Extrication Safety: Hybrid vehicles, Airbags, and movable pedals

Hybrid vehicles: Ford, Honda, Toyota, Volvo, Chevrolet, GMC, Dodge, Saturn, Lexus all have a hybrid vehicle. A hybrid vehicle has a gasoline motor and an electric motor powered by a battery. As the vehicle travels, it operates off of the battery powered motor at speeds less than 30 mph. At speeds over 30 mph the gasoline engine operates the vehicle and charges the battery system.

High voltage components of the vehicles: The HV (hybrid vehicle) battery, transaxle, inverter, and service plug are all high voltage components. All of the high-voltage wires and harness are indicated by orange colored insulation or wrapping. The HV battery consists of 38 modules, each module consists of six 1.2 volt cells with a total voltage of 273.6 volts (about 300 volts) This system is separate from the 12 volt wiring system and is located in the trunk area of the vehicle - normally NiMH (Nickel-Metal Hydride) Battery: The cells contain potassium hydroxide (Emergency Response Guidebook - guide #154) which is a highly alkalinic substance that reacts intensely with zinc, aluminum, tin, other active metals, and various type of organic compounds creating flammable hydrogen gas. Furthermore Potassium hydroxide is hazardous to all human body tissues. Toyota required its technicians to use safety items such as alkali-resistant safety goggles, a facemask, synthetic rubber gloves, boots, an apron and a rain coat for handling the battery. Items must not be made of leather or wool. Toyota and Honda both recommend rescuers be in the same chemical resistive equipment while working around a wrecked vehicle. Careless handling of the damaged vehicle may result in electrocution or severe injury.

(The following is taken from the Toyota Prius Emergency Response Guide and information from a discussion with a Honda engineer)

Handling the damaged vehicle:

1. Necessary items
a. Protective clothing (insulated gloves, rubber gloves, goggles) wear nothing made of leather or wool
b. Saturated boric acid solution 20L
c. Red litmus paper
d. Class D extinguisher
e. Towels
f. Vinyl tape for insulating cables
2. Actions to be taken
a. Wear protective gear
b. Do not touch a bare cable that could be a high voltage cable. If you need to touch it, wear insulated gloves and use vinyl tape to insulate ends of cable.
c. If the vehicle is on fire in the engine compartment or trunk (battery) area use a

Type D dry powder extinguisher to extinguish the fire. Using water can be more dangerous than effective unless using a very large flow of water (250gpm +)
d. If the vehicle is partially submerged in water, do not touch any of the high voltage components or cables because of the danger of electrocution.
e. Do not touch any leaking fluids because it could be the highly alkaline electrolyte. If the fluid needs to be removed wear rubber gloves and goggles, neutralize the electrolyte with saturated boric acid or a charcoal solution, and check with red litmus paper to make sure it does not turn blue.
f. If damage to any of the high voltage components and cables are suspected, disconnect the high voltage circuit by putting the vehicle in park and engaging the emergency brake, shut off and remove the ignition key. Disconnect the 12 volt battery cables and isolate.

Standard battery locations: the normal locations of the 12 volt battery are under the hood (visible or hidden under engine components), in the front wheel well, under the rear seat, or in the trunk. These locations are being utilized in all makes of vehicle. Most vehicles with the battery under the rear seat, in wheel well, or hidden in the engine compartment may have remote jumper cable terminals in the engine compartment, which may be used to disconnect the battery system. Disconnecting the battery is preferred to cutting the battery cables. Both cables need to be removed to ensure rescuer safety during car fire and rescue operations. Watch in the future for multiple battery systems (48 volt) due to the increased power needed for multiple electrical components and accessories. The Automotive Engineers Association is pushing for the 46/48 volt battery systems.

Airbag Warnings:

This notice is for all first responders, Dual Action type airbag have two inflators! It is now important to treat all un-deployed airbags with the same respect as an active airbag. 2000 Honda Accords, Acura RL and TL models, Ford Taurus, Mercury Sable, and all Volvo models. There is very little information being discussed about the dual action airbag system, or released at this point from the industry. Cooperate legal "red tape" is the major cause for delay or unanswered concerns.

Airbag Inflators

There three different type of inflators used in today's SRS. Solid fuel (sodium azide), Hybrid, and liquid fueled.

