U.S. Fire Administration
Working for a fire-safe America

Electric Vehicle Fire/Rescue Response Operations

July 2025

FEMA

Mission Statement

We support and strengthen fire and emergency medical services and stakeholders to prepare for, prevent, mitigate and respond to all hazards.

U.S. Fire Administration

Working for a fire-safe America

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Acknowledgments

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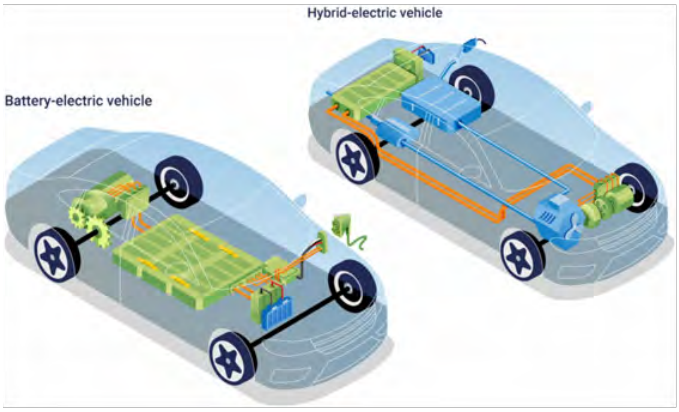
The International Association of Fire Fighters developed and produced this guide, with assistance from a diverse group of subject matter experts representing multiple disciplines, organizations and perspectives.

Introduction

Electric vehicles (EVs) of all types are increasingly found on roadways across the United States.



Even as EV technology and deployment become commonplace, currently there is limited credible response guidance available for local fire departments, emergency medical services (EMS) providers, law enforcement agencies, towing operators and the automotive recovery industry.

Given the dynamic nature of battery technology and EV manufacturing, at present there are substantial gaps in the science that is available to inform safe and effective approaches for identifying, locating, confining and extinguishing EV fires resulting from manufacturing issues, crashes or other incidents. There are significant differences from brand to brand, model to model and year to year. The differences can include battery type, battery chemistry, battery location, battery size, etc. This means that the fire service's approach may have to be different for each, and science has trouble keeping up because of all of these potentially significant variables.

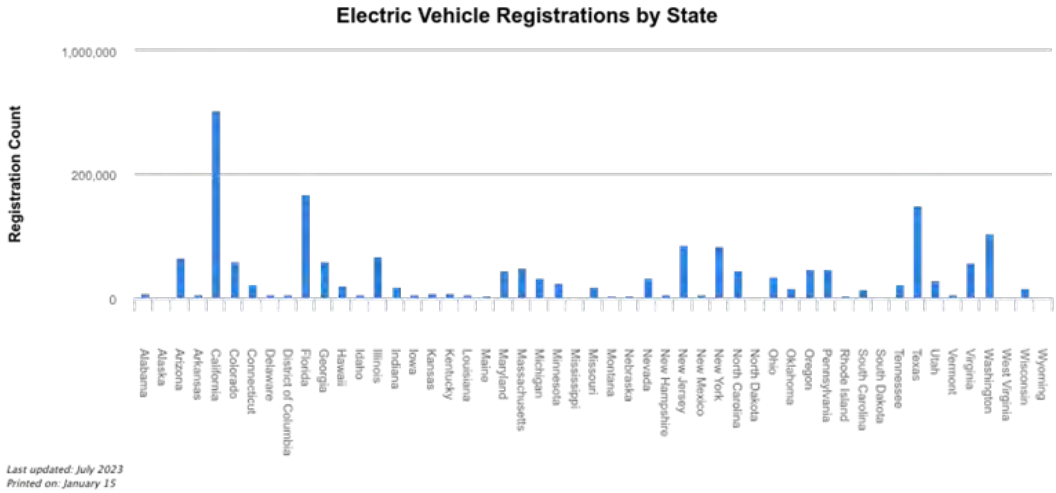
It is important to recognize that many of the tactics, tools and procedures that are being used to address EV fires today are not based on scientific evidence. Multiple experiments and research studies are currently underway, sponsored by government agencies, battery manufacturers, automobile companies, academic institutions and not-for-profit researchers, to close existing knowledge gaps.

As with any aspect of fire and EMS response, it is critically important for first and second responders to keep learning about changing strategies and tactics for safely handling EV-related incidents as new, evidence-based information becomes available from credible sources.

The aim of this guide is to provide basic information and resources, based on the limited scientific research available today, to help ensure safe response operations at emergency incidents involving EVs. In addition, some key knowledge gaps and areas of future inquiry are identified to aid responders, researchers and regulators with advancing the collective understanding of this rapidly evolving technology.

Electric vehicle trends

Data from the U.S. Department of Energy (DOE) reflect there were almost 2.5 million registered EVs across the nation as of July 2023. Additionally, over 6 million hybrid vehicles were reported registered through 2022 (DOE, 2023).

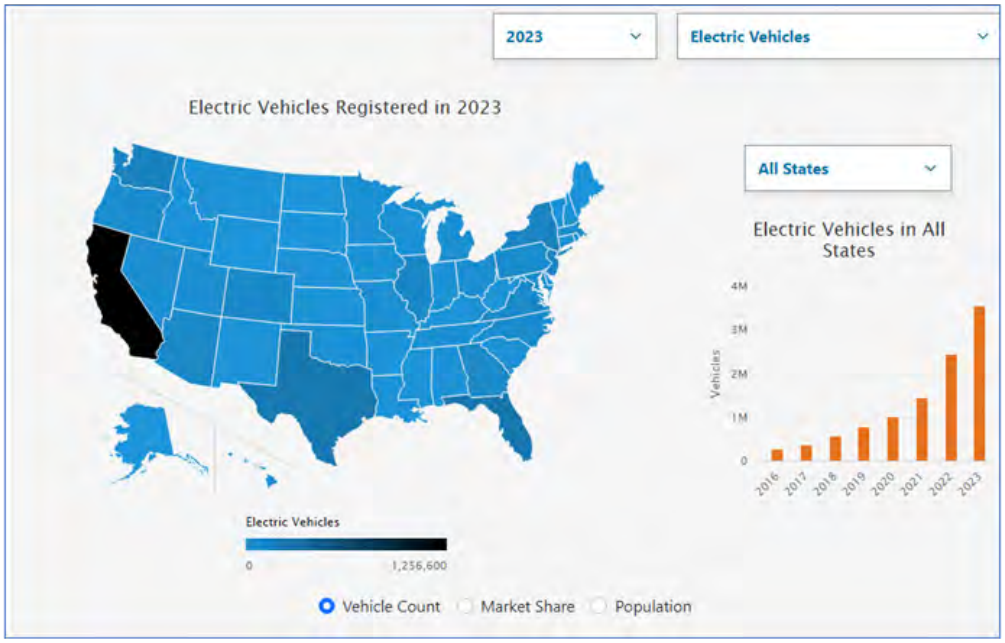


Source: DOE Alternative Fuels Data Center (AFDC) (2023). https://afdc.energy.gov/data/10962

The Edison Electric Institute (EEI) projects "more than 78 million total EVs on U.S. roads in 2035" (Satterfield et al., 2024).

Electric vehicle growth

The Alternative Fuels Data Center (AFDC) within the DOE lists a wide range of benefits and considerations for EVs. As of July 2023, California had 1,256,600 EVs registered statewide, representing 37% of total EV registrations for the entire United States (DOE, 2024).



Source: DOE TransAtlas (2024)

Electric vehicle challenges

At present, there is not a generally accepted, scientifically validated method for effectively extinguishing EV fires of all types. As with any other fire-related incident, responders must continually analyze, plan, implement and evaluate the specific situation they are facing — from dispatch to recovery — as conditions change throughout the event.

While multiple tactical options are currently being used for extinguishing EV fires around the world, the variety of battery chemistries, configurations and initiation variables make responding to these incidents an ongoing challenge for EMS, fire, law enforcement, towing operators and other responders.

There is a wide range of tools, equipment and products being marketed for use with EVs but limited data for first responders to evaluate their viability for use.

Background

Electric vehicle types

EVs are being produced in many different sizes and shapes for multiple modes of transportation.

- So-called "micromobility" or "e-mobility" vehicles include scooters, hoverboards, bicycles and other variations using battery packs to augment human-powered equipment. These are typically regulated by the Consumer Product Safety Commission (CPSC).
- Passenger vehicles are a growing segment of EV production and adoption. Most of the forecasted growth in EVs will likely occur in this segment, as EVs gain market share and displace internal combustion engine (ICE) vehicles from the nation's roadways. These are typically regulated by the DOT.
- EVs for public transit, such as buses, are already commonplace in many U.S. cities.
- Commercial trucking is another growth area for EVs.
- Railroad locomotives are also being retrofitted with lithium-ion batteries in addition to their existing diesel-electric propulsion systems.
- Commercial aircraft, while not EVs per se, contain multiple lithium-ion batteries as part of aircraft systems, cargo and passengers' belongings.
- It should also be noted that the use of lithium-ion batteries is expanding in the marine industry as well.

The focus of this guide is on passenger car and light truck EVs.

How they work

Simply stated, in an EV, batteries replace other forms of power as the method of propulsion. Throughout this guide, 3 general types of EVs will be discussed:

- Plug-in hybrid electric vehicles (PHEVs).
- Hybrid electric vehicles (HEVs).
- Battery electric vehicles (BEVs).

In passenger car and truck EVs such as PHEVs or HEVs, battery packs augment the ICE. These vehicles have traditional fuel-related hazards, along with additional hazards from the supplemental battery system.

All-electric vehicles, also referred to as BEVs, contain batteries and motors that completely replace the ICE and associated fuel hazards, but create new hazards related to the size, location and number of battery cells.

Component identification

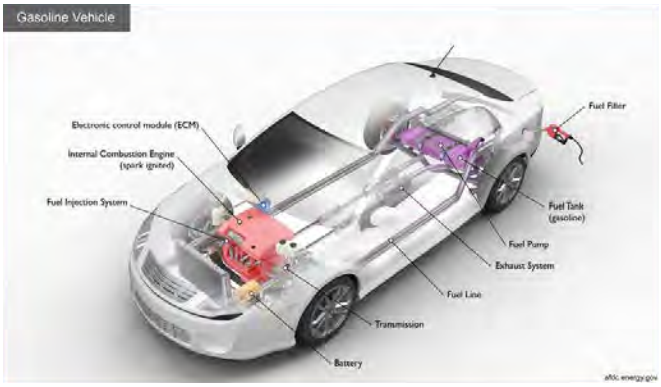
The exact components and configurations of EVs vary widely, and at this time the U.S. has not consistently adopted a standardized methodology of identifying such vehicles.

For specific information about a particular vehicle, first responders should consult the original equipment manufacturer's (OEM's) corresponding Emergency Response Guide (ERG). While not mandatory, most manufacturers provide an ERG that may be 30 to 40 pages and a rescue card that is typically 3 to 4 pages. The ERG will typically provide information on identification, immobilization, vehicle design with hazards and steps to take during certain scenarios. The rescue guide is a condensed version of the ERG. Examples can be found in the appendices of this report.

Some common components and configurations for various EV types are displayed in this section, with a traditional gasoline-powered vehicle illustrated for comparison.

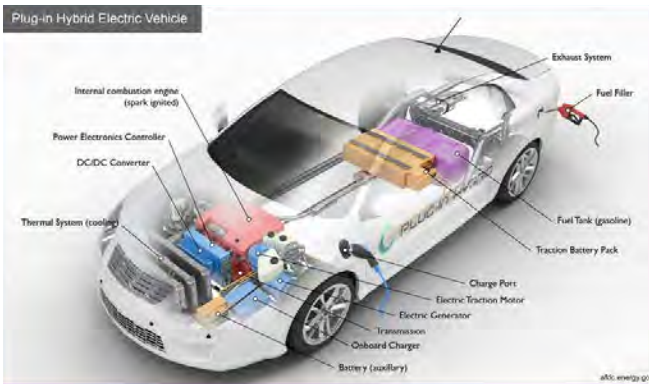
The ICE revolutionized transportation in the early 20th century. These engines rely on burning gasoline or diesel to provide the force required to move a vehicle.

In an EV, electricity from onboard batteries provides the force required for movement, either replacing the engine entirely in a BEV or complementing it, as with a PHEV or HEV.



