Hybrid Vehicle Rescue: Replacing Fear with Knowledge

RON SHAW — new vehicle innovations and extrication techniques

Explained

Hybrid Vehicle Safety

Innovative vehicles, what are they? Perhaps to a responder they are hybrids. To the automotive industry its fuel cell technology; hybrids are now considered mainstream technology. What does this mean to the emergency services? There is a distinct informational gap between the automotive industry’s development of new vehicle technology and the emergency responder awareness.

However, this informational gap of the past is now closing due to greater understanding of the responder needs and joint cooperation.

What is a hybrid vehicle?

A hybrid vehicle by definition is any motor (street) vehicle with two power sources. We generally consider a hybrid as being fueled in part by a high voltage battery pack, and in part by gasoline stored in a small fuel tank. The hybrid vehicle’s transaxle consists of the following components:

- Internal combustion (IC) engine
- Motor-generator (re-charges high voltage battery pack)
- One or more electric traction (drive) motors-generators
- Hybrids may operate in electric only, gasoline only or combination of both electric and gasoline power. The drive mode usually is determined by the hybrid computer based on the driving conditions. However, late model hybrids may also have an Electric Vehicle (EV) mode, which the operator can manually set with a push button.

Recharging

Current hybrids do not require recharging by an external power source. This may change in the future with the introduction of Plug-In hybrids. These hybrids will have a larger capacity high voltage battery pack for greater reliance on electric power versus gasoline. Plug-in hybrids, as the name implies, will have the ability to both recharge while operating, and externally by plugging into a recharging unit/electrical receptacle.

Regenerative Braking

The electric traction motors also have the ability to convert kinetic energy (covered during braking and other periods of deceleration) into electric energy to recharge the high voltage battery pack. This magnetic-electric conversion is called regenerative braking.

Responder Fear

When hybrids were first introduced to North America, training officers were overwhelmed with hybrid concerns. Since training officers did not have adequate information they couldn’t reply with the appropriate answers. This prompted a phenomenon I refer to as “responder fear”. Meaning responders fear what they don’t know. Misinformation and conjecture is often accepted due to the lack of available factual information and/or proper training.

There is a cure for fear of the unknown is easily replaced with knowledge through proper education. Responders concerns dropped drastically when the manufacturers started publishing Emergency Response Guides (ERG) to educate the responder. Hybrid ERGs have allowed program developers, instructors/trainers and individual agencies to formulate definitive answers to the responder’s concerns and questions. Program developers now have the information to develop new vehicle rescue programs or simply update current information to an existing program.

Emergency Response Guides

The ERGs are not new to the emergency services. Conventional (non-hybrid) vehicle ERGs were first introduced by Volkswagen and Audi over ten years ago. Today every hybrid vehicle manufacturer publishes ERGs specific to their make and model.

Why are there so many hybrid ERGs? Each hybrid manufacturer has developed and/or adopted one or more hybrid systems in their model line. Each hybrid system may vary from one model to the next with regards to configuration, emergency shut down procedures and voltage. Until such time, if ever, there is a universal hybrid drive system, there is a need to develop specific ERGs for various hybrid systems.

There are (5) essential tasks generic to all vehicle rescue:

- Immobilize
- Stabilize
- Disable

The three tasks were not developed specifically for hybrids.

continued on next page
Immobilizing a Vehicle

Responders need to prevent the vehicle from moving under power or from gravity. To immobilize any vehicle, responder should do the following tasks:

- Chock the wheels
- Set the parking brake
- Move the shift selector to PARK

Conventional Vehicle Crash

In a crash involving conventional vehicle, when the responder arrives on scene and the vehicle is silent, the silence would indicate one of the following has occurred:

- The internal combustion engine stalled and will not restart on its own.
- The ignition was already shut off and will not restart on its own.
- The SRS has stopped the electrical power to the fuel pump, essentially starving the internal combustion engine, and will not restart.

Hybrid Vehicle Crash

Hybrid crashes offer a unique situation not associated with a conventional vehicle crash. When a hybrid vehicle is involved in a crash and the impact sensors have not activated (hybrid and SRS) sending an impulse to the hybrid computer to shut down, the hybrid vehicle can remain operational, while silent.

Why do hybrids run silent?

continued on page 46

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Hybrids are engineered to be efficient; the onboard hybrid computer is programmed to optimize the best use of power and shut down non-essential power components to conserve energy during periods when motionless.

For example; when the vehicle is stopped in traffic and remains motionless for an extended period. The onboard computer starts to shut down the high energy hybrid power using components. Such as the electric motors to conserve high voltage battery power. And, the Internal Combustion (IC) engine to conserve fuel and reduce emissions when they are the greatest at idle. The vehicle is now silent, but operational.