Hot gas and cold gas

1. The solid fuelled inflator uses sodium azide pellets to generate a mass quantity of nitrogen gas need to fill the airbag. Temp of around 1200 degrees.
2. Hybrid, usually in passenger side air bags and roof mounted systems. Argon

gas (plus a small percentage of Helium) is in a 3000psi canister. A small igniter assembly ruptures a burst disc to release the gas. Boyle's Law states that Temperature/Pressure/Volume are directly proportional, so the inflator assembly warms the gas as it is released into the bag. I have heard of the hybrid style being used on the current Chrysler minivan, Ram pickups, and LH cars on both the drivers and passenger's side airbags. Sodium Azide is still used in the inflator module.
3. Liquid fueled inflators replace the Sodium Azide with jelled Ethyl Alcohol.

Side Impact Curtains

It should be noted that side impact curtains deploy down from the headliner approximately 12 inches. Do not place body parts through open side windows to access the patient. Should an accidental deployment occur, having body parts positioned through an open window could result in serious injury. This type airbag uses a hybrid inflator. Before cutting any post in a vehicle it is imperative to remove the interior plastic covering and visualize what the cutter is going to shear through. Cutting a hybrid inflator can cause it to fragment like a grenade. 2000 Saturn and GM are offering the inflatable curtain as an option this year and standard next year on most of their vehicles. 2000 Ford SUVs also have it as an option and standard next year with the addition of a yaw sensor for use in SUV rollovers. Also as of December, Freightliner Trucks will be putting the Inflatable Tubular Structure side air bag system in their trucks; this is the same inflatable tubular structure in BMWs. The hybrid inflator is low in the firewall; hoses extend to bottom of the 'A' post. The ITS is attached to an anchor at the bottom of the 'A' post and top of the 'B' post. The system deploys out of the 'A' post and roof area along the top of the drivers and passengers window. Side Impact Curtains are also available on 2000 Mercedes Benz S-class, CL, and all E-class, Audi A4, A6, A8, Toyota, VW, 2001 Ford SUVs. Inflatable tubular structures are available on BMW 7 series and as options on the 3 and 5 series models.

Side Impact Curtain Cut Tests

The airbag company (Autoliv) conducting the cutting tests wanted to emulate extrication technicians accidentally cutting through an inflator, which could be possible during roof displacement. The spring "99" tests were conducted in the company's Sweden facilities in Europe. During the first testing there were multiple failures of the inflator vessels, resulting in parts of the test inflators becoming projectiles. While this was not good news, it was a major break through for first responders! A leading manufacturer of supplemental restraint airbags was conducting safety tests with the first responder in mind. Perhaps this will some day lead the industry to develop a fire service disconnect for all systems within a vehicle including the SRS! If the industry wants to add SRS to protect the occupant, why doesn't the industry want to protect the rescuer aiding the occupant as well? Saab requested a second test that was conducted at the US facilities in Utah. The second test was conducted on November 9, 1999.

While the test results improved from the spring testing, there were still a failures to the pressure vessel when cut with hydraulic cutters. When the hybrid inflator was cut at the solid propellant chamber where the initiator and extruded propellant were located, there was no reaction. However, when the cutters breached the pressure vessel, both ends (one loose and one secured) became projectiles. This time the testing was video taped, perhaps at some point the video tape will be released to assist training personnel by re-enforcing safety precautions.

Fall 1999 Testing

The second tests used hybrid inflators similar to that which are used on the side impact curtain (IC). This type inflator uses an igniter (detonator) to ignite an extruded propellant (oxidizer) creating a hot oxygen enriched mixed gas to inflate the IC. The gas may be a pressurized mixture of argon and nitrous oxide. Effluent gases may cause skin and eye or mucous membrane irritations. PPE is recommended; safety goggles, latex or equivalent gloves and approved respirator or SCBA is recommended.

If activated, carbon dioxide, water vapor, argon, nitrous oxide, and trace amounts of carbon monoxide and nitric oxide will be present. Besides the data available on the possible fragmentation of breached inflators, the responder should also be cautious of exposure to any raw materials of inflators in general. Some inflators contain sodium azide, which is moisture reactive. Although the industry states that the chemical residue is harmless, they do precaution you from touching deployed airbags with your bare hands or skin!