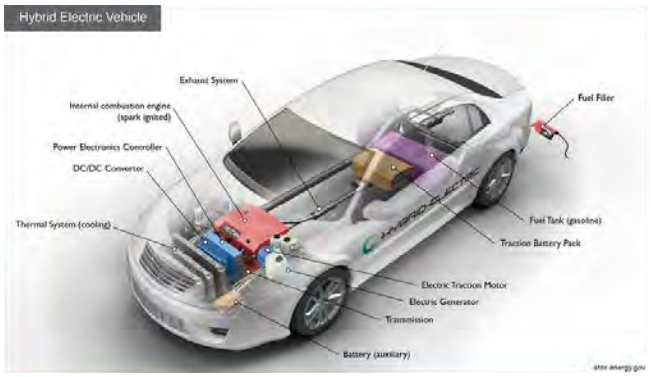
PHEVs have an ICE and an onboard traction battery pack that can store electricity created by an onboard generator or drawn from an external charging source.

PHEVs generally have larger battery packs than HEVs, and smaller battery packs than BEVs, since power for the vehicle's movement can come from either the ICE or electric traction motor at any given time.



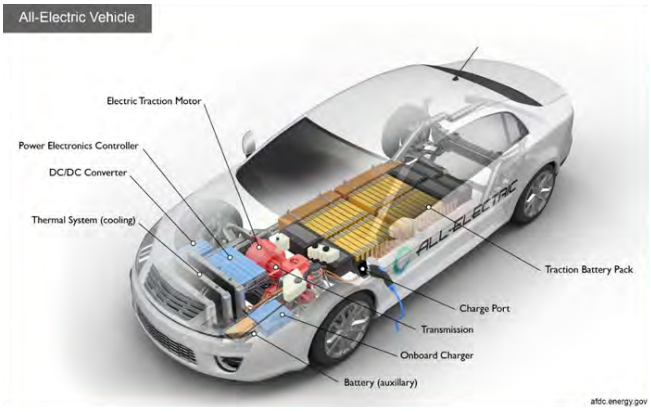
In an HEV, the onboard battery pack is charged with electricity created by an onboard generator that receives power from the vehicle's ICE.

The primary movement source for an HEV is the ICE, supplemented by the electric traction motor. HEVs do not have the ability to plug into an external charging source like a PHEV.



Current EV manufacturing trends reflect the production of a greater number of BEVs than ever before.

BEVs do not have ICEs; instead, they rely entirely on electricity from onboard battery packs for movement. The battery packs in BEVs are typically larger than those in HEVs and PHEVs and contain a substantial amount of stored energy.

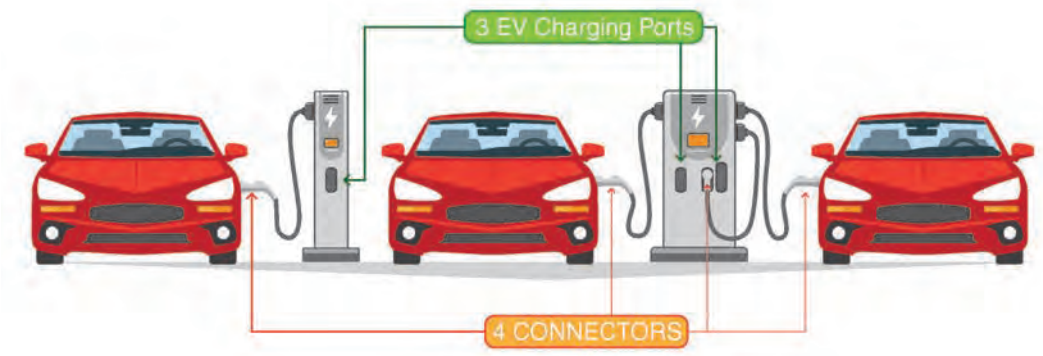


BEV battery packs receive electricity from external charging devices and store electricity in the onboard battery packs until it is needed for movement as power is applied to the wheels through the vehicle's electric traction motor.

Charging interface

EV charging stations can be found almost anywhere and can vary widely in terms of their specific components and configurations. Some basic components and terminology include:

- **Station location:** a site with 1 or more EV charging ports at the same address. Examples include a parking garage or a mall parking lot.
- **EV charging port:** provides power to charge only 1 vehicle at a time even though it may have multiple connectors. The unit that houses EV charging ports is sometimes called a charging post and can have 1 or more EV charging ports. EV charging ports are also sometimes referred to as electric vehicle supply equipment (EVSE) ports.
- **Connector:** what is plugged into a vehicle to charge it. Multiple connectors and connector types (such as CHAdeMO ("CHArge de MOve") and CCS (Combined Charging System)) can be available on 1 EV charging port, but only 1 vehicle will charge at a time. Connectors are sometimes called plugs.



Charger types, speeds and locations can vary depending on a range of factors. EVs can be charged using EVSE ports operating at different charging speeds. The DOT maintains a website identifying basic EV charging configurations and can generally be divided into 3 types:

Level 1

Level 1 equipment provides charging through a common residential 120-volt alternating current (AC) outlet. Level 1 chargers can take 40 to 50-plus hours to charge a BEV to 80% from empty and 5 to 6 hours for a PHEV.

Level 2

Level 2 equipment offers higher-rate AC charging through 240V (in residential applications) or 208V (in commercial applications) electrical service, and is common for home, workplace and public charging. Level 2 chargers can charge a BEV to 80% from empty in 4 to 10 hours and a PHEV in 1 to 2 hours.

Direct current fast charging

Direct current fast charging (DCFC) equipment offers rapid charging along heavy-traffic corridors at installed stations. DCFC equipment can charge a BEV to 80% in just 20 minutes to 1 hour. Most PHEVs currently on the market do not work with fast chargers.

Level 2 and DCFC equipment has been deployed at various public locations including, for example, at grocery stores, theaters or coffee shops. When selecting a charger type, consider its voltages, resulting charging and vehicle dwell times, and estimated up-front and ongoing costs.

The figure below shows typical Level 2 and DCFC charging stations.

Sources: 123RF and Washington State Department of Transportation photos

Level 2 chargers (left) are common in home, workplace and public settings and can charge a BEV from empty in 4 to 10 hours. Direct current (DC) fast chargers (right) are common as public chargers and along highway corridors and can charge a BEV to 80% in under an hour.

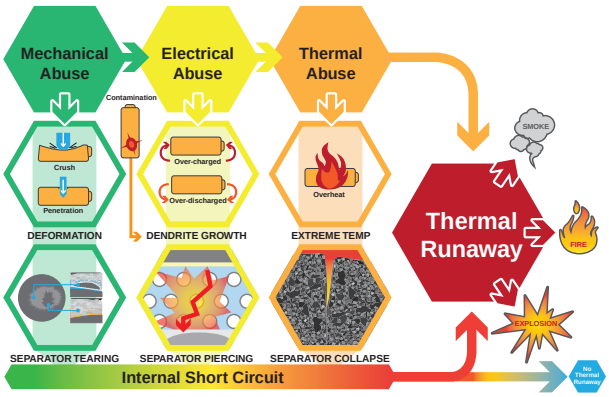
Risk Assessment

The Fire Safety Research Institute (FSRI), part of UL Research Institutes, has released an online training program demonstrating the science of lithium-ion battery fire and explosion hazards that can be found on FSRI's website[1].

Below are some of the hazards related to EVs.

Thermal runaway

- The energy density of the batteries used in EVs can make them extremely volatile when the process of thermal runaway begins.



- Thermal runaway is rapid uncontrolled release of heat energy from a battery cell that creates more heat than it can effectively dissipate. Thermal runaway in a single cell can result in a chain reaction that heats up neighboring cells and can result in battery fire or explosion. Popping noises or white smoke (toxic and flammable) are common indicators of impending thermal runaway.

Electric shock

All EVs should be considered to pose an electric shock hazard until proven otherwise.

Stranded energy

- Stranded energy occurs when a battery cell is damaged without being fully discharged.
- Stranded energy can cause electrocution and serious injury to first responders who are unaware of this hazard.
- It is sometimes possible to dissipate stranded energy using guidance from OEM ERGs, the U.S. Environmental Protection Agency or devices from third-party companies.

Deflagration

- Deflagration is the phenomenon where a subsonic explosion occurs, versus a supersonic detonation.
- While deflagration will not produce the concussive blast wave formed by an explosive detonation, the other effects are similar enough to present a severe hazard for first responders near an EV or battery pack that experiences deflagration.

[1] https://fsri.org/research-update/online-training-available-science-fire-and-explosion-hazards-lithium-ion-batteries

Disposal

- Recent incidents suggest that EVs involved in crashes or fires can experience delayed thermal runaway during removal and transport, disposal and/or salvage processes.
- Fires have occurred several days after the first apparent extinguishment, when damaged EVs were located in impound lots or salvage yards. Reignition while being transported is also possible.
- Damaged battery packs and EV components should only be handled by qualified hazardous materials team members or recovery firms, with proper disposal a must.
- Even with all proper precautions, however, damaged EVs can still experience "rekindle" incidents.

Size-Up

Recognition

With the wide variety of EV models now available from many OEMs, it can be difficult to immediately distinguish between EVs and ICE vehicles.

As with any emergency, the size-up process begins even before the response. Public safety telecommunicators (911 call takers and dispatchers) can ask questions about the presence of EVs when receiving citizen calls for motor vehicle crashes, vehicle fires, structure fires and EMS incidents along roadways.

Identification

There are some vehicle makes/models that can be immediately identified. For example, all Tesla vehicles are BEVs, and some other manufacturers make BEV-only models (e.g., Lucid, Rivian, etc.).

Where an OEM offers a particular model or body style in both ICE and EV versions, responders can look for EV-related branding or markings to help distinguish between an EV and ICE version of the same basic vehicle (e.g., Jeep Wrangler 4xe, Ford Mustang Mach-E, etc.). Some states have EV-specific license plates. Other indicators could include a lack of a tailpipe, orange high-voltage cabling, presence of a charging port, or a smaller (or lack of) front radiator.

It can be difficult to distinguish BEVs from their traditional models, and in many cases slight branding differences may be the only clue.

Chevy Equinox BEV

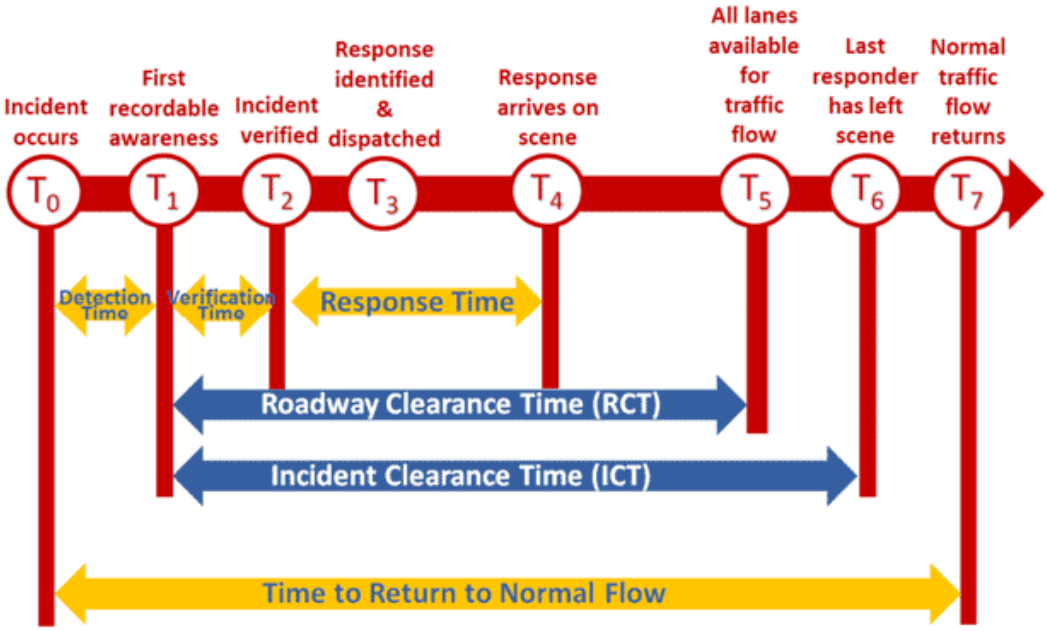
Traditional Ford F-150

Ford F-150 Lightning (BEV)

Incident action plan

As with size-up, developing an incident action plan starts at the time of dispatch. Public safety answering points should consider additional questions related to EVs as part of their standard dispatching guide cards.

The presence of an EV should not change some of the most basic size-up considerations for responding to a vehicle or structure fire, for example: stopping the apparatus/ambulance uphill and upwind of the scene, if possible; controlling traffic using traffic incident management system principles; and donning all appropriate personal protective equipment (PPE), including structural firefighter protective clothing (SFPC) and self-contained breathing apparatus (SCBA), where available.



Size up should include consideration for how to best immobilize the vehicle given most EVs do not have a traditional ignition or key system, nor is there engine noise, as far as determining whether the power train is immobilized. Whether or not to chock the wheels should also be considered.

