

Firefighter Safety and the Modern Vehicle

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Vehicle accidents scenes are very dynamic and require firefighters at all levels to be aware of their surroundings and the vehicle or vehicles involved in the accident. The days of coming on scene of a motor vehicle accident and starting vehicle extrication without any regard to the possible dangers involved in the tactics of the extrication are long gone. The modern vehicle is definitely designed with every intention to keep the driver safer if involved in an accident. Unfortunately for the rescuers who are trying to save the victims, due to the vehicle's technology, they can be injured as bad or worse than the patient they are trying to extricate. Modern vehicles are different across the board compared to older models, from the safety systems, materials being used to construct them, and the energy being used to run them. As technology improves, the gaps in likeness will continue to grow farther apart compared to older vehicles, so it is imperative that firefighters are continually educated. The materials used to construct modern vehicles can also react differently when exposed to fire. Therefore, firefighters need to be aware of the tactics involved when firefighting with such a vehicle.

According to the NFPA, a fire department in the United States responds to a structure fire every sixty-two seconds. By comparison, the frequency of vehicle accidents in the United States occurs every ten seconds according to the National Highway Traffic Safety Administration (NHTSA.) Given these statistics, it is alarming that some fire departments still take vehicle extrication lightly. Many firefighters are aware of the dangers of going into a well-involved commercial building with a truss

constructed roof with the potential for roof collapse and the tactics involved for that type of building construction. Firefighters know this potential through education and unfortunately, through LODD due to truss construction failure. Ask the same firefighters who arrive at a minor motor vehicle accident with frontal air bag deployment if there is any further hazards with that deployed airbag and surely you will get different answers. Just as building contractors don't stop by the local fire department and advise them they just put up a new truss building in their district, car manufactures are not knocking down any fire department doors letting us know of the dangers involved with the modern vehicle. The only way to help avoid injuries to rescuers during extrications is through education and awareness of all the possible dangers.

In 1974 GM produced the first model that had an airbag system. Starting in model year 1998 all new passenger vehicles must have both driver and passenger airbags. As of October 2005 there were over 163 million of the more than 224 million cars on U.S. roadways that had driver side airbags. Over 144 million of these also had passenger side airbags. The airbags are doing their job as an estimated twenty thousand lives have been saved due to airbag technology, but the fire service needs to deal with the dangers of airbags during extrication procedures.

Firefighters are taught during bomb scares of the potential of secondary explosions intended to injure rescue personnel. This concept should also be recalled while performing auto extrication with airbag equipped vehicles. The rescuer can also be fooled when arriving on scene to find airbag deployment and thinking the potential for additional airbag deployment is over, unfortunately this would be a false assumption for the rescuers and possibly the patient.

Airbags pack a powerful punch that can cause serious injury and even death. A force of 3,000-4,000 pounds per square inch results in the first few inches of airbag deployment. The adult human chest can experience injury at 3,000 pounds a square inch. The frontal airbag has been clocked at speeds of 200-300 miles per hour and side impact airbags at over 495 miles per hour. With this type of power and speed a weighty extrication tool being struck by an airbag and sent flying could definitely cause injuries or even death to anyone in its path.

It is estimated that over twenty rescuers and technicians have been injured by accidental airbag deployment. These estimates are probably low as many cases have probably not been reported and data collection on such incidents has been weak to date. One such case occurred in Arizona in 1996 when a law enforcement officer helping a woman from a crashed vehicle accidentally deployed a side impact airbag which sent the moderately injured woman into the roof of her vehicle. She later died from the impact caused by the airbag deployment. Another such incident occurred in 1999 when two Dayton, Ohio firefighters were injured during vehicle extrication when an airbag struck the firefighters.

Airbags can be in a variety of different locations including the drivers steering column, below the column at the driver's knees, in the dash on the passenger's side, in the driver and passenger-side front doors, within the outer edges of the driver and passenger's front seats, in the driver and passenger roofline/A-C pillar area and, for rear occupants, along the outboard edges of the rear passenger seats or rear doors on both sides of the vehicle. The newer more expensive modern vehicle can have up to twelve different airbags as is the case in the BMW seven series. To identify the different airbag

locations, rescuers must scan all vehicles on the inside of the patient compartment. The following abbreviations will be noted on the trim on the inside of the vehicle indicating the presence of an air bag:

- “SIR”- Supplemental Inflatable Restraint
- “SRS”- Supplemental Restraint System
- “SIPS”- Side Impact Protection System
- “SPS”- Side Protection System
- “SIRS”- Side Impact Restraint System
- “ITS”- Inflatable Tubular Structure
- “ARS”- Advanced Restraint System
- “IC” or “VIC”- Volvo Inflatable Curtain
- “KPS”- Knee Protection System
- “FPS”- Foot Protection System

Often firefighters arrive on scene and see a deployed frontal airbag and come to the conclusion that the airbag is dead. This would be a mistake as dual stage airbags are becoming quite popular on vehicles. This system has become so popular automakers are using it as a selling point and putting it on the window sticker of vehicles. These airbags carry two charges and depending on the severity of the crash both or only the necessary charge is used during the accident. Firefighters must treat all deployed frontal airbags as if deployment can occur again. A good practice when turning a vehicle off at a motor vehicle accident when airbag deployment has occurred is to reach behind the steering wheel rather than in front of the deployed airbag in case the airbag re-deploys due to the second charge firing.

While airbags are a danger to the rescuer, certain steps can be taken to help avoid injuries from them. The first thing rescuers need to accomplish is to locate the vehicle's battery which can be in numerous locations. Firefighters should operate anything they think they might need to operate including seats, doors, and the lowering of windows prior to disconnecting the battery. To disconnect the battery, firefighters should disconnect the negative prior to the positive cable. It is a good practice to take two cuts from both cables to prevent the cables from coming back on another as has been seen with a single cut. Disconnecting the battery will start the drain down time on the airbag capacitors which hold the charge for the deployment. Firefighters must remember drain down times vary in range from one second all the way up to thirty minutes, as in a Rolls Royce. Another point to remember is that anything plugged into the cigarette lighter must be disconnected including cell phones and laptop computers, which can allow back feeding into the cars electrical system even after batteries have been disconnected and cause airbag deployment.

Airbags can also deploy when they are affected by static electricity. Once a door is removed it should be removed from the immediate area surrounding the work area and placed with inside interior of the door facing up on the ground in case of accidental deployment, which could send the door flying through the air. Firefighters must also remember that wires running through the wire lumen on the vehicle many times will still be attached to the door when it is being removed and should be cut with wire cutters one by one to prevent accidental deployment of the airbag or be sure that if all wires are cut simultaneously the airbag cannot injure anyone if it deploys. Even after all the above

things have been accomplished firefighters must still consider all un-deployed airbags as dangerous and practice the “5-10-20 Rule:”

- Maintain a minimum of 5 inches from side impact airbags.
- Maintain a minimum of 10 inches from frontal airbags.

Maintain a minimum of 20 inches from passenger side frontal airbags.

Another danger firefighters need to be aware of with airbags are the pressurized stored gas inflators that are used to inflate the airbag. Stored gas inflators used for side curtain airbags can have up to over ninety-five hundred pounds of pressure in them, which if cut into by a rescue tool, can send shards of metal like little missiles out towards the rescuers or into the patient compartment striking an already injured patient. These inflators can be found in the A, B, C and D posts and also in the roof lines of vehicles. Any rescue tool has the capability of cutting through them, from the more powerful hydraulic cutting tools to a hacksaw. To avoid cutting into these high pressure gas cylinders firefighters should always peel away any trim prior to making a cut or any type of pinch maneuver on a vehicle. When cylinders are discovered, firefighters must change their tactics and find another course of action to get the objective accomplished or simply cut above or below the cylinder. It is also important for the rescuer to realize they can cut into the airbag curtain itself without causing any harm, but the airbag can still be activated and will now have an open passage way for the high pressure gas to escape.

Seat mounted airbags also have pressurized stored gas inflators to inflate them. These airbags are found on the outer edge of the seat and should be avoided at all costs as 3,000 pounds of pressure is used to inflate them. Rescuers must realize this type of airbag system is found even on economy cars today. This airbag is designed to inflate

and rap around the door so the patient does not strike the door during an accident.

Unfortunately for the rescuer, once door removal is accomplished the airbag will deploy straight out of the patient compartment if accidental deployment occurs and have the potential to strike a rescuer that is in the deployment path.

A safety measure two manufactures are starting to put on their vehicles is a 10 centimeter marking system that can be seen on the front and rear windows by the A and C- posts. This marking system will show two small arrows and the word “cut”. This indicates to the firefighter the best possible location to cut the post by avoiding high pressure airbag cylinders and the weakest part of the post structurally. The two vehicles are the Dodge Sprinter and the S-Class Mercedes. Hopefully for firefighters, this will become a trend in the manufacturing of all new vehicles.