Renault

Renault will now be using a rear passenger seatbelt airbag called a "bag-in-the belt system". The airbag is located in the lap belt not the diagonal belt. It will offer rear occupants the same protection that is offered to front passengers. Renault will also be introducing the double action airbag, two-bag system. It will debut at the Paris Motor Show in the Laguan/P5. The company claims to protect the driver in a crash of 55 km/h (40 mph) The based on computer technology, the new system uses two airbags in one package, and varies the level of restraint it offers according to the impact level received by the sensors. The system operates in three levels: In mild crashes below 35 km/h the seatbelt pretension will only activate. Above 35 km/h and up to 45 km/h, the system activates the seatbelt pretensioner and the deployment of a 35-liter airbag. A crash above 45 km/h will activate a further seatbelt pretensioning and the deployment of a second airbag with the capacity of 50-60 liters. This second action of the seat belt pretensioner will pull the body back more creating 5 cm of knee room during the crash which the company feels is a critical factor in avoidance of injuries during a crash. This system was designed by Autoliv for Renault's top of the line vehicles. It can be expected that other companies will soon be using a similar system.

SAFETY

Maintain a safe working distance from all airbags by using the following guide:

* Side Impact Airbags - 5 inches distance
* Driver Frontal Airbags - 10 inches distance
* Passenger Frontal Airbags - 20 inches distance

While these distances will not be appropriate for all newly developed airbags, it does give the responder a general guideline to work from. The airbag manufacturers, the automobile industry and NHTSA-DOT state that you should not restrain any airbag system. Most airbag systems use hot gases to fill the airbags. Passenger frontal inflators containing sodium azide will reach temperatures in excess of 1,200 degrees F. Cutting the cushion to the airbag system will only allow hot gases to be released un-restrained into the ambient atmosphere of the occupant cabin. Cutting the inflator could result in the two ends becoming projectiles. This data only re-enforces our recommended safety procedures to reduce the risk of injury when displacing metal and coping with airbags, especially the side impact curtain. It is recommend that any undeployed airbag component should not be cut.

Should an undeployed airbag be accidentally deployed, hot gases under pressure could cause injury to patients or responders as the release occurs. Normally, these hot gases are released into the ambient atmosphere at a controlled rate. Should the airbag/IC be cut during an accidental deployment, there would be no control of the force and hot gases released. Anyone in the path of the release could be seriously injured.

Vehicle Fires With Undeployed Airbags

Car fires in modern vehicles can be more dangerous due to the supplemental restraint systems and hydraulic hood and trunk openers. We are seeing more hydraulic openers being used in vehicles today due to lighter body components. Supplemental restraint systems are now standard in the sides of the vehicle and in the roof structure. These systems utilize a hybrid type inflator which is a compressed gas cylinder from 1400 psi to 3000 psi found in the firewall, 'B' post, and 'C' post of vehicles. These compressed gas cylinders may become heated, fail, and fragment. Care should be taken when approaching a vehicle fire, full protective gear and SCBA should be worn and the fire attacked from a distance.

During a fire, Auto Ignition will occur at 480 degrees Fahrenheit, the first burst disk will rupture venting argon. At 750 degrees Fahrenheit the initiator auto-ignites. Extended exposure to temperatures above 250 degrees will also activate the device. Use proper firefighting procedures for fighting vehicle fires.

It has been documented, that there are incidents where catastrophic failures of the driver's airbag occurred, resulting in the fragmentation of the inflator units. Videotapes of actual incidents show how the airbag assembly, in part or in whole became projectiles. Some units were propelled through the roofs of the vehicles.

At one incident, inflator fragments tore a gapping 3-5 inch whole through the metal roof of one vehicle during an actual vehicle fire. Investigators discovered the remains of the driver's inflator approximately 100 feet away form the vehicle. Other parts have been found such as rivets, whole and partial remains of the airbag assembly, and the airbag.

Movable Pedals

Ford offers power-adjustable accelerator and brake pedals in Taurus, Sable, Expedition, Lincoln Navigator, and Mercury & Ford Winstar minivan. Chevy will be adding this system to their SUVs in the 2001 model year. Chevrolet plans to offer four wheel steering on their SUVs in the 2003 model year.

I hope some of this information was useful, if anyone has anything different please forward to me, Thanks ED