Obtaining the vehicle key/card or otherwise ascertaining whether the vehicle drivetrain is engaged should also be an included step. Similarly, some modern vehicles lack a physical key or can also be activated by cell phone or proximity key/card, so knowing to look for these items can be important for ensuring the vehicle is in a safe and stable state.

If the vehicle is on fire, the department should attempt to verify whether the fire involves the high-voltage battery. Many EV incidents do not initially involve the battery but could as the incident evolves. Directional and extremely hot jet flames have been observed during early stages of battery failure as well.

Tactical Considerations

Personal protective equipment

Proper PPE is always a primary tactical consideration for any type of emergency incident.

With confirmed or suspected EV fires, the use of SCBA is mandatory — as with ICE vehicle fires — due to the toxic byproducts released by involved batteries and other materials. These toxic products of combustion can include hydrogen fluoride, hydrogen cyanide, polycyclic aromatic hydrocarbons, PFAS, perfluorooctanoic acids, aromatic hydrocarbons and other known carcinogens.

Routes of exposure for these materials can occur through inhalation, absorption via skin contact or secondary exposure from PPE, or ingestion. Although methods for decontaminating PPE continue to evolve, proper decontamination is also a must.

Emergency medical services

For EMS incidents involving EVs, it is typically best to safely remove the patient from the vehicle as soon as possible. An EV that has been damaged in a crash or experienced a battery failure can be extremely volatile, and second-order effects to nearby responders will likely overwhelm any type of available PPE, including SFPC.

Firefighting

At present, there is no generally accepted method for extinguishing EV fires. Guidance in OEM ERGs varies widely, and the specific ERG for a given vehicle should be consulted, if possible, during fire-rescue operations.

From a review of the available literature, however, plain water appears to be the best available extinguishing agent for EV fires. Compared to an ICE vehicle fire, EV fires will likely require much larger quantities of water, delivered at higher flow rates over a longer period of time.

Fire departments facing an EV fire should prepare for high-volume, long-duration water supply, using high-flow hydrants if available and tender/tanker shuttles, if municipal water supplies are not readily available.

It should be noted that a passenger compartment fire is basically the same between ICE and EV vehicles and that a normal handline (150 gallons per minute) is still adequate to extinguish the passenger compartment if that is desired.

Higher flow rates may not always be useful, especially if water supply is limited. The battery box can be cooled which may slow thermal runaway, but no water will get to the cells experiencing thermal runaway.

Some OEMs' ERGs recommend total immersion of EVs that are on fire, and this practice has also been adopted internationally. Other OEMs, however, do not recommend immersing their EVs or battery packs when they are on fire.

Similarly, some OEMs recommend direct water application on their EVs' battery packs, while others strongly recommend against any tactics that might (further) damage the battery packs or individual cells. Products that are on the market to pierce or puncture battery packs — allowing water application inside the pack — should be used with extreme caution and only with direct guidance from the specific vehicle manufacturer.

Again, it should be noted that there is no universally accepted, evidence-based general guidance for EV firefighting available at present. Fire departments facing EV fires should consult the specific vehicle manufacturer's ERG and/or technical support hotline for assistance.

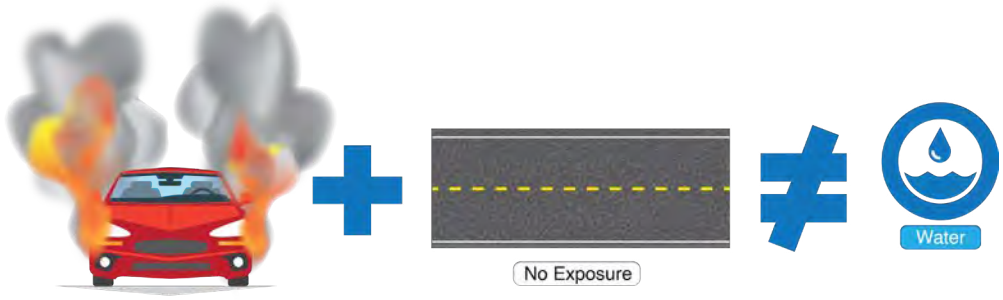
Battery packs in thermal runaway, or on fire, also release hydrogen gas — which is lighter than air and highly explosive. Hydrogen gas as well as other vapors can accumulate in surrounding areas, so this is a particular concern when EVs are parked in enclosed areas. A burning battery pack will not release hydrogen, as the hydrogen will burn off, but will produce heat that could result in adjacent cells releasing toxic and flammable gases, requiring adequate ventilation.

If the fire is contained to the passenger compartment or other areas of the car and does not involve the battery compartment, it can be extinguished with standard vehicle fire tactics and then observed for signs of battery failure.

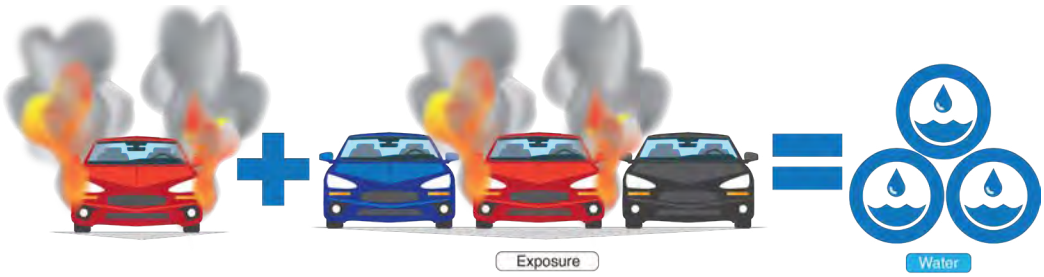
Due to the high quantity of water required to extinguish an EV fire, it is recommended to let it burn unless there are exposure issues.

Tactical considerations for EV fires

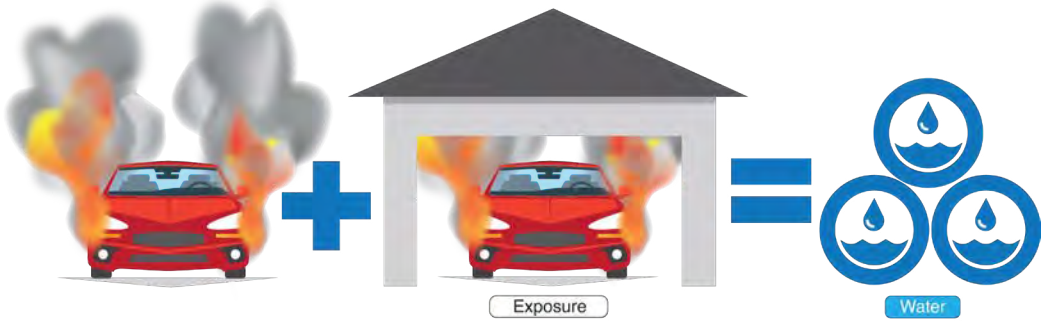
Scenario 1: No exposure — let burn.



Scenario 2: Exposure to other vehicles — attempt to extinguish with copious amounts of water.



Scenario 3: In a garage or structure — attempt to extinguish with copious amounts of water.



Vehicle rescue

As with ICE vehicles, EVs have a tremendous variety of specific construction methods and features potentially affecting vehicle extrication tactics. When responding to a vehicle rescue incident, it is vital to consult the specific OEM's ERG for that vehicle to identify manufacturer-recommended approaches to making the vehicle safe for extrication, handling stranded energy, and identifying locations on the vehicle where cutting and pushing techniques should not be used.

The National Fire Protection Association (NFPA) has also released a directory of EV types that might prove a useful resource, although it should be noted that EV technology and techniques are rapidly evolving and materials can become dated quickly — even for the same make and model vehicle. OEMs and their ERGs are typically still the best resource for updated guidance on a specific vehicle.

Electric

Personnel should always assume the vehicle's high-voltage system is powered up and should refer to the OEM's guide for instruction on disabling direct electric hazards.

Environmental

Fires involving EVs and ICE vehicles present environmental hazards from the toxic products of combustion, battery effluents, firefighting water runoff, and — for ICEs — liquid fuels.

Ejected batteries and battery components involved in fires and vehicle crashes should be handled carefully by qualified hazardous materials technicians or disposal services during the response and recovery phases of the incident. Damaged EVs and battery components have been known to experience thermal runaway hours to days after an incident appears to be concluded. Damaged EVs have been documented to retain large amounts of stranded energy nearly a year after the initial damage.

Decontamination

As with any fire involving contemporary materials, EV fires release a wide range of toxic byproducts. EV fires can also release dangerous quantities of hydrogen fluoride in gas and/or liquid (hydrofluoric acid) form.

On-scene decontamination is a must after an EV fire, using the same techniques as for other types of fires. PPE should be carefully inspected for damage. Firefighters should also take personal hygiene showers and change their uniforms/garments after an EV fire. Ideally, PPE should be laundered using techniques recommended by the manufacturer and/or a qualified independent service provider with experience handling contaminated SFPC.

Recovery Considerations

Accident reconstruction

Law enforcement and recovery personnel performing accident reconstruction involving EVs should remain aware of the hazards typically faced with ICE vehicles.

In addition, EVs present some additional hazards that must be considered and guarded against.

- Stranded energy:
  Stranded energy presents a serious electrocution hazard for accident reconstruction personnel. Stranded energy can remain present for hours or days after an incident. The ERG and/or technical support hotline from that specific vehicle's OEM should be consulted for guidance about how to handle stranded energy before starting accident reconstruction work involving the vehicle or any of its components (e.g., ejected batteries or packs).

- Thermal runaway:
  Recent incidents suggest that thermal runaway can happen at any time, and without warning, on any EV; EVs exposed to physical damage or fire are likely at higher risk for thermal runaway, even after an incident appears closed — for hours or days afterward.

- Delayed fire or deflagration:
  Recent incidents suggest EVs can experience delayed thermal runaway, fire and deflagration for an extended period of time after emergency operations have concluded. Accident reconstruction technicians should remain vigilant for these potential hazards and immediately cease operations if there is any suspicion of thermal runaway or fire.

- Hazardous materials exposure:
  Damaged batteries and battery packs can continue to leak or discharge toxic products in solid, liquid, gas or vapor form for a long period of time.

Towing/removal

Given the potentially delayed and ongoing effects of an EV crash or fire, towing and recovery operators face all of the same hazards described previously for first responders and accident reconstruction technicians.

If there is any suspicion that a vehicle involved in towing, recovery or removal operations is experiencing continued effects, the vehicle and components should be isolated and 911 called immediately. It is generally preferred to transport EVs via rollbacks and to keep crashed or burned vehicles at least 50 feet away from other vehicles and structures. In some cases, this is not possible due to space limitations, and damaged vehicles may be placed in fire-resistive "bunkers" that would prevent fire spread should ignition occur.

In the case of a BEV, the electric motor provides all of the power for the drivetrain, and in HEVs and PHEVs the drivetrain is powered by a combination of an electric motor and an ICE. In either case, when the vehicle's wheels are turning but the motor(s) is not being used to power the drivetrain (during coasting and braking), the electric motor becomes a generator of electricity. The power generated during coasting or braking is often called regenerative braking and is sent back to the battery to recharge it. This design works well for extending the range of the vehicle but can create some issues when the vehicle is shut down and being rolled because the power generated has nowhere to go. If the vehicle is in a nonoperational state, the energy generated in the motor will result in overheating of the unit and will likely result in damage to the motor and possibly fire! Electric and hybrid vehicles should be moved on dollies, flatbeds/rollbacks or in another way that does not roll the vehicle's drive wheels.

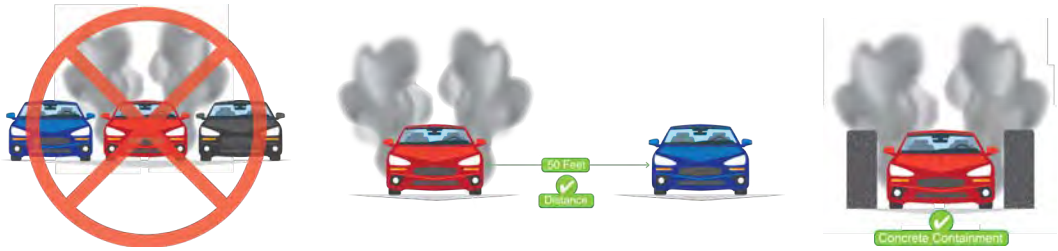
Rolling/dragging guidelines:

- Do not roll on drive wheels over 1 mph.
- Do not roll on drive wheels for long distances (only as far as absolutely necessary to transport properly).
- If the vehicle has been rolled on the drive wheels for long distances or high speeds, check for heat and fire before transporting.
- High-voltage shutdown procedures will **not** make the vehicle safe to roll.