When the operator depresses the electronic accelerator, the vehicle will start and move insistently, without hesitation or the usual cranking of the engine to start the IC.

Why is it important that a responder understands that a hybrid can remain silent and still operational? If the crash is minor and/or the collision did not activate any of the automatic safety features (collision sensors), the hybrid computer does not interpret a crash shutting down the hybrid system. Instead it goes back to its motionless default mode to conserve power and remains operational. Thus it is essential that responders chock or block the wheels to prevent moving under power or by gravity.

Again, this is not new to the emergency services. There would be nothing worse to roll up to a conventional vehicle fire, put the apparatus in pump only to watch the vehicle roll down the street because of the grade. It’s a common sense procedure that has been in place for decades, well before hybrids.

Stabilize
Stabilizing a vehicle is the process of transferring the vehicle’s weight from the suspension system to the frame onto cribbing or other stabilizing equipment. Responders should be careful not to place cribbing under any high voltage (ORANGE color coded) cabling. Other than the possible exposed high voltage cables, stabilization is identical to a conventional procedure.

continued from page 45

NEW VEHICLE INNOVATIONS AND EXTRICATION TECHNIQUES
continued on page 69

Ford Motor Company High Voltage Battery Pack Disconnect

Locate the HV battery pack disconnect switch.

Rotate the “dot” identified in the photo by the black arrow on the orange dial, counter clockwise from the “LOCK” For Operation (High Voltage) position to the “Service Shipping” (No Voltage) position.

FMC recommends removing the orange switch once the dial has been turn to the SERVICE SHIPPING position, identified by the orange arrow in this photo.

Photos Courtesy of Extrication.Com.

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GMC HV Battery Disconnect Switch

Step one is to located HV battery; disconnect behind access panel.

GMC HV battery disconnect switch key.

Photos courtesy of Jack Rosebro of Perfect Sky

NEW VEHICLE INNOVATIONS AND EXTRICATION TECHNIQUES

continued from page 46

vehicle. Other than a severe crash, responders would not normally find high voltage cabling in proximity to crib points.

The closest routed high voltage cable was found in the Toyota Prius 1st generation. And, this was located under the floor pan approximately (1) foot inbound of the driver side of the vehicle. The Prius and all the other hybrid high voltage cabling is not routed in any of the normal stabilization points typically used for extrication.

Disabling the Vehicle

The simplest method to disable any vehicle is to shut the ignition OFF. This would be considered the normal shut down procedure, and can be performed by utilizing either procedure below. Normal shut down procedure for vehicles equipped with a cut metal ignition key:

- Ensure the shift selector is in the PARK position.
- Turn the key to the OFF position.
- Remove the key to a distance greater than 16 feet.

Normal shut down procedure for vehicles equipped with a smart key/FOB with
push button ignition performing the following steps will shut the vehicle off:
1. Check the dash to see if the vehicle is operational. Toyota/Lexus/Nissan hybrids will have an illuminated “READY” indicator light. If the dash is blackened out, the vehicle is already shut off.
2. If READY indicator light is illuminated, push the ignition button once; the vehicle will then shut down.
3. If the smart key/FOB can be located, remove it from the vehicle to a distance greater than 16 feet.
4. If the smart key/FOB can not be located disconnect the 12 V auxiliary battery to prevent restarting should the start button be pushed again.
Before disconnecting the 12 V auxiliary battery, as with any conventional vehicle, use the low voltage power to your advantage:
- Utilize power seat controls
- Open windows to vent out any noxious gases due to deployed airbags
- Unlock door latches
- Raise Rollover Protection System (RPS) if so equipped.
- Open relays prevent high voltage flow from the HV battery pack.
- Gasoline fuel pump shuts off.
- Shuts down the hybrid system (electric motors/gas engine).
- Power flow stops to the SRS ECU
- Open relays prevent high voltage flow from the HV battery pack.
- Gasoline fuel pump shuts off.
- Shuts down the hybrid system (electric motors/gas engine).

Notation
It should be pointed out that it may not be necessary to perform low voltage power disconnect at every crash. Minor, so called fender benders not requiring extrication would be an example. As with a conventional vehicle, this determination for disconnecting the low voltage auxiliary battery should be left up to the on scene incident commander.

