

TOWING AND RECOVERY OF ELECTRIC VEHICLES

By Robert Swain, www.HowItBroke.com

Tow operators have a saying about electric vehicles (EVs): there are those who have had one catch fire and those who will. EVs, with their distinct mechanical and electrical systems, require specialized knowledge and handling techniques.

Tow truck operators should undergo specialized training on EV systems. Certification programs provide essential knowledge on safe handling, isolation procedures and emergency response. This article is intended to address only some of the mystery and myths and to avoid unintentionally creating problems.

First, we need to recognize what an EV is, because manufacturers are reducing the badging on these vehicles. For example, the photo below is of a Volvo XC60 Plug-In Hybrid (PHEV) which has only a small generic badge on the tailgate.



The Volvo XC60 Hybrid is an example of an EV with the current trend to minimize badging.

Source: Volvo Emergency Response Guide

For our purposes, an EV includes any car, light truck, bus, or even heavy truck which can be powered by a large high voltage "traction battery," whether hybrid or pure electric. Light vehicle traction batteries are commonly 400 to 800 volts or more, weigh 1,500 to 5,000 lbs., and usually take up the entire bottom of the vehicle between the four wheels. While a surprisingly large number of electric buses and heavy trucks are now on the road, this article is about fully electric and hybrid light passenger cars and pickups that are more popular.

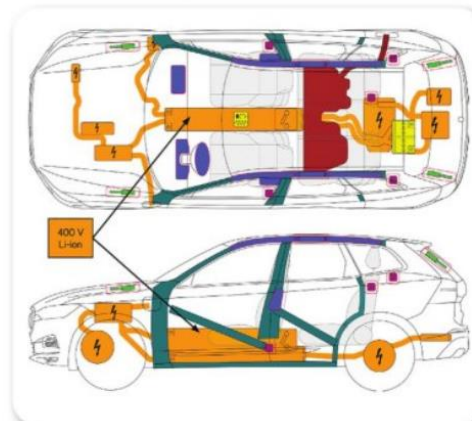
CHOCK - PARK - PARK - OFF

The one thing to remember about any EV or hybrid is: chock - park - park - off.

- Chock the wheels before any other steps because EVs can move silently. This has led to numerous injuries and deaths.
- Park. Pull the physical or electric parking brake control and do not release it until the EV is ready to be pulled onto the flatbed/rollback.

- Park. Put the shifter into park.
- Off. Push the power button or turn the key to off. Then move the key fob away from the EV, possibly to the cab of the truck.

Avoid contact with anything orange, the standard color for high-voltage components, according to National Highway Traffic Safety Administration (NHTSA) Regulation FMVSS 305. Never cut or damage an orange component.



This illustration shows the Volvo XC60 battery in orange between/beneath the front seats, as well as other high-voltage components. The gasoline tank is the brown shape beneath the rear seat.

Source: Volvo Emergency Response Guide

BREAKDOWNS OR ACCIDENTS

Next, we need to separate the types of towing to be undertaken into two groups: one for simple breakdowns and service calls and the other for vehicles involved in accidents.

Undamaged EVs being moved for repair or general transport typically are not a problem and can be treated like most any modern vehicle. If the EV's battery is completely depleted, the vehicle may not engage in neutral mode, making it difficult to tow. In such cases, refer to the owner's manual for instructions on manually disengaging the parking brake and shifting into neutral.

A key thing to know is that the drive wheels generate electricity whenever they rotate because the rotating tires are used to recharge the traction battery when coasting. The

faster the tires turn the higher the power being generated. An issue is not knowing whether the individual car has motors driving one axle or both, and the tow operator will not have time to do research.

The answer is to use a flatbed to keep the wheels stationary during the tow. Most manufacturers do not permit the use of wheel dollies. Load the EV slowly to minimize how fast the tires turn.



The Volvo Emergency Response Guide is typical in only permitting use of a flatbed/rollback to move vehicles. Source: Volvo Emergency Response Guide

In the extremely rare case where a tow operator arrives and the EV looks normal but is full of smoke, immediately call the fire department and stay away from it. The smoke can contain a large amount of explosive hydrogen and detonations have occurred, including in the Volvo model shown above.

EVs involved in accidents generally are transported without incident, but precautions can be taken to minimize risks. Again, we can separate the accident vehicles into two groups: those having what only appears to be relatively minor collision damage versus those that have had smoke, fire, or with exposed orange components.

EVs with apparent minor collision damage can be moved much the same as those being moved for service. Again, the key is to minimize rotating the tires and load slowly so electricity is not generated. Note that it is essential when loading to watch for any indication of smoke, and be prepared to unload quickly at the first sign.