Disposal

Given the potentially delayed and ongoing effects of an EV crash or fire, disposal and salvage operators face all of the same hazards described previously for first responders, accident reconstruction technicians and towing/recovery personnel.

Vehicles should be stored at least 50 feet away from other vehicles or structures or in a containment area if space is limited:



If there is any suspicion that an EV is experiencing a fire or component failure, the vehicle and components should be safely isolated and 911 called immediately.

Case Studies

These case studies are presented here for illustrative purposes only and should not be interpreted as best practices, but rather as potential tactical options depending on the specific vehicle and situation involved in an incident.

Charging

October 2023, Norwalk, Connecticut

Norwalk firefighters responded to a fire in a parking garage,[2] where they found a vehicle charging station on an upper floor fully involved upon arrival. Units secured power to the charging station and were able to extinguish the fire with multiple dry chemical extinguishers upon arrival.

Consideration: Charging station fires not involving an actual vehicle can generally be treated like other electrical fires where power to the unit should be secured first and then the fire can be extinguished with an appropriate extinguishing agent.

Crash

May 2018, Fort Lauderdale, Florida

In May 2018, Fort Lauderdale firefighters responded to a single-vehicle accident[3] involving a 2014 Tesla Model S. Upon arrival, units found the vehicle fully involved with subjects trapped. Crews were able to quickly extinguish the interior of the car with 200 to 300 gallons of water and foam. Pieces of the car's lithium-ion high-voltage battery had separated from the vehicle and, as a precaution, firefighters applied water and foam to the debris.

As part of the police investigation and cleanup, the vehicle and associated debris were loaded onto tow trucks. During that operation, modules that had separated from the battery ignited on the tow truck when workers passed a chain over them. The fire went out by itself. But while the vehicle was being loaded onto a second tow truck, the battery reignited, and the battery case separated from the vehicle. The fire department applied more foam and water to extinguish the fire. While being unloaded from the tow truck at the tow yard, the battery case and modules reignited a final time, but the fire again self-extinguished.

Consideration: Damaged high-voltage batteries have a history of reigniting. First responders should ensure towing services are aware of damaged batteries and the potential for ignition so that they can make appropriate accommodations during transport and storage.

[2] https://www.firerescue1.com/electric-fire/articles/conn-firefighters-battle-ev-charging-station-fire-in-parking-garage-j7HckqXLg7Do2f3x/
[3] https://www.ntsb.gov/investigations/AccidentReports/Reports/HAB1908.pdf

December 2023, Autauga County, Alabama

The Pine Level Fire Department responded to a motor vehicle accident[4] with a vehicle reported on fire. Upon arrival, units found an EV well involved. It took over 36,000 gallons of water and nearly an hour to extinguish the fire.

Consideration: EV fires involving the main battery packs require a tremendous amount of water to extinguish. Many interstates and highways lack hydrants that would allow for this type of water supply. In these cases, the best action is to simply let the fire burn itself out unless there are exposure concerns.

Floods

September 2022, Florida

Fire department personnel in Naples, Florida, responded to at least 6 EV[5] fires in the wake of Hurricane Ian. These vehicles caught fire due to being submerged in saltwater for an extended period of time.

Consideration: EVs that have been submerged in water have greater potential for a high-voltage vehicle fire. Emergency management agencies should consider public messaging related to this hazard for areas prone to flooding or storm surge.

Fire

January 2023, Sacramento, California

Sacramento firefighters responded to an EV fire on a local interstate.[6] Firefighters utilized jacks to elevate the vehicle to access the battery pack and applied water for an extended period of time.

July 2023, Wilmington, North Carolina

Firefighters in North Carolina responded to an EV fire in Wilmington[7] on Interstate 140. The fire started after the driver ran over a piece of debris that punctured the high-voltage battery pack.

August 2023, Carson, California

Carson firefighters responded to an electric truck fire that was the result of a crash. Firefighters had challenges extinguishing the fire, and it ultimately smoldered for 2 days prompting local street closures.

[4] https://www.wsfa.com/2023/12/26/driver-custody-after-tesla-crashes-burns-interstate-65/
[5] https://www.nfpa.org/news-blogs-and-articles/blogs/2022/10/19/experts-warn-of-electric-vehicle-fires-after-hurricane-ian-damages-lithium-ion-batteries
[6] https://www.sfchronicle.com/bayarea/article/tesla-explodes-in-flames-on-side-of-freeway-17749093.php
[7] https://www.wect.com/2023/07/21/electric-vehicle-catches-fire-after-hitting-debris-i-140/

February 2023, Dearborn, Michigan

> 3 Ford F-150 Lightning EVs were involved in a fire at Ford holding facility in Dearborn. The fire took several hours to extinguish and resulted in the manufacturer stopping production of the vehicle for 5 weeks.

Considerations: EV fires involving the high-voltage battery packs are more difficult to extinguish than traditional ICE fires. Due to the high volume of water (which may not be available on many highways and interstates) required to cool battery packs, the best tactic is often to let the vehicle burn unless there are exposure issues. Based on the fact that you are cooling the batteries to stop a reaction (as opposed to actual extinguishment), there is also a much greater risk of reignition.

Extrication

Firehouse Magazine, University of Extrication

> EVs require additional size-up considerations[8] and possible alternatives to standard vehicle rescue techniques. Nearly everything in an EV is electric, and response personnel must ensure all needed doors and windows are open prior to securing 12V power. In addition, the location of the high-voltage battery pack can affect techniques typically utilized to manipulate the dash. Reviewing vehicle rescue cards can point out cable runs that may also negate standard cut points.

Reignition

June 2022, Sacramento, California

> Firefighters in Sacramento struggled to extinguish an EV fire[9] as it continued to reignite. Firefighters ultimately dug a shallow pit in the ground which they filled with water and partially submerged the vehicle to sustain cooling and prevent reignition.
>
> Consideration: Reignition of EV fires is well documented and presents challenges for firefighters with no single solution available at this time. Alternative solutions as mentioned in this article must be weighed against firefighter safety, resource allocation and other risks such as environmental damage.

[8] https://www.firehouse.com/rescue/vehicle-extrication/article/21253251/university-of-extrication-modifying-extrication-methods-for-firefighters-and-first-responders-for-electric-vehicles
[9] https://ctif.org/news/fire-department-ad-hocs-new-extinguishing-method-ev-battery-fire-minimal-water-runoff

Knowledge Gaps

Although research is being conducted to better understand the hazards associated with lithium-ion batteries and means for mitigation, several knowledge gaps remain. To the extent possible, the fire service must continue to mitigate exposure to toxic chemicals released during fires involving lithium-ion batteries and to understand the new and complex hazards lithium-ion batteries can present to provide firefighters with data and information to inform operational procedures. As an emerging technology, there are additional research questions that the fire service can take the lead in to address its community partners. For example, how do charging stations fit safely within current zoning and code ordinances? There is an existing roadway infrastructure built for gasoline distribution, but how do these 2 systems work together safely? What challenges exist during the entire lifecycle of lithium-ion-powered products? What risks exist and how do they evolve? How effective are current exposure reduction efforts (e.g., laundering, preliminary exposure reduction) at removing lithium-ion battery contamination from firefighter turnout gear? While lithium-ion batteries are an emerging technology, the reality is that the industry is already seeking alternatives. New technologies will likely seek to increase energy density, allowing a smaller battery footprint with increased capacity. It is critical for the fire service to understand the risks of these new technologies.

Recommendations

Data needs:

- Establish a mechanism to monitor industry for incidents and research. The mechanism should include the USFA's National Emergency Response Information System and the ability to collect EV and battery product incidents.
- Dissemination and incorporation of data collected from ongoing research on topics such as: EV suppression, battery fire environmental exposure, firefighter exposure during lithium-ion battery and EV fires, hazards of battery fires in structures (parking garages, homes, energy storage systems, etc.), safe operations around and management of stranded energy, and safe disposal of damaged batteries.

Partnerships:

Utilize and form new partnerships to stay informed of the new and evolving issues.

Training:

- Survey state and local training academies for training programs for best practices.
- Share work group findings and recommendations with fire service curriculum developers and publishers.

Regulation:

Work with agencies like DOE, CPSC, DOT, the Department of Health and Human Services, etc., on battery risk mitigation, health effects, etc.

Codes and standards:

- Encourage fire service representation and participation in future code development committees such as the proposed standard on lithium-ion batteries, NFPA 800, *Battery Safety Code*.
- Encourage fire service participation in all current codes and standards pertaining to lithium-ion batteries, such as NFPA 855, *Standard for the Installation of Stationary Energy Storage Systems*; UL 9540; and UL 9540A.

Firefighting:

Support research to develop best practices on all forms of lithium-ion battery fires including mobility, EV and battery energy storage systems. Based on research support development of job performance requirements and other processes in various NFPA standards on firefighting.

Conclusion

EVs present a series of challenges for first and second responders. The number of EVs on our nation's roadways, in garages, on driveways, in enclosed garages and parked adjacent to structures will only continue to grow in the coming years.

The pace of EV adoption and deployment has been so fast that significant knowledge gaps remain for fire-rescue, law enforcement, recovery and disposal operators to safely and effectively handle these incidents. Until knowledge gaps are resolved, ERGs remain the best source of information in resolving EV incidents. It should be noted that the NHTSA has developed an ERG application to allow vehicle manufacturers to submit required, standardized emergency response documents to NHTSA so that first and second responders can access information when handling electric vehicles in an emergency. Once the NHTSA site is live, vehicle manufacturers will be able to access the NHTSA ERG application via the NHTSA Enterprise Portal to view all uploaded documents for the manufacturer, upload new ERG and Rescue Sheets, and update documents as necessary. The uploaded ERGs and Rescue Sheets will be publicly available on NHTSA's website (www.nhtsa.gov) for easy searchable access.

Acronyms and Abbreviations

AC	alternating current
AFDC	Alternative Fuels Data Center
BEV	battery electric vehicle
CPSC	Consumer Product Safety Commission
DC	direct current
DCFC	direct current fast charging
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EEI	Edison Electric Institute
EMS	emergency medical services
ESA	Energy Security Agency
ERG	Emergency Response Guide
EVSE	electric vehicle supply equipment
EV	electric vehicle
FSRI	Fire Safety Research Institute
HEV	hybrid electric vehicle
ICE	internal combustion engine
NFPA	National Fire Protection Association
NHTSA	National Highway Traffic Safety Administration
OEM	original equipment manufacturer
PHEV	plug-in hybrid electric vehicle
PPE	personal protective equipment
SCBA	self-contained breathing apparatus
SFPC	structural firefighter protective clothing
USFA	U.S. Fire Administration

Definitions

Accident reconstruction: the process of investigating, analyzing and drawing conclusions about the causes and events during a vehicle collision.

Battery: a device containing an electric cell or series of electric cells storing chemical energy that can be converted into electrical power, usually in the form of DC.

BEVs: vehicles consisting of a fully electric powertrain that is powered solely by an electric motor fueled by rechargeable batteries. Battery cells are typically located in the low points of the vehicle, such as the floorboard and truck bed areas.

Case: battery packs for multicell batteries can be furnished with a number of different casing materials and configurations. The case material may be plastic or metal and, in some applications, an integral part of the battery.

Cell: a single power generating unit which stores the chemical energy and then converts it into electrical energy.

Charging cable: a cable responsible for transmitting electricity from a charging station or outlet to the vehicle's battery.

Cut loops: low-voltage wire loops that emergency responders can safely cut to disconnect the high-voltage system from the rest of an EV. Cutting the cut loop will **not** remove energy from the high-voltage battery.

Deflagration: to burn rapidly with intense sparks and heat.

Disposal: the action or process of throwing away or getting rid of something.

Dumpster: a large trash receptacle.

Dump truck: an automotive truck for the transportation of bulk material that has a body which tilts to dump its contents.

Engine: a machine for converting any of various forms of energy into mechanical force and motion.

HEVs: vehicles combining an ICE with an electric motor. These vehicles use the electric motor as a secondary power source powered by a nickel-metal hydride battery that is charged by the ICE. Power can also be generated through the turning of the wheels and brake application.

Hydrogen: a nonmetallic gaseous chemical element with atomic number 1 that is the simplest and lightest of the elements and that is used especially in the processing of fossil fuels and the synthesis of ammonia.

Lithium-ion battery: a rechargeable battery that uses lithium ions as the primary component of its electrolyte micromobility.

Plasma: ionized gas consisting of positive ions and free electrons in proportions resulting in more or less no overall electric charge, typically at low pressures (as in the upper atmosphere and in fluorescent lamps) or at very high temperatures (as in stars and nuclear fusion reactors).

