

Fighting Hybrid Vehicle Fires



RON SHAW — new vehicle innovations and extrication techniques

(This is the third segment of a four part series on hybrid vehicles addressing responder concerns and safety at the scene of an incident involving a hybrid vehicle. This issue will give a general overview and guide on how to cope with a hybrid vehicle fire.)

With permission from Toyota Motor Sales of USA, Inc., this article is based on the Toyota hybrid ERG firefighting model template. Hybrid live fire testing is unique to Toyota; no other hybrid manufacturer has conducted hybrid vehicle live fire testing. The live fire test data by Toyota and its recommendations have been utilized by other manufacturers for their own use as well as thousands of responders worldwide.

This article is intended to serve as an informational reference, and should not replace any existing live fire standard or SOP/SOG that your agency may have for vehicle fires.

Vehicle Fire Training

Most firefighters have experienced, or have been given live fire training for fighting vehicle fires with a conventional fueled vehicle fire. Here in the United States, the training you received has followed firefighting practices and recommendations by the U.S. National Fire Fighting Academy, IFSTA, and/or the NFPA standards for qualifications for live firefighting training.

However, it is reasonable to say that most firefighters have not experienced a hybrid vehicle fire, or participated in live fire training with a hybrid vehicle. This would be too costly an undertaking for most agencies or training faculties regardless of their size.

Due to the practicality of "cost vs. benefits," the



FIGURE 1 Toyota Hybrid Vehicle Live Fire Testing. Photo courtesy of Ex-trication.Com with permission from Toyota.

benefits simply would not outweigh the investment of such an undertaking, especially since hybrid live fire research has already been done by Toyota Motor Sales of the U.S.

The Toyota data gained during the live fire tests has helped to develop a generic hybrid model response template for all gasoline-electric hybrid vehicle fires.

Firefighting Practices

Approach and extinguish a fire using accepted firefighting practices. From a firefighter's perspective, conventional and alternative fueled vehicles share many commonalities:

- Size-up
- Approach
- Immobilize (keep the vehicle from moving under power or by gravity)
- Extinguishment
 - Flammability
 - Reactivity
 - Health
 - Special hazards

Where the two vehicles differ is in fire extinguishment and overhaul. Hybrid vehicles have high voltage components and a hybrid NiMH battery pack. Firefighters should become familiar with and avoid contact with the high voltage components of a hybrid system such as:

- High voltage cables
- Inverter
- High voltage battery pack

The only way you may be able to identify these components at a fire is through visual identification because badges, labels and other identifiers can be blackened or burnt off from the intensity of a fire.

Firefighters should reference manufacturer's response guides and/or view the various hybrids at their local dealership.

Firefighting Considerations

Water has proven to be a suitable extinguishing agent for hybrid vehicle fires. Other agents can be used, but may

see RECOMMENDATIONS page 10



Figure 2 Toyota Prius 1st generation used for live fire testing by Toyota Motor Sales of U.S. Photo courtesy of Ex-trication.Com by permission of Toyota.

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Recommendations for Offensive and Defensive Fire Attack

continued from page 9

not be practical for NiMH battery fires.

As with any incident, common sense plays an important roll, DO NOT over react. For example, if the fire is compartmentalized, and located in the engine compartment; flooding the occupant cabin or trunk would be considered excessive, and can create additional problems. Deal with the situation on hand, and adjust your fire attack as necessary. The incident commander's decisions during any vehicle rescue will be based on previous knowledge of hybrid systems during training and prior experience fighting vehicle fires.

When a vehicle is fully involved, your initial fire attack should be aggressive, and follow accepted fire practices as you would for any vehicle fire.

Once it has been determined the fire vehicle is a hybrid, the attack crew should be cautioned not to open, touch, or breach any high voltage component. Doing so may cause serious injury or death, severe burns or electric shock.

Firefighters should use a broken water pattern to cool the area and allow the high component to burn itself out. This practice of extinguishment is not new to the fire service, chemical shed fires can be handled in a similar manner.

Warning: Do not open, touch or breach any high voltage component, for any reason including fire. Doing so may cause serious injury or death, severe burns or electric shock.