THERMAL RUNAWAY

Batteries are assembled from groups of cells installed into separate modules. Manufacturers use extensive plastic throughout the modules to keep the high voltage connections separated from metal parts. Any internal damage to the plastic insulating materials can result in short circuits explosively releasing thousands of amps of energy causing injuries. More commonly, lower power short circuits involving a single cell can lead to heating the cells around it, releasing smoke or even flames from the case. This is called a thermal runaway.

If an EV starts to smoke, the smell may not be bad enough to initially cause concern and it is easy to underestimate

the risk of breathing it. Be aware that the smoke typically contains acids which will lead to shortness of breath the following day and pneumonia-like symptoms as fluids accumulate in the lungs. Further, the ash has metals such as cobalt and lead that cause cancer and can cripple. Therefore, try to load with the EV downwind.

Smoke or venting flames typically come from beneath the EV and especially the rocker areas located between the front and rear wheels. EVs have ignited once loaded, and operators using controls beneath the bed have been burned. To stay away from an EV as it starts to move onto the bed, use trucks with a bed that can be operated remotely.



Brian Jones of Morton's Towing and Recovery demonstrates use of a wireless remote to load an EV. The car is downwind from where he is standing. It can be dangerous to use the controls located beneath the bed.

Pause when a collision-damaged EV is first coming off the ground and the bottom becomes accessible as shown below. EVs do not have a transmission like gasoline-powered cars do, so chock the rear wheels to prevent the vehicle from rolling backward.

See *Towing and Recovery of EVs* on page 56



PHOTO: R. SWAIM

Stopping at this point allows the tow operator to examine the bottom of the battery for road damage and hot areas. Check the rear wheels so the EV cannot inadvertently roll backward.

Get down to look for road damage such as punctures or dents in the bottom of the battery. Few tow operators carry a thermal camera, but even an inexpensive (\$30) infrared non-contact thermometer from any hardware store can be used to scan the bottom and look for hot spots. If nothing else, feel around the bottom of the battery by hand for a conspicuously hotter area. If a hot area is found, the EV should be kept off the truck. Be aware that some models have a cooling plate beneath the cells, so this may not be effective.

EVs use coolants for battery cooling, cooling the drive components, and heating the cabin. If coolant is leaking from the vehicle, look for the source. While a leaking cabin heat system could be dismissed, leaking battery coolant may be a sign of significant internal damage.

If a collision-damaged EV has any visible traction battery damage, treat it as if it has had a thermal event described below. Otherwise, the loading procedure can be completed once satisfied that the battery is not damaged.

Once an EV or hybrid is loaded for any reason, watch closely in the tow truck's rearview mirrors for any sign of smoke during transport when stopped at lights or for traffic, and be prepared to unload it.

FIRE-DAMAGED VEHICLES

Having now covered transport of undamaged EVs and those with collision damage, we are left with the very few which have had a thermal incident that produced smoke or fire. While few catch fire even after a major accident, about 13% of those which have been involved in a fire have re-ignited — many more than once.

Instead of simply breaking the insulating plastic in the case like in a crash-damaged battery, the heat of a thermal runaway will have melted it, potentially leaving hidden but high-voltage components in near contact. The EV may have been sitting for hours to weeks, appearing to be unremarkable and safe to move. However, the bouncing and distortions involved with loading can result in those internal components developing short circuits which bring a thermal runaway to life. That is why it is even more essential to pause when the EV is at the bottom of the ramp, check the tires, and slowly check the bottom for hot sections. Then closely watch it during transport.

When unloading a fire-damaged EV, keep it away from any other vehicles due to further reignitions from bouncing and distortion of the battery case.

Tow operators should be equipped with appropriate personal protective equipment (PPE), especially if the transport is more than just moving a car for service, which is low-risk. Firefighter-style bunker gear, complete with a face shield and insulated fire-safe gloves should be worn when loading and unloading collision and fire damaged EVs.

EMERGENCY RESPONSE GUIDES

Emergency response guides are available for nearly all EVs and hybrids. These are short documents intended for first responders and include towing instructions. They also cover water recovery. While the emergency response guides can be found on the manufacturers' websites, they are collected in one archive and can be downloaded for free from <https://autorecueapp.com>.

Some emergency response guides call for disconnection of the 12-volt battery while others do not. All will show how to disconnect the high-voltage battery. Be aware that this is different in nearly every EV and may not be effective if collision damage has resulted in internal damage to the high-voltage contactors. Therefore, never trust the orange components to be disconnected even if the procedure is followed.



The Volvo XC60 PHEV emergency response guide shows how to disconnect the high-voltage battery by locating a plug in the floor between the rear seats.

Finally, be prepared for customer questions because towing an EV will likely be new to them too. Explain the steps you will take and be prepared to answer questions about the safety of their EV as well as how you will prevent damage to the battery and drivetrain. Transparency builds trust and ensures a positive experience.