Pumper: a fire apparatus with a water pump with a capacity of at least 750 gallons per minute that also contains a water tank and hose.

Response guide: a guidebook that identifies hazardous materials and gives emergency actions for spills or releases.

Stranded energy: the energy remaining inside the undamaged modules and cells of a damaged high-voltage battery. This can cause the battery to reignite multiple times after an EV is extinguished. In this case, the best practice may be to let a battery fire burn itself out.

Tender: a type of fire apparatus that specializes in the transport of larger quantities of water than a standard fire engine.

Thermal runaway: a rapid uncontrolled release of heat energy from a battery cell that creates more heat than it can effectively dissipate. Thermal runaway in a single cell can result in a chain reaction that heats up neighboring cells and can result in battery fire or explosion. Popping noises or white smoke (toxic and flammable) are common indicators of impending thermal runaway.

Tow operator: an individual, partnership or business entity that owns or operates a commercial tow truck.

Waste stream: the complete flow of waste from its domestic or industrial source through to recovery, recycling or final disposal.

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Resources

DOE AFDC (https://afdc.energy.gov/)

FDNY Foundation (https://www.fdnyfoundation.org/)

NFPA (https://www.nfpa.org/)

NFPA Research Foundation (https://www.nfpa.org/Education-and-Research/Research/Fire-Protection-Research-Foundation)

National Highway Traffic Safety Administration (https://www.nhtsa.gov/)

National Transportation Safety Board (https://www.ntsb.gov/Pages/home.aspx)

Fire and Rescue New South Wales (https://www.fire.nsw.gov.au/)

RISE Fire Research (Norway) (https://risefr.com/)

SAE International (https://www.sae.org/)

UL FSRI (https://fsri.org/)

Appendices

Model Standard Operating Procedures

Electric Vehicle Fires

Fire Department Standard Operating Procedure

Effective Date: **Revised:**

Concept/Procedures: Response to electric vehicle fires

Objective/Purpose: Provide policy for the response to electric and hybrid vehicle fires

Page: 1 of 2 **SOP#**

Approved by:

Authorized by:

I. Introduction

A. Electric and hybrid vehicles present additional risks and tactical considerations to ensure firefighter safety.

1. Hybrid vehicles run on a combination electric and gasoline engine. These vehicles have high voltage battery systems as well as the standard 12-volt system. The high voltage system is often in a rear compartment, with cables running from that area to the engine. Most often these cables are colored orange, although some may be other colors such as blue or black and should be avoided.

B. Electric vehicles are typically powered by lithium-ion batteries located on the underside of the vehicle. Lithium-ion batteries are composed of up to several thousand individual cells that can suddenly and violently combust when exposed to high heat or physical damage. This sudden combustion is called thermal runaway and cannot be stopped once it has begun.

C. The following procedures should be considered in addition to existing standard operating guidelines for vehicle and/or highway incidents.

II. Procedure

A. Ensure proper scene safety (Refer to existing traffic management SOG**).**

1. Apparatus positioning.
2. Personnel PPE that is appropriate for known and potential hazards.

B. Identify the presence of an EV.

1. Charging ports.
2. Emblems/Badges.
3. Labels.
4. Instruments.
5. Components (Bright orange wiring and disconnects).

C. Immobilize the vehicle (**Remember, these vehicles run silent**).

1. Approach the vehicle at an angle or from the side.
2. Place the vehicle in park.
3. Applying parking brake if equipped.

D. Fire suppression considerations.

1. If fire does not involve battery pack initiate offensive attack.
2. If vehicle is a safe distance from exposures and fire involves battery pack, consider letting the fire burn.
3. If fire involves battery pack and requires extinguishment, ensure long term water supply is available.
4. High voltage components should never be overhauled as there is no guarantee the system is de- energized.
5. Utilize thermal imager to ensure battery pack is sufficiently cooled before transporting.

E. Ensure towing company is aware of electric vehicle hazard before removal.

Motor Vehicle Crash Involving Electric Vehicles

Fire Department Standard Operating Procedure

Effective Date: **Revised:**
Concept/Procedures: Response to vehicle accidents involving electric vehicles
Objective/Purpose: Provide policy for the response to electric and hybrid vehicle accidents
Page: 1 of 2 **SOP#**
Approved By:
Authorized By:

I. Introduction

A. Electric and hybrid vehicles present additional risks and tactical considerations to ensure firefighter safety.

1. Hybrid vehicles run on a combination electric and gasoline engine. These vehicles have high voltage battery systems as well as the standard 12-volt system. The high voltage system is often in a rear compartment, with cables running from that area to the engine. Most often these cables are colored orange, although some may be other colors such as blue or black and should be avoided.

2. Electric vehicles are typically powered by lithium-ion batteries located on the underside of the vehicle. Lithium-ion batteries are composed of up to several thousand individual cells that can suddenly and violently combust when exposed to high heat or physical damage. This sudden combustion is called thermal runaway and cannot be stopped once it has begun.

B. The following procedures should be considered in addition to existing standard operating guidelines for vehicle and/or highway incidents.

II. Procedure

A. Ensure proper scene safety (Refer to existing traffic management SOG**).**

1. Apparatus positioning.
2. Personnel PPE that is appropriate for known and potential hazards.

B. Identify the presence of an EV.

1. Charging ports.
2. Emblems/Badges.
3. Labels.
4. Instruments.
5. Components (Bright orange wiring and disconnects).

C. Immobilize the vehicle (**Remember, these vehicles run silent**).

1. Approach the vehicle at an angle or from the side.
2. Place the vehicle in park.
3. Applying parking brake if equipped.
4. 12-volt power-down procedure should include using electric power to unlock doors and lower windows, if safe to do so, prior to killing the power.

D. Extrication Considerations.

1. Use of proper PPE required.
2. Deployment of manned pre-connect prior to extrication (Consider hydrant location for sustained water supply).
3. Only use tools and techniques on EVs when the location and condition of EVs high-voltage battery and cables are certain.
    a. The location of high voltage batteries may require deviation from standard vehicle rescue techniques such as dash rolls.

EMS Incidents

Fire Department Standard Operating Procedure

Effective Date: **Revised:**
Concept/Procedures: Response to EMS incidents in electric vehicles
Objective/Purpose: Provide policy for EMS response involving electric and hybrid vehicles
Page: 1 of 2 **SOP#**
Approved By:
Authorized By:

I. Introduction

A. Electric and hybrid vehicles present additional risks and tactical considerations to ensure firefighter safety.

1. Hybrid vehicles run on a combination electric and gasoline engine. These vehicles have high voltage battery systems as well as the standard 12-volt system. The high voltage system is often in a rear compartment, with cables running from that area to the engine. Most often these cables are colored orange, although some may be other colors such as blue or black and should be avoided.

2. Electric vehicles are typically powered by lithium-ion batteries located on the underside of the vehicle. Lithium-ion batteries are composed of up to several thousand individual cells that can suddenly and violently combust when exposed to high heat or physical damage. This sudden combustion is called thermal runaway and cannot be stopped once it has begun.

B. The following procedures should be considered in addition to existing standard operating guidelines for vehicle and/or highway incidents.

II. Procedure

A. Ensure proper scene safety (Refer to existing traffic management SOG).

1. Apparatus positioning.
2. Personnel PPE that is appropriate for known and potential hazards.

B. Identify the presence of an EV.

1. Charging ports.
2. Emblems/Badges.
3. Labels.
4. Instruments.
5. Components (Bright orange wiring and disconnects).

C. Immobilize the vehicle (**Remember, these vehicles run silent**).

1. Approach the vehicle at an angle or from the side.
2. Place the vehicle in park.
3. Applying parking brake if equipped.

D. Provide standard patient care per protocols.

Structure Fires involving EVs

Fire Department Standard Operating Procedure

Effective Date: **Revised:**
Concept/Procedures: Response to structure fires involving electric vehicles
Objective/Purpose: Provide policy for the response to structure fires involving electric vehicles
Page: 1 of 2 **SOP#**
Approved By:
Authorized By:

I. Introduction

A. Electric and hybrid vehicles present additional risks and tactical considerations to ensure firefighter safety.

1. Hybrid vehicles run on a combination electric and gasoline engine. These vehicles have high voltage battery systems as well as the standard 12-volt system. The high voltage system is often in a rear compartment, with cables running from that area to the engine. Most often these cables are colored orange, although some may be other colors such as blue or black and should be avoided.

2. Electric vehicles are typically powered by lithium-ion batteries located on the underside of the vehicle. Lithium-ion batteries are composed of up to several thousand individual cells that can suddenly and violently combust when exposed to high heat or physical damage. This sudden combustion is called thermal runaway and cannot be stopped once it has begun.

3. Additional hazards related to increased hydrogen and carbon monoxide may exist when an electric vehicle is in a contained residential garage (door down) that may warrant alternative forcible entry measures based on the departments gas leak SOP.

B. The following procedures should be considered in addition to existing standard operating guidelines for structure fires.

II. Procedure

A. First arriving suppression piece.

1. Follow Standard Operating Guidelines for structure fires for overall unit placement and assignments.
2. Identify involvement of electric vehicle as part of scene size up.
3. If it can be done safely, remove the electric vehicle from the structure to prevent exposure or facilitate extinguishment if on fire.
4. Consider hazardous materials team response.
5. Initiate fire attack.
   a. Vehicle still in structure.
      - Initiate offensive attack.
   b. Vehicle removed from structure.
      - If fire does not involve battery pack initiate offensive attack.
      - If vehicle is a safe distance from exposures and fire involves battery pack, consider letting the fire burn.

c. High voltage components should never be overhauled as there is no guarantee the system is de-energized.
d. Utilize thermal imager to ensure battery pack is sufficiently cooled before transporting.

Salvage Yard Fires with EVs

Fire Department Standard Operating Procedure

Effective Date: **Revised:**
Concept/Procedures: Response to salvage yard fires involving electric vehicles
Objective/Purpose: Provide policy for the response to salvage yard fires involving electric and hybrid vehicles
Page: 1 of 2 **SOP#**
Approved By:
Authorized By:

I. Introduction

A. Electric and hybrid vehicles present additional risks and tactical considerations to ensure firefighter safety.

1. Hybrid vehicles run on a combination electric and gasoline engine. These vehicles have high voltage battery systems as well as the standard 12-volt system. The high voltage system is often in a rear compartment, with cables running from that area to the engine. Most often these cables are colored orange, although some may be other colors such as blue or black and should be avoided.

- Electric vehicles are typically powered by lithium-ion batteries located on the underside of the vehicle. Lithium-ion batteries are composed of up to several thousand individual cells that can suddenly and violently combust when exposed to high heat or physical damage. This sudden combustion is called thermal runaway and cannot be stopped once it has begun.

B. The following procedures should be considered in addition to existing standard operating guidelines for vehicle and/or highway incidents.

II. Procedure

A. First arriving suppression piece.

1. Follow Standard Operating Guidelines for salvage yard fires for overall unit placement and assignments.
2. Identify involvement of electric vehicle as part of scene size up.
3. If it can be done safely, isolate the electric vehicle from other vehicles or structure to prevent exposure or facilitate extinguishment if on fire.
4. Consider hazardous materials team response.
5. Initiate fire attack.
   - If fire does not involve battery pack initiate offensive attack.
   - If vehicle is a safe distance from exposures and fire involves battery pack, consider letting the fire burn.

a. High voltage components should never be overhauled as there is no guarantee the system is de-energized.
b. Utilize thermal imager to ensure battery pack is sufficiently cooled before transporting.

Accident Reconstruction

Police Department Standard Operating Procedure

Effective Date: **Revised:**
Concept/Procedures: Vehicle accident reconstruction involving electric vehicles
Objective/Purpose: Provide policy for safe operation when reconstructing accidents involving electric vehicles
Page: 1 of 2 **SOP#**
Approved By:
Authorized By:

I. Introduction

A. Electric and hybrid vehicles present additional risks and tactical considerations to ensure officer safety.

1. Hybrid vehicles run on a combination electric and gasoline engine. These vehicles have high voltage battery systems as well as the standard 12-volt system. The high voltage system is often in a rear compartment, with cables running from that area to the engine. Most often these cables are colored orange, although some may be other colors such as blue or black and should be avoided.

2. Electric vehicles are typically powered by lithium-ion batteries located on the underside of the vehicle. Lithium-ion batteries are composed of up to several thousand individual cells that can suddenly and violently combust when exposed to high heat or physical damage. This sudden combustion is called thermal runaway and cannot be stopped once it has begun.

B. The following procedures should be considered in addition to existing standard operating guidelines for accident reconstruction.

II. Procedure

A. Ensure proper scene safety (Refer to existing traffic management SOG).

1. Vehicle positioning.
2. Additional PPE should be considered if operating in and around an electric vehicle that has damaged battery pack.