Since more and more hybrids are being introduced in the consumer market, a safe practice would be to consider all vehicles hybrid unless proven otherwise. Ten years from now, conventional passenger vehicles may be a relic of the past.

As a result of the Toyota live burn tests, there are two recommended modes for fire attack: Offensive and defensive.

The offensive fire attack mode should be used for an initial fire attack, or deep seated fires. With the exception of a hybrid vehicle when the fire is in proximity, or within any high voltage component.

The defensive fire attack mode should be used when the fire is located within any high voltage component. In this situation you should protect the exposures directly around the fire and allow that component to burn itself out.

Note: In a defensive mode, this does not mean you allow the entire vehicle to burn itself out, only the high voltage components. Maintain a protective water pattern to the adjacent components at a safe distance.

ter, will burn themselves out.

“However, flooding a hybrid battery pack is not recommended due to the battery case design and location preventing the responder from properly

applying water through the available vent opening(s) safely. Therefore, it is recommended that the incident commander allow the HV battery pack to burn itself out.”

It is important that firefighters protect all other exposures within the vehicle as the battery pack is burning. This can be done with a broken water pattern at a safe distance. Always assume that high voltage components are live, even when severely burned.

It is important to note that NiMH fires are hard to identify as still burning, and the firefighter



FIGURE 3 Hybrid badges and labels may not readable due to a fire, it is important that responders have a familiarity with high voltage components. Photos courtesy of Extrication.Com with permission from Toyota.

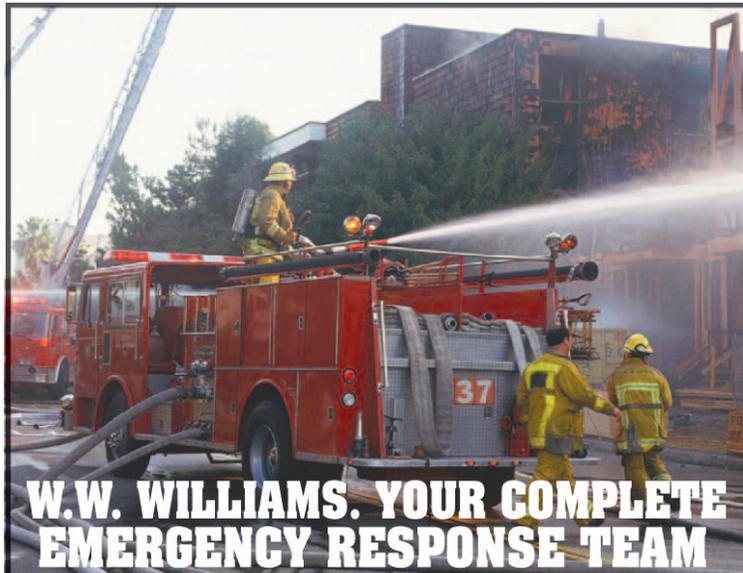


FIGURE 4 A fire attack crew using water during an aggressive offensive fire attack to an interior occupant cabin during a Toyota's hybrid live burn test. Photo courtesy of Extrication.Com with permission from Toyota.

may assume that the byproducts of combustion (smoke/fire gases) are steam conversion. When there is significant fuel (electrolyte) the fire can continue and cause a rekindle up to an hour or more.

Like any fire, the byproducts of combustion can be deadly, all members should wear SCBA, including during overhaul.

see THINGS page 12



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Things You Should Know When Fighting Hybrid Fires

continued from page 10

Toyota Recommendations for Defensive Fire Attack

“If the decision has been

made to fight the fire using a defensive attack, the fire attack crew should pull back to a safe distance and allow the NiMH battery module to burn itself out. During this de-

fensive operation, fire crews may utilize a water stream or fog pattern to protect exposures or to control the path of smoke.”

When the HV battery pack

is on fire, and allowed to burn itself out, the HV NiMH battery modules will be quickly reduced to ashes.

The NiMH electrolyte has known and suspected carcinogenic ingredients, if the battery pack is flooded, any water runoff should be diverted from entering the water shed.

case of overpressure.