High Voltage Battery Pack
Honda, Ford, and Mercury are equipped with high voltage battery power disconnect switches that can be utilized by the responder when normal shut down procedures can not be performed. Responders should review the manufacturer’s specific ERG for that make and model for their location and recommended procedures.
Nissan also has a orange colored high voltage battery disconnect switch located on the system main relay adjacent to the HV battery pack. However, it is the author’s opinion, that only trained technicians who have been taught high voltage safety, how to properly utilize the disconnect switch (service plug) while donning high voltage RUBBER gloves should perform this method.
This is only mentioned since Nissan has referenced the ‘service plug’ in the Altima ERG. The Altima uses a similar hybrid system as Toyota and Lexus hybrids. While compiling the Toyota-Lexus ERGs, as a matter of increased responder safety, the responder was determined that lay responders not trained or equipped with the proper Personnel Protective Equipment (PPE) should not utilize pull the service plug method for emergency shut down.
Instead, alternative procedures using more responder friendly methods have been developed, not requiring the use of high voltage rubber gloves. Responders should consult the Toyota-Lexus ERGs specific to make and model hybrid for emergency shut down procedures.

RESPONDER TIPS
Shutting the ignition OFF should be done as soon as possible for any type vehicle. Doing so will ensure the following functions have not been accomplished for a hybrid vehicle:
- Shuts down the hybrid system (electric motors/gas engine).
- Open relays prevent high voltage flow from the HV battery pack.
- Gasoline fuel pump shuts off.
- Power flow stops to the SRS ECU
Other than performing normal low voltage battery disconnect, you have essentially disabled the hybrid vehicle.
Disconnecting the 12 V auxiliary battery for a silent hybrid may not shut it down. The high voltage system is stepped down via a converter to power the low voltage system.
Once the vehicle is shut OFF, disconnecting the 12 V auxiliary battery will shut down voltage systems and prevent the hybrid system from restarting.
continued from page 65

dow, protecting the head and neck during impact. These systems work well, and are quickly becoming “standard equipment” in the design of new apparatus.

**Chassis Design and Weight Distribution**

When we design fire apparatus, or any vehicle for that matter, the projected weight and overall dimensions must be carefully considered. Weight distribution from front to rear, side to side, and up and down must be matched to the capacity ratings of tires and wheels, driveline components, axles, hubs, brakes and suspensions. Center of gravity must also be carefully considered — generally, the lower the better. The higher the center of gravity, the more unstable the vehicle will be. Factors that effect the center of gravity include frame rail height, tire size, location and size of the water tank, and location and weight of equipment stored on the vehicle. For example, a “T” shaped water tank may provide a lower center of gravity than a rectangular shaped tank. Heavy equipment such as hose stored high on the vehicle may effect the vehicles overall stability. Both NFPA 1901 and the Fire Apparatus Manufacturers Association have equipment weight charts that can assist departments in estimating the weight of equipment loaded on the vehicle. Not only will lowering heavy equipment mounted on the vehicle help to lower the center of gravity, but it will also reduce injuries caused by personnel lifting heavy equipment located high on the vehicle.

**NIOSH Recommended Practices**

The risk of truck rollovers can also be reduced by implementing NIOSH recommended practices which include:

- Develop, implement, and enforce standard operating procedures (SOPs) for emergency vehicles — particularly with regard to the use of seat belts.
- Ensure that drivers have necessary driving skills and experience and provide them with periodic refresher training.
- Consider terrain, weather, and bridge and road conditions when purchasing a mobile water supply vehicle.
- Adhere to the requirements of NFPA 1915 for maintaining a vehicle on a maintenance schedule and documenting the performance of the maintenance (NFPA 2001).
- Inspect the complete vehicle at least once per year to comply with Federal and State motor vehicle regulations.
- Adhere to the requirements of NFPA 1901 for an approved mobile water supply vehicle (NFPA 2001).
- Equip all vehicles with seat belts.
- Ensure that water tank capacity is adequate and has proper tank mounting and sufficient front and rear weight distribution.
- Ensure that the weight of the fully loaded vehicle does not exceed the gross axle weight rating of any axle and the gross vehicle weight rating of the chassis.
- Ensure that the center of gravity of the vehicle does not exceed the chassis manufacturer’s specified center of gravity.
- Provide proper baffles to control water movement for all vehicles equipped with water tanks.
- Verify that vehicles are of proper design and have adequate suspension, steering, and braking ability.

Remember, our first and primary responsibility when responding to an emergency call is to arrive safely. Let’s make emergency vehicle operations a high priority so we can all go home at shifts end.

Ed Hines is Battalion Chief and Fleet Director (Retired) with 37 years at Palm Beach County Fire Rescue. He has written specifications for and/or purchased over 400 emergency vehicles.

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