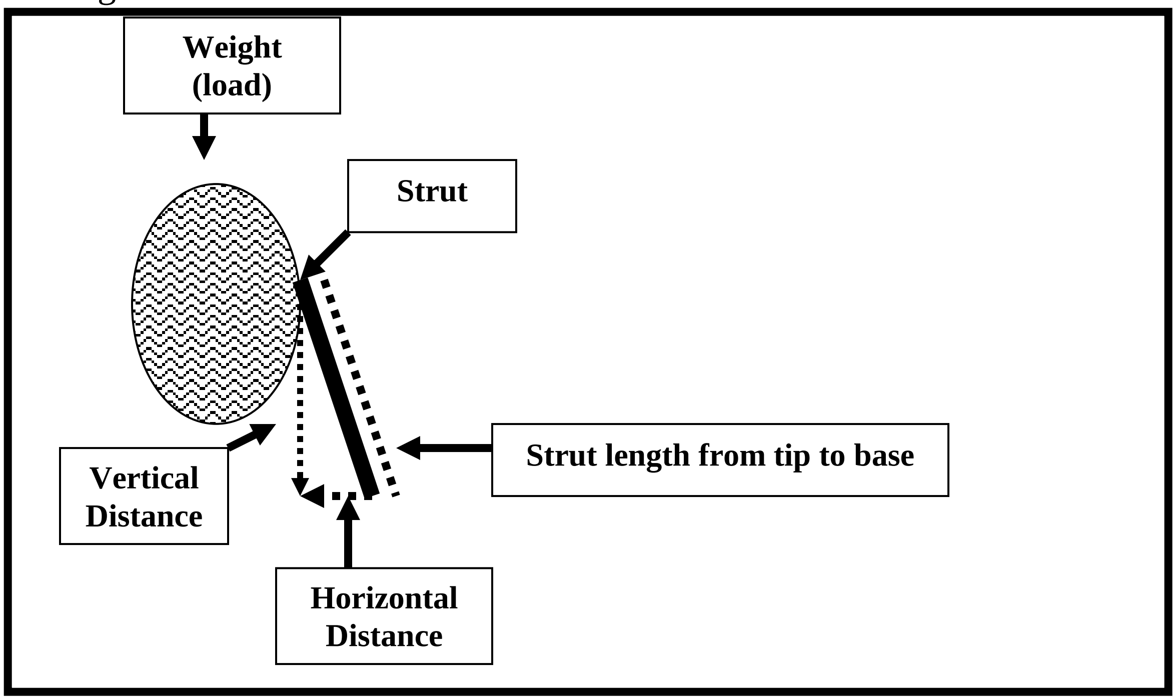
Examples of specialized trailers:


KALYN
SIEBERT

Strut Loading and Base Restraint Calculation

By Carlos Silva, PhD, Mechanical Engineer

First, basic calculations must be made to determine the **Force Constant (FC).** Once the FC is calculated, the actual strut loading and base restraint loading can be calculated.



<u>Basic Calculation to Determine Force Constant (FC):</u>

1. Measure vertical distance from strut tip to surface. Mark this point.
2. Measure horizontal distance from point on surface to strut base.
3. Divide weight (load) by vertical distance. This is the **FC**.
   For example, if the weight is 10, 000 pounds and the vertical distance is 72", the FC is 139 lb/in

Strut Load Calculation:

1. Multiply FC by length of strut from tip to base.
   For example, if the FC is 139 in/lb and the strut length is 85",
   the strut load is 11, 805 pounds.

Restraining Force Calculation:

1. Multiply the FC by the horizontal distance. This is the total force, disregarding friction resistance.
   For example, if the FC is 139 in/lb and the horizontal distance is 45",
   The total force applied to the restraint is 6, 250 pounds.

This calculation is only for horizontal surfaces.