B. Identify the presence of an EV.

1. Charging ports.
2. Emblems/Badges.
3. Labels.
4. Instruments.
5. Components (Bright orange wiring and disconnects).

C. Ensure vehicle is and remains immobilized **(Remember, these vehicles run silent).**

1. Approach the vehicle at an angle or from the side.
2. Place the vehicle in park.
3. Applying parking brake if equipped.

D. Follow normal investigative procedure.

Model Emergency Communications Center Guidance

911 call takers and dispatchers should consider additional questions related to EVs as part of their standard dispatching guide cards:

1. Motor vehicle crash EV vital point questions:
   - Is an electric or hybrid vehicle involved?
     - If yes, what is the make and model?
     - If yes, is the vehicle damaged?

2. Vehicle fire EV vital point questions:
   - Is an electric or hybrid vehicle involved?
     - If yes, what is the make and model?
     - If yes, what part of the vehicle is on fire?

3. Structure fire EV vital point questions:
   - Are there EVs in the structure?
     - If yes, what is the make and model?
     - If yes, is the vehicle involved in the fire?

4. Garage fire EV vital point questions:
   - Is an electric or hybrid vehicle in the garage?
     - If yes, what is the make and model?
     - If yes, is the vehicle on fire?
     - If no, are there any EVs near the garage?

5. Parking garage fire EV vital point questions:
   - Is an electric or hybrid vehicle involved?
     - If yes, what is the make and model?
     - If yes, what part of the vehicle is on fire?
     - If no, are there any EVs near the vehicle on fire?

6. Salvage or junkyard fire EV vital point questions:
   - Is an electric or hybrid vehicle involved?
     - If yes, what is the make and model?
     - If yes, what part of the vehicle is on fire?
     - If no, are there any EVs near the vehicle on fire?

Sample Tactical Worksheet

Apparatus/ambulance positioning:

- ☐ Position first suppression apparatus to ensure scene safety.
- ☐ EMS units should pull past the incident scene.

Select PPE and SCBA:

- ☐ Full structural gear and SCBA should be worn if vehicle is on fire.

Recognize EV:

- ☐ Always assume a vehicle is some type of hybrid or EV until proven otherwise.
- ☐ Look for external labels or markings indicating a hybrid vehicle.
- ☐ Look for charging ports.

Identify EV:

- ☐ Determine vehicle make and model.
- ☐ Obtain additional information from manufacturer's ERG.
  - NFPA Emergency Response Guideline Portal[10]
  - Energy Security Agency (ESA) Emergency Response Guideline Portal[11]

Immobilize vehicle:

- ☐ Chock the wheels.
- ☐ Set parking brake.
- ☐ Place vehicle in park.

Assess damage:

- ☐ Is the main battery pack damaged?

Water supply:

- ☐ If the vehicle is on fire, can a long-term water supply be established?

Tactics:

- ☐ Offensive attack should be used if fire does not include battery pack or exposures are present.
- ☐ Defensive attack should be used if the high-voltage battery packs are involved in the fire and no exposures are present.
- ☐ Consider allowing battery fire to burn itself out.
- ☐ Exposure protection.

[10] https://www.nfpa.org/education-and-research/emergency-response/emergency-response-guides#aq=%40culture%3D%22en%22&cq=%40taglistingpage%3D%3D(%22EV%20Guides%22)%20%20&numberOfResults=12&sortCriteria=%40title%20ascending

[11] https://energysecurityagency.com/erg/

Sample Original Equipment Manufacturer Emergency Response Guides

Generally speaking, OEM ERGs are readily available from EV manufacturers.

At present, not all ERGs are standardized, despite recommendations from the National Transportation Safety Board (2020) and the 2022 publication of the International Organization for Standardization Standard 17840: Road Vehicles — Information for First and Second Responders.

The NFPA and the ESA both maintain an ERG collection covering many of the leading manufacturers of passenger car, bus and cargo truck EVs — with free downloads — at the following websites:

- NFPA Emergency Response Guideline Portal.[12]
- ESA Emergency Response Guideline Portal.[13]

It is important to note that firefighting, vehicle rescue/recovery and disposal guidance provided by OEMs in their ERGs cannot always be independently verified and may not be clearly backed by scientific evidence or evolving industry practices for handling emergency incidents involving EVs.

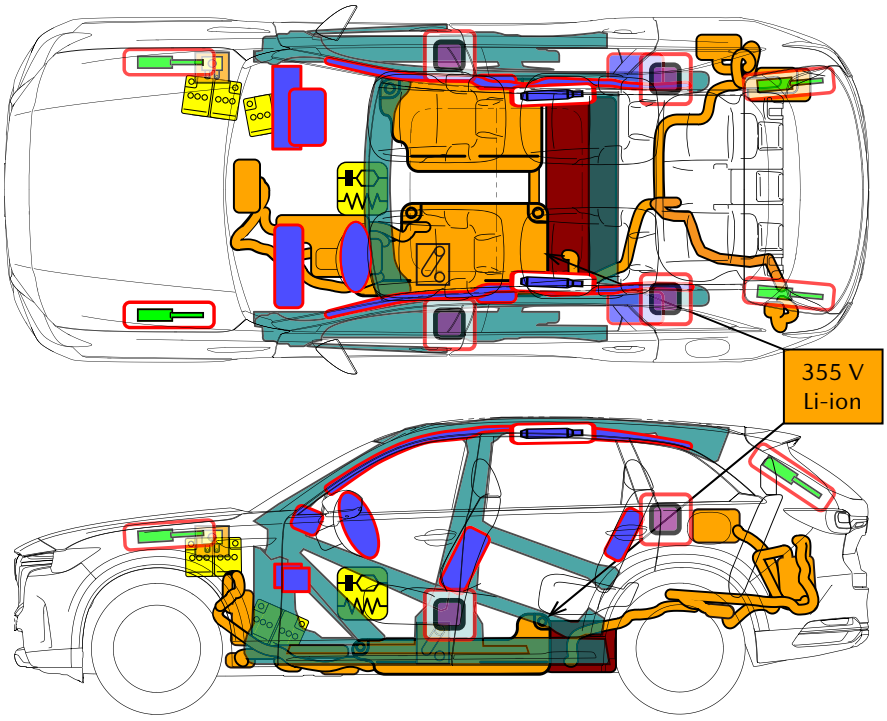
The following pages provide an example of an ERG.

[12] https://www.nfpa.org/education-and-research/emergency-response/emergency-response-guides#aq=%40culture%3D%22en%22&cq=%40taglistingpage%3D%3D(%22EV%20Guides%22)%20%20&numberOfResults=12&sortCriteria=%40title%20ascending

[13] https://energysecurityagency.com/erg/

MAZDA CX-90

(2023-)



	Airbag		Stored gas inflator		Seat belt preten-sioner		SRS control unit		Gas strut / Preloaded spring
	High strength zone		Battery low voltage		High voltage battery pack		High voltage power cable / component		High voltage disconnect
	Fuse box disabling high voltage system		Fuel tank content gasoline / ethanol						

This sheet is applicable for MAZDA CX-90, L.H.D, and e-SKYACTIV PHEV.

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MAZDA CX-90 (2023-)

1. Identification / recognition

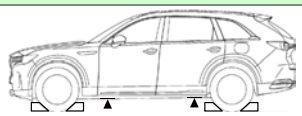
LACK OF ENGINE NOISE DOES NOT MEAN VEHICLE IS OFF: SILENT MOVEMENT OR INSTANT RESTARTCAPABILITY EXISTS UNTIL VEHICLE IS FULLY SHUT DOWN. WEAR APPROPRIATE PPE.

2.Immobilisation / stabilisation / lifting

IMMOBILIZE THE VEHICLE

- Block the wheels.
- Set the parking brake.
- Put the car in P position.

LIFTING POINTS



Appropriate lifting points High voltage battery

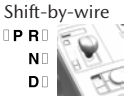
3.Disable direct hazards / safety regulations

Systems that do not operate if power is lost

Door lock

Power window

Shift-by-wire



Electric parking brake (EPB)

Power seat

Electric liftgate opener

Tilt and telescopic

Procedure when EV is connected for charging

Charge connector is unlocked

1. Remove the charge connector.

Charge connector is locked

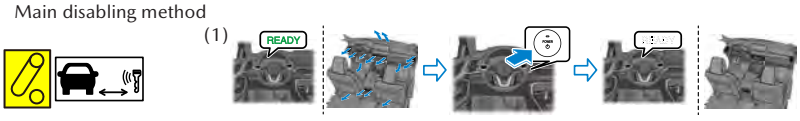
1. Remove the trunk covering.

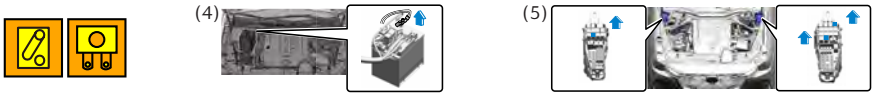
2. Remove the trunk board.

3. Pull the charge connector lock manual release cable in the release direction shown in the figure.
4. Remove the charge connector with the charge connector lock manual release cable pulled.

Procedure for disabling high voltage system

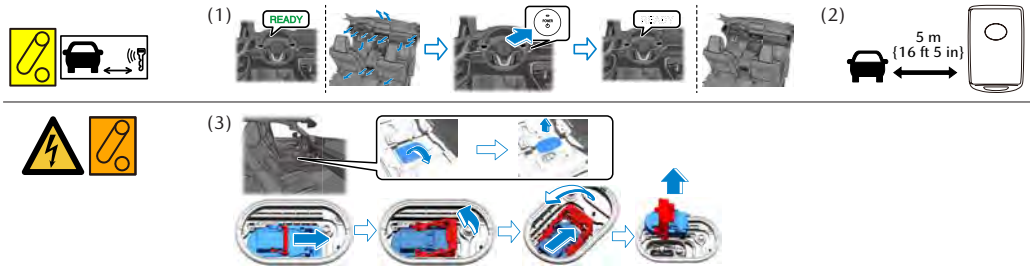
Main disabling method





MAZDA CX-90 (2023-)

Alternative disabling method



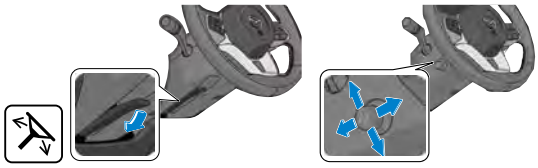
4.Access to the occupants

Glass types

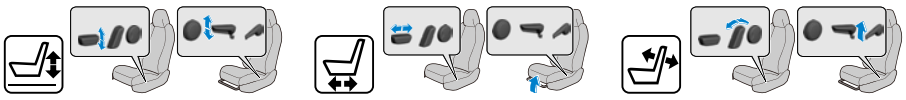
Laminated glass

Tempered glass

Steering wheel angle adjustment



Seat position operation



High strength steel in body

1800 MPa {18355 kgf/cm2, 261068 psi}
1500 MPa {15296 kgf/cm2, 217557 psi}
1470 MPa {14990 kgf/cm2, 213206 psi}
1310 MPa {13358 kgf/cm2, 190000 psi}
1180 MPa {12032 kgf/cm2, 171145 psi}
980 MPa {9993 kgf/cm2, 142137 psi}
780 MPa {7954 kgf/cm2, 113130 psi}
590 MPa {6016 kgf/cm2, 85572 psi}

5.Stored energy / liquids / gases / solids

	Li-ion / DC 355V	
	Pb / DC 12V	
	R-1234yf / 960 g {33.9 oz}	
	Gasoline / 70.0 L {18.5 US gal, 15.4 Imp gal}	

IR

THE BATTERY ASSEMBLY COVER SHOULD NEVER BE BREACHED OR REMOVED UNDER ANY CIRCUMSTANCES, INCLUDING FIRE. DOING SO MIGHT RESULT IN SEVERE ELECTRIC BURNS, SHOCKS, OR ELECTROCUTION.

MAZDA CX-90 (2023-)

6.In case of fire

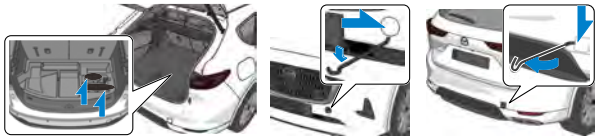
EXTINGUISH THE FIRE USING LARGE AMOUNTS OF WATER OR AN ABC FIRE EXTINGUISHER.

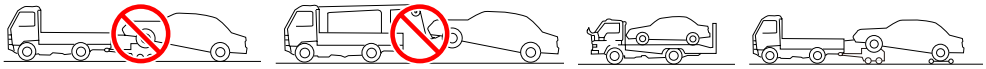
BATTERY RE-IGNITION!