In addition to the dangers in extrication, vehicle fires in the new modern vehicle can pose some very dangerous and unexpected results when traditional tactics are used. Not only can the airbags deploy and strike a firefighter working a hose line on the interior, but the use of magnesium is starting to be used more and more with newer vehicles due to the strength and weight. Unlike most metals, magnesium can burn and will react violently with water. Magnesium can be found in steering columns, radiators, dashboards, engine blocks and wheels. Firefighters must fight vehicle fires from a distance using the full reach of the stream initially and anticipate the possibility of magnesium involvement. Magnesium involved vehicle fires require large amounts of water to extinguish them and in some cases tank water may not be sufficient and hydrant water will need to be secured and anticipated. Unfortunately, for firefighters there are no vehicle markings to identify the use of magnesium, so firefighters should always

anticipate the involvement and protect themselves with full protective firefighting gear and breathing apparatus.

Along with knowing the potential dangers of the safety systems and materials being used in the construction of these vehicles firefighters must educate themselves in what is powering the modern vehicle. The most common alternative fuel driven vehicle on U.S. roadways today is the hybrid vehicle. The first hybrid electric model in the U.S. market was the Honda Insight developed in 1999. In the early development these vehicles were rather easy to identify to the rescuer with only a couple models on the market. From 1999-2006 there have been over two-hundred and sixty thousand hybrid sales in the U.S. In April 2007 alone there were 28,330 vehicles sold. Today there are over twelve different models ranging from the small compact vehicle, SUV's, pick-ups and even luxury hybrid vehicles are being produced. With all the new models it can be difficult to identify a hybrid powered vehicle compared to a straight gasoline powered vehicle.

The hybrid has two forms of electrical energy. One is a very high voltage electrical system that is used in conjunction with gasoline to power the vehicle and the other is the standard twelve volt battery. The high voltage system is provided by a battery pack that is located in the trunk area of hybrid vehicles. This high voltage system is designed to short circuit in the event of a severe crash and should de-energize itself according to manufacturers. However, sometimes the crash is not severe enough to cause the shut-down of the system and firefighters must follow certain procedures to maintain safety.

The electrical lines involved with this high voltage system run under the vehicle and also can be seen in the trunk area and the engine compartment. With over three hundred volts of electricity running through them in some cases, a firefighter cutting through it could have fatal results. Firefighters should never cut through any orange cables on hybrid vehicles. Saturn has introduced a hybrid vehicle that has a blue cable that carries upwards of thirty-six volts. The medical field defines the threshold for voltage the human body can take before being fatal is about sixty volts. Regardless, any large cable should never be cut while performing extrication on any hybrid vehicle. Fortunately for firefighters, these cables should not pose any unusual hazards during extrication procedures if avoided; firefighters should realize the locations and make every attempt in avoiding them.

When arriving at any emergency scene, firefighters are taught to ensure the vehicle is still not running and is in park. In the case of a hybrid, the vehicle is always quiet when at a standstill making it difficult to determine if it is turned off. When the vehicle is in drive and the pedal is depressed the vehicle will move, so firefighters need to take certain steps to ensure total vehicle shutdown to avoid possible movement during extrication efforts or even on a routine emergency not involving extrication. Firefighters must still perform the basics of vehicle stabilization and ensuring the vehicle is in park. In older hybrids it is acceptable still to remove the key from the ignition to achieve vehicle shut-down. Almost all new hybrids are being equipped with the “Smart Key” system where the key does not have to be in the ignition to energize the system, but if the key is within fifteen feet of the vehicle it will energize all systems. Firefighters must remove these keys from the patient if possible to avoid having electrical systems that

could still be fully energized. In some cases it will take looking through purses or feeling the patient's pockets to locate such keys. Once complete vehicle shut down has been achieved the "ready" indicator light on the dash should not be illuminated.

The hybrid vehicle provides all of the same safety systems of the normal modern vehicle. The twelve volt battery is what controls the safety systems and other important components that normal non-hybrid twelve volt battery's power. These batteries can be in a variety of locations including under the hood, in the front wheel well, under the rear seat or in the trunk. It is just as important to gain control of these batteries early in the extrication to prevent accidental deployment of a safety system.