Toyota Recommendations for Overhaul

“During overhaul, immobilize and disable the vehicle if not already done. The HV battery cover should never be breached or removed under any circumstances — including fire. Doing so may result in severe electrical burns, shock or electrocution.”

Immobilizing a vehicle simply means to prevent the vehicle from moving under its own power or by gravity. What could be worse than to put your apparatus in pump and see the vehicle roll away while on fire. This is not a new task to vehicle rescue, it's a common sense practice to use for any type vehicle regardless of the type rescue incident.

Disabling a vehicle is quickly and easily done by powering down the vehicle via the ignition system. Shutting off the ignition system will shut down the hybrid system and gasoline fuel pump, disable the HV battery pack, and prevent power to the SRS ECU.

For more comprehensive disabling procedures, firefighters will need to consult the specific make and model hybrid vehicle ERG.

The removal of a NiMH battery pack is not the responsi-

continued on NEXT PAGE

HV NiMH Battery Pack Fires

There is a similarity between all NiMH batteries, which allows for generic fire fighting recommendations. The NiMH electrolyte used for HV battery packs is proprietary and the ingredients should be consistent from one manufacturer to the next.

HV battery packs are comprised of low voltage modules in series. Most manufacturers utilize prismatic low voltage NiMH modules having plastic casings. These are less likely to catastrophically fail during a severe burn since the plastic will melt and or burn venting any gases building up pressure.

Honda utilizes a different style battery, they are D-size stainless steel case NiMH batteries. This type battery was not tested in the Toyota burn tests. However, the battery manufacturer has designed a built-in safety feature allowing excessive gases to vent in



FIGURE 5 Safely applying copious amounts of water needed to extinguish a NiMH battery fire is not practical. Therefore the incident commander should consider allowing the battery pack to burn itself out as his action plan. Photo courtesy of Toyota.

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 bility of the fire department. Any battery pack intact, consumed or partially consumed, is typically the responsibility of the vehicle recovery operator, recycler or hybrid service technician. The local dealership or manufacturer will have specific instructions for its removal from the car by the recycler.

Hybrids are not earth to ground, touching the skin of a hybrid even when wet will

age system is discharged completely, therefore never overhaul any high voltage

pack may remain live even after the plastic prismatic module bottoms have been totally burned away. DO NOT touch high voltage components even with an insulated tool. Arcing may occur and vaporized matter may spatter onto the responder.

ception of high voltage components. Firefighters should never touch, open or breach any high voltage component even in the event of a fire. When a high voltage component is burning, the recommended attack would be to allow that component to burn itself out while applying a broken water pattern at a safe distance. Any water runoff from the HV battery pack should be diverted from a watershed due to its toxicity. Allowing a HV battery pack on fire to consume itself will reduce your time on scene and help eliminate possible hazardous runoff.



FIGURE 6 Unlike a typical 12V lead acid battery, prismatic HV NiMH battery modules do burn. Firefighters may not recognize fire gases from steam conversion, and maybe challenging to extinguish. Photos courtesy of Extrication.Com with permission from Toyota.

Warning: NiMH battery electrolyte is a caustic alkaline (pH 13.5) damaging to all human tissues.

Water Hazards

Submersed, partially submersed or hybrid vehicles flooded by water such as from a firefighter applying water to the vehicle in itself will not cause electric shock.

not cause shock or electrocution. As with any vehicle, the exception would be if there was an external power line in proximity or touching the vehicle.



FIGURE 7 Fire attack crew carefully performing overhaul, avoiding touching any possible high voltage components. Photo by Extrication.Com with permission from Toyota.

However, touching a high voltage component can cause shock or electrocution! NEVER touch a high voltage component, even after the vehicle has been burnt out due to a severe fire. There will be no way for firefighters to ensure that the high volt-

component.

Only a service technician with a high voltage meter can test the HV system to ensure total electrical discharge. HV battery

Summary

Fire fighting practices for a hybrid vehicle fire are similar to that of conventional vehicles, with the ex-

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