7.In case of submersion

- DO NOT TOUCH ANY HIGH VOLTAGE PARTS WHEN THE VEHICLE IS SUBMERGED OR PARTIALLY SUBMERGED IN WATER.
- IF THE HIGH VOLTAGE BATTERY IS DAMAGED OR YOU ARE UNSURE WHETHER OR NOT IT IS DAMAGED, PERFORM THE RESCUE OPERATION WHILE WEARING THE APPROPRIATE INSULATING PROTECTIVE EQUIPMENT.
- AFTER PULLING THE VEHICLE OUT OF THE WATER, DRAIN THE INTERIOR OF THE VEHICLE AND REMOVE THE SERVICE PLUG.

8.Towing / transportation / storage





BATTERY RE-IGNITION!

KEEP THE VEHICLE OUTDOORS AWAY FROM FLAMMABLES.

10. Explanation of pictograms used

	Hybrid Electric Vehicle on fuel of liquid group2		Air conditioning component		Corrosives
	Left hand drive		General warning sign		Hazardous to the human health
	Bonnet		Warning, Electricity		Remove smart key
	Device to shut down power in vehicle		Use thermal Infrared camera		Door-lock control
	Steering wheel, tilt control		Use water to extinguish the fire		Window lift (power-operated)
	Seat adjustment, longitudinal		Use ABC powder to extinguish the fire		Parking brake
	Seat height adjustment		Explosive		Laminated glass
	Seat adjustment, seat back recline		Gases under pressure		Tempered glass
	Lifting point; central support		Flammable		

This sheet is applicable for MAZDA CX-90, L.H.D, and e-SKYACTIV PHEV.	ID No.	Version No.	Page No.
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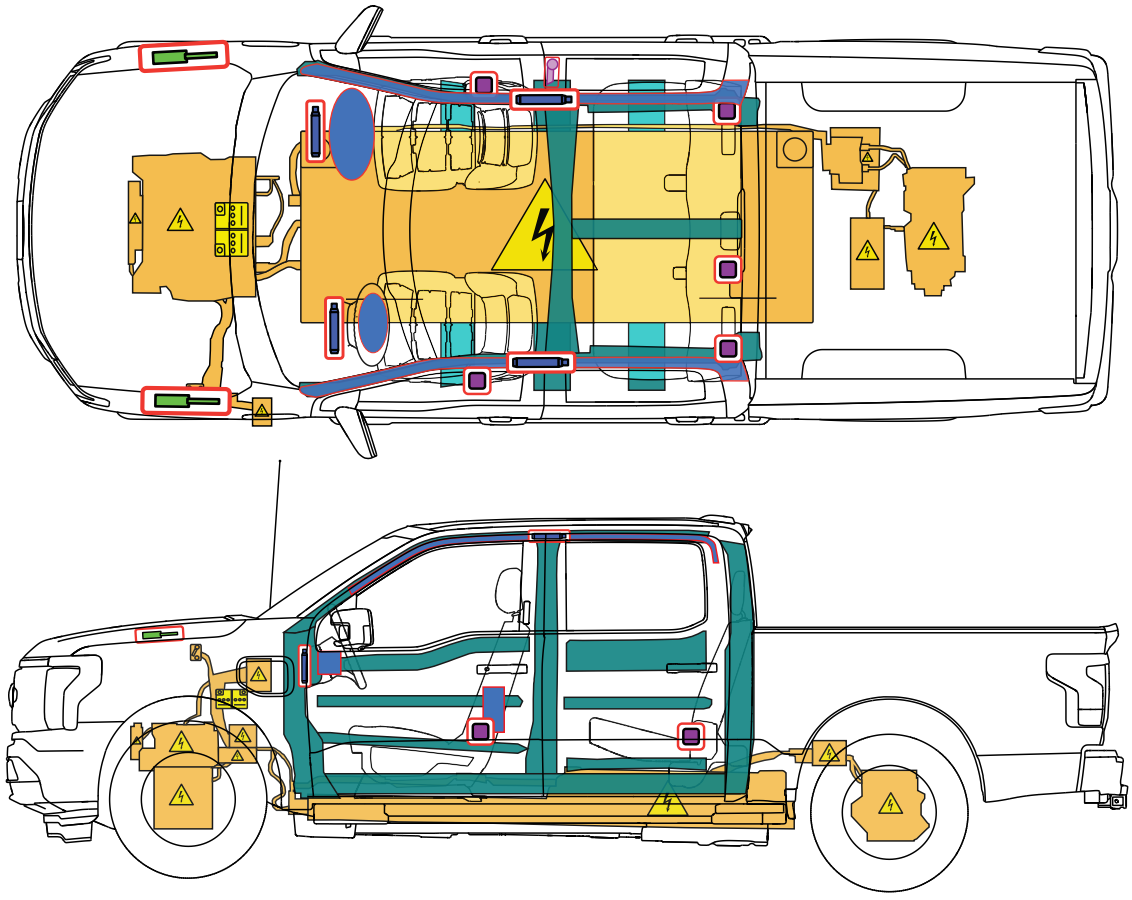
FORD F-150 Lightning
2022 ->



Legend

- Airbag
- Structural Reinforce-ments
- Control unit
- High-voltage battery
- High-voltage disconnection point
- Gas generator
- Gas filled spring device
- Battery
- High-voltage wire / components
- Fuel tank Gasoline
- Seat belt tensioner

1. Identification / recognition

1. Vehicle Identification Number (VIN)
2. Charging port and Lightning badging on tailgate.

Vehicle Identification Number (VIN) Layout

The 8th position of the VIN identifies the vehicle's engine type as electric.

2022-2023 Model Year Vehicles:

- L - BEV (Duel Electric Motor), (Standard Battery #1)
- V - BEV (Duel Electric Motor), (Extended Range Battery #2)

Sample VIN

BEV - 1FT6W1EV2NWG01689

2024 Model Year Vehicles

- 7 - Duel Electric Motor, Extended Range Battery #4 - Single onboard charging
- K - Duel Electric Motor, Standard Battery #1
- M - Duel Electric Motor, Extended Range Battery #2 - Dual onboard charging
- S - Duel Electric Motor, LFP Battery #3

Sample VIN

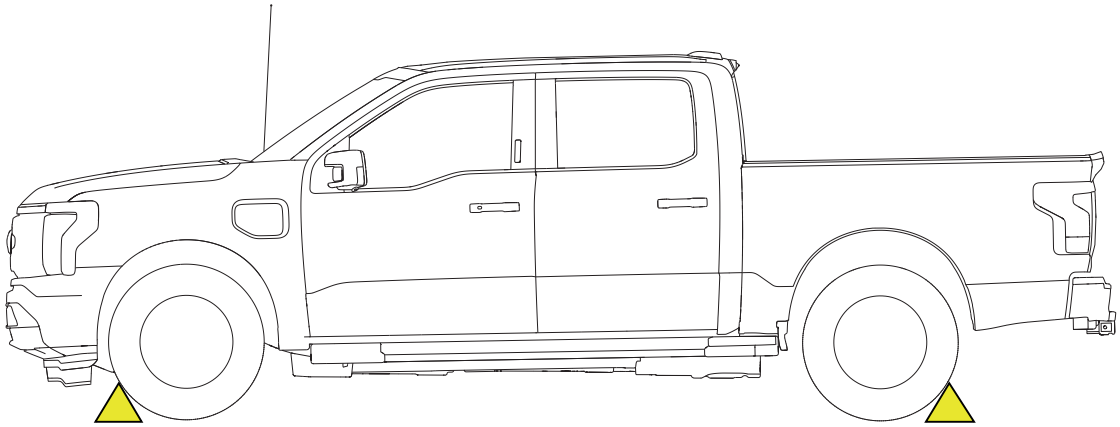
BEV - 1FTVW3LK6RWG02995

2. Immobilization / stabilization / lifting

IMMOBILIZATION

IMPORTANT! Be careful to not damage the battery pack while stabilizing or lifting the vehicle.

1. Position Wheel And Tire Chocks to prevent vehicle movement.



NOTE: The red warning lamp flashes during operation and illuminates when the parking brake is applied.

NOTE: You can apply the electric parking brake when the power is off.

NOTE: The electric parking brake could apply when you shift into park (P).

2. Put vehicle into Park position (1), ensure that the parking brake is engaged (2).

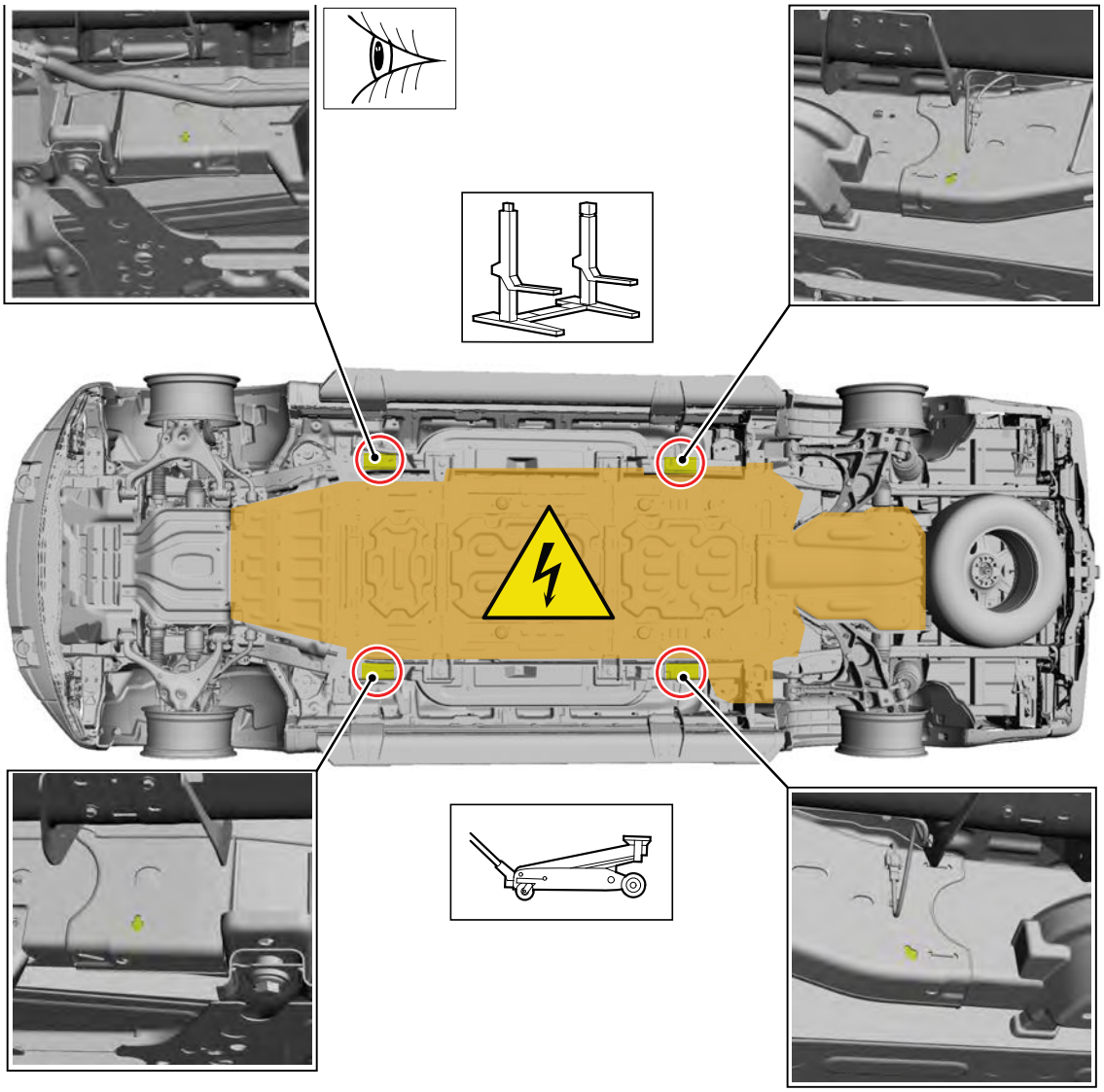
STABILIZATION / LIFTING POINTS

WARNING:
The vehicle should be lifted or manipulated only by personal that are properly trained and equipped. Use caution to ensure you never come into contact with the high voltage battery or other high voltage components while lifting or manipulating the vehicle.