Fires involving hybrid vehicles should be fought with the same procedures as if it was a normal fuel powered passenger vehicle. Fire suppression crews will not be shocked or electrocuted during a direct fire attack on a hybrid vehicle fire, even if the flames are impinging on the high voltage battery pack itself. Large amounts of water, such as from a 1 ¾ attack line, will not be able to directly attack a fire burning inside the battery pack itself. The metal cover on the battery pack will prevent the direct application of water to the internal cells of the battery. The water application will cool the vehicle, control the spread of fire and cool the adjacent battery cells. The burning nickel metal hydride batteries will eventually burn themselves out. It is important for firefighters not to remove the metal cover that houses the high-voltage battery pack under any circumstances.

Because of all of the different dangers involved with emergencies involving the hybrid vehicle, all manufactures provide a free Emergency Response Guide about their particular hybrid vehicle, which is prepared for Fire Service, Law Enforcement, EMS,

and Professional Towing Personnel on their websites which can be easily downloaded. Some of the information in these guides includes vehicle description, hazards and emergency procedures involved when dealing with such a vehicle.

Fire departments can also purchase *The Rescuer's Guide to Vehicle Safety Systems* by Holmatro 5th edition. This manual includes data from vehicles 1985-2006 that have safety systems, including medium and light trucks. Also, included in this book are all available Hybrid Emergency Response Guides written by the manufacturers. It also includes hyperlinks to each manufacturer so the purchaser can check for updates on particular vehicles. Some departments are carrying this book on their rescue vehicles to quickly identify the vehicles safety systems prior to performing extrication procedures. This is helpful when resources allow for researching this information at the scene.

With all the new technology being introduced at a rapid rate, there are some things all firefighters can do to stay safe. Fire departments must provide real life training when doing auto extrication drills. While many firefighters do not have the opportunity to perform extrication on the new modern vehicles, a simple solution is to mark the insides of these older vehicles with a magic marker to simulate an actual airbag or a stored pressure cylinder. This will train firefighters to scan the interior of the vehicle looking for any indicators of safety systems and to peel away the interior trim prior to making cuts. Another benefit is the firefighters will be forced to stay out of the strike zones of airbags. During extrication training it is also beneficial to practice new alternative techniques in case a safety system is discovered that requires a different strategy to be utilized. Also, firefighters should visit a local car dealership and ask the technicians to explain some of the new technologies in vehicles being introduced into the

market. Many dealerships will also have un-deployed airbags on site and will gladly deploy them for firefighters to get a better appreciation of their power and the speed in which they deploy.

Manufactures of the new modern vehicles can definitely help the fire service by providing some simple standards that all vehicles would be equipped with that would keep rescuers and patients safe during vehicle extrications. Ron Moore, a frequent writer on vehicle extrication, came up with a proposal called the “Vehicle Safety Data Sheet” back in 1999 that would be placed on all vehicles. The placard would be placed at a minimum of two places, one located under the hood and one under the driver’s side sun visor. Some of the information on this placard would consist of all airbag locations, all airbag crash sensors, battery location (s), seatbelt pretensioner locations and any other pertinent information relating to that vehicle. It is unfortunate for rescuers that this system is not in use today as it could prevent injuries and save valuable time.

Another possible solution to limit the dangers to firefighters during extrication would be some type of “kill switch” that would disable all power to the safety systems including depressurizing the high pressure gas cylinders immediately. If such a switch were required by manufacturers, this switch in conjunction with twelve volt battery disconnection would ensure rescuers that all additional safety devices are disarmed and no additional drain down time is required. This “kill switch” could be in the exact same location on all vehicles, so firefighters would be familiar with the location no matter the make or model of the vehicle involved.

Car manufactures are doing their job by providing a safer and more efficient vehicle for the consumer. Vehicles are changing every year from the safety systems

designed to protect the passenger to the energy that powers them, with no real end in sight. Firefighters need to keep up with these changes and the risks that are associated with each vehicle being produced. There is no other training issue or topic in the fire service that is constantly changing from year to year compared to firefighter safety during vehicle extrication. True, the techniques are generally the same, but the technology that can injure the firefighter is always changing. Just as firefighters are pushing for changes in building codes that can affect their life, firefighters need to push for some type of standardization of the modern vehicle and a system that will allow firefighters to perform extrication without the threat of being struck by an un-deployed airbag. Firefighters must continue to train and stay up to date on all the new technologies with the modern vehicle. As proven, whether it is building construction or car design, the safety of the firefighter is usually not figured into the equation.

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