Bob Swaim began working on cars when he was old enough to pass tolls to his father. After becoming a licensed aircraft mechanic and engineer he investigated major aircraft accidents around the world for the National Transportation Safety Board (NTSB) for 32 years. He was the launch investigator in January 2013 when a Boeing 787 lithium-ion battery caught fire. He began investigating electric vehicle fires with the NTSB Highway Division in early 2017 and joined the SAE J2990 Responder Safety Group, which he is still part of. Swaim continues to work extensively on lithium battery issues. His website is www.HowItBroke.com.

EDITOR'S NOTES

By Tim Jackson, Editor
tjackson@towtimesmag.com



Shock Hazard from Submerged Electric Vehicles?

This issue's article, "Towing and Recovery of Electric Vehicles" by lithium battery expert Robert Swaim, offers insight on the safe handling of electric vehicles (EVs) involved in breakdowns, collisions and fires.

He noted that EV and hybrid emergency response guides are available from vehicle manufacturer websites, and the EV rescue app autorecueapp.com. Sources also offer towing instructions — including water recovery.

Submerged and flooded vehicles can be a common call for tow operators, especially after flooding events from heavy rains and hurricane/tropical storm surges. These vehicles may likely include EVs, and while an EV may not be totally submerged, its lower portion, which houses the EV's traction battery, will often be underwater.

Approaching and hooking up to a submerged EV can certainly pose questions of risk to tow operators, mainly a potential shock hazard.

The National Fire Protection Association (NFPA) produced a safety bulletin titled, "Submerged Hybrid/Electric Vehicles," that provides safe response practices for responders.

Does a submerged EV pose a shock hazard? The following information is contained in the bulletin:

Hybrid, electric, and fuel cell vehicles are designed to be safe in water, even when fully submerged. The high voltage (HV) system is isolated from the chassis and is designed to NOT pose a shock and NOT energize the surrounding water.

Warnings:

- Never remove a submerged service disconnect.
- Submersion in water (especially salt water) can damage low- and high-voltage components. Although not a common occurrence, this could result in an electrical short and potential fire once the vehicle is no longer submerged.
- Damaged HV batteries can produce flammable gas. Venting the passenger compartment is recommended once the vehicle is out of the water. Do not store vehicle indoors.

Tips for Safe Response Practices

Submerged Vehicles

- Avoid contact with HV components, cabling, or service disconnects on a submerged vehicle.
 - If possible, turn the ignition off in a submerged vehicle, but do not attempt any other disabling activities.
 - If ignition cannot be turned off, wait until the vehicle is no longer submerged and is drained of water before attempting to disable it.
 - In some instances, small bubbles may be seen coming from an immersed HV battery. This is referred to as micro-bubbling. This DOES NOT indicate a shock hazard and DOES NOT energize the surrounding water.
- The Energy Security Agency (ESA, energysecurityagency.com) advises the following in a safety checklist for EVs that are submerged or exposed to high volumes of water:
- "If the vehicle is found totally or partially submerged, fire department should conduct a surface water assessment. If the water is bubbling, vehicle is buzzing/popping/hissing or gas meter sampling reveals CO (carbon monoxide) presence, DO NOT attempt recovery for a minimum 14 days. Contact local EPA for water hazard assessment or conduct pH evaluation of water.
 - "If the water assessment is negative for hazards, attempt appropriate recovery. Use only synthetic connections and avoid nonstructural anchors including control arms. Doors most likely will be inaccessible due to low voltage loss of power — roof sling capturing A or B posts is recommended. DO NOT make contact with high-voltage components or battery pack. The body of water will not present a direct electrical hazard to operators."

Robert Swaim adds that while there is virtually no direct shock hazard, at least 21 EVs caught fire following recovery in Florida's Hurricane Ian aftermath and the batteries were drained. National Highway Transportation Safety Administration (NHTSA) bought and disassembled the batteries of 10 of those saltwater flooded EVs to find that despite manufacturer's best efforts, water penetrated nearly all of them. Further, the salt aggressively attacked seals and electrical connections. Off-gassing may be silent so heed the NFPA guidance to keep the vehicle open and vented which prevents explosive gasses from accumulating inside.

Swaim notes that the Florida floodwater experience with post recovery fires reinforces the need to keep flooded EVs away from other vehicles in a tow yard. Some yards now have concrete block enclosures to minimize loss of space and others simply keep salvage EVs in steel containers, such as 20-foot roll-off dumpsters.

Fortunately, there is a wealth of information available by online sources as well as EV training programs like the one being held at this year's Tennessee Tow Show. See the ad on page 20 for details. Learning as much as possible before responding to the call can help eliminate guesswork and enhance tow operator safety.