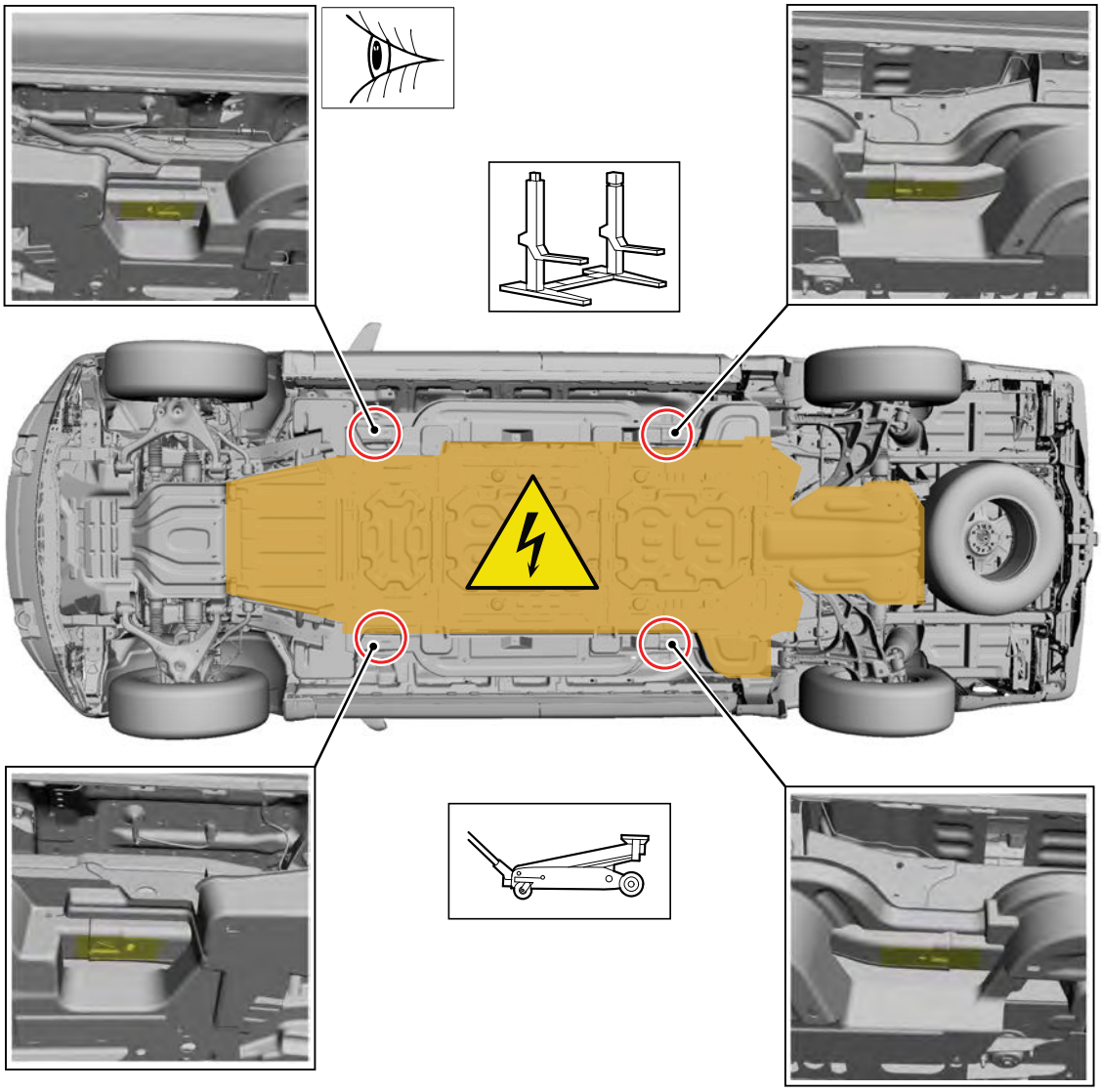
The high voltage battery is located behind an underbody air shield under the vehicle. When lifting or stabilizing only use the designated lift areas, as shown.

DO NOT USE THE HIGH VOLTAGE BATTERY TO LIFT OR STABILIZE

VEHICLES WITH AIR DEFLECTOR TYPE 1:



VEHICLES WITH AIR DEFLECTOR TYPE 2:



3. Disable direct hazards / safety regulations

General Warnings for Extraction Procedures

WARNING:
ALWAYS ASSUME THE VEHICLE'S HIGH VOLTAGE SYSTEM IS POWERED UP! Cutting, crushing, or touching High Voltage components can result in serious injury or death.

WARNING:
Always use appropriate tools, such as a hydraulic cutter, and always wear appropriate personal protective equipment (PPE) when cutting. Failure to follow these instructions can result in serious injury or death. Pyrotechnic Device Health and Safety Precautions

WARNING:
Pyrotechnic components are very hot immediately after deployment and might be covered with pyrotechnic residuals. Do not handle pyrotechnic components immediately after deployment. Always wear protective gloves, safety glasses and breathing protection to prevent skin contact and inhaling of pyrotechnic residuals. Failure to follow this instruction may result in serious personnel injury.

WARNING:
Always carry a live airbag with the deployment door, trim cover or tear seam pointed away from the body. Do not place a live airbag down with the deployment door, trim cover or tear seam facing down. Failure to follow these instructions may result in serious personal injury in the event of an accidental deployment.

WARNING:
Always carry a live Safety Canopy or side air curtain assembly with the tear seam pointed away from your body. Failure to follow this instruction may result in serious personal injury or death in the event of an accidental deployment.

WARNING:
Never disassemble or tamper with seat belt deployable components, including pretensioners, load limiters and inflators. Never back probe deployable device electrical connectors. Tampering or back probing may cause an accidental deployment and result in personal injury or death.

WARNING:
Never probe the electrical connectors on airbag, Safety Canopy or side air curtain assemblies. Failure to follow this instruction may result in the accidental deployment of these assemblies, which increases the risk of serious personal injury or death.

WARNING:
Do not handle, move or change the original horizontal mounting position of the restraints control module (RCM) while the RCM is connected and the ignition switch is ON. Failure to follow this instruction may result in the accidental deployment of the Safety Canopy and cause serious personal injury or death.

WARNING:
Service and handling of Pyrotechnic Components is restricted to qualified personnel. The required qualifications vary by region. Always observe local laws and legislative directives regarding Pyrotechnic Components service and handling. Failure to follow this instruction may result in serious personal injury or death.

WARNING:
DEPOWERING THE HIGH VOLTAGE SYSTEM DOES NOT DISSIPATE VOLTAGE INSIDE THE BATTERY, THE BATTERY PACK REMAINS LIVE AND DANGEROUS. CONTACT WITH THE HIGH VOLTAGE BATTERY PACK INTERNALS MAY RESULT IN SERIOUS PERSONAL INJURY OR DEATH.

WARNING:
ELECTRIC VEHICLES DAMAGED BY A CRASH MAY HAVE COMPROMISED HIGH VOLTAGE SAFETY SYSTEMS AND PRESENT A POTENTIAL HIGH VOLTAGE ELECTRICAL SHOCK HAZARD. EXERCISE CAUTION AND WEAR APPROPRIATE PERSONAL PROTECTIVE EQUIPMENT (PPE) INCLUDING HIGH VOLTAGE SAFETY GLOVES AND BOOTS. REMOVE ALL METALLIC JEWELRY, INCLUDING WATCHES AND RINGS. ISOLATE THE HIGH VOLTAGE SYSTEM AS DIRECTED BY THIS DOCUMENT. FAILURE TO FOLLOW THESE INSTRUCTIONS MAY RESULT IN SERIOUS PERSONAL INJURY OR DEATH.

Approaching a Damaged Vehicle

Remove all jewelry such as watches, necklaces and earrings. Remove all metal objects that are conductors of electricity.

PLEASE NOTE: The vehicle high voltage system could still be energized even if the ready light is not on. In accessory mode, the ready light is not present but the high voltage system is energized under normal operation.

If necessary, apply the parking brake and/or block the wheels to prevent vehicle movement.

The vehicle has an electric parking brake. You operate it with a switch instead of a lever. The switch is on the center console or to the left hand side of the steering wheel, on the lower part of the instrument panel.

High Voltage System - Do Not Cut Zones

If possible, depower the High Voltage system before attempting any removal procedure. Always assume the High Voltage cabling and components are powered up.

If The High Voltage Battery Case Has Been Ruptured

Just like any other battery, hose down the area with LARGE amounts of water.

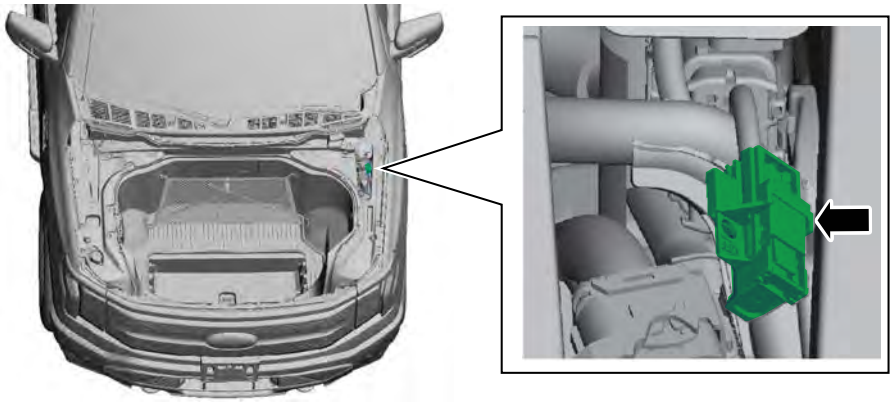
HIGH VOLTAGE SYSTEM DISABLE PROCEDURE

IMPORTANT:

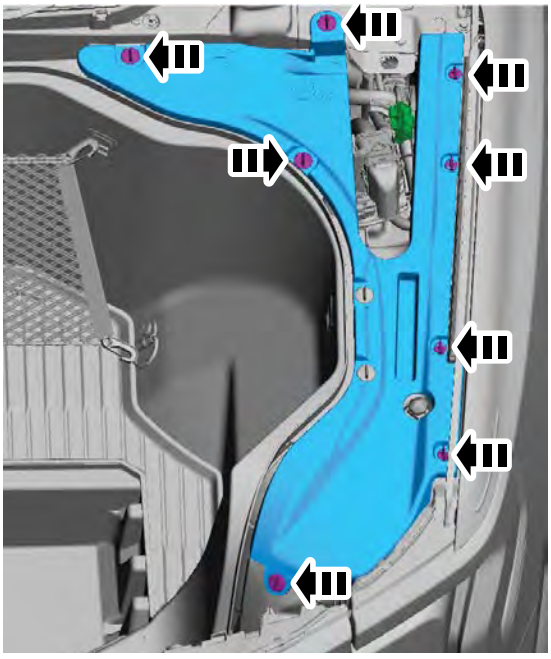
- Under urgent situations perform Option 1.
- Under non-urgent situations perform Option 2.

OPTION 1 - Under urgent situations ONLY

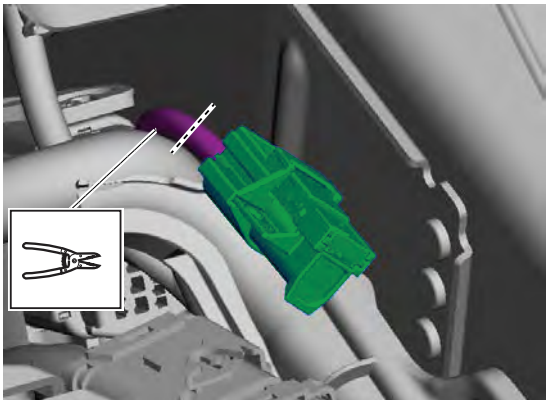
1. Open the hood and locate the Low Voltage Service Disconnect.



NOTE: If using a larger cutting tool, turn the hand screws to unlock and remove trim panel shown below.



2. Cut the wires and remove the Low Voltage Service Disconnect. Isolate the wires to prevent reconnection.



OPTION 2 - Under non-urgent situations

1. Ensure the vehicle transmission gear selector is in the PARK position. Check that the vehicle READY light is off to verify the high voltage system is disconnected. If the vehicle READY light is on, press the engine Start/Stop button to turn off the ignition.

Ensure that the Pro Power Onboard (PPO) System, if equipped, has been deactivated by following the steps below:

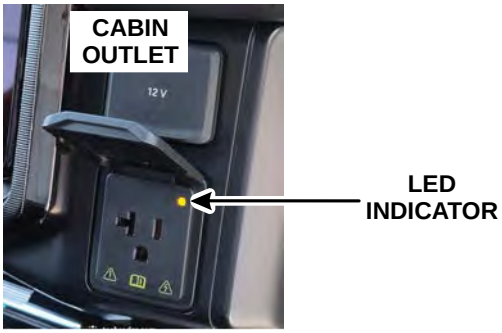
2. Vehicle must be powered down for AT LEAST 60 seconds before continuing the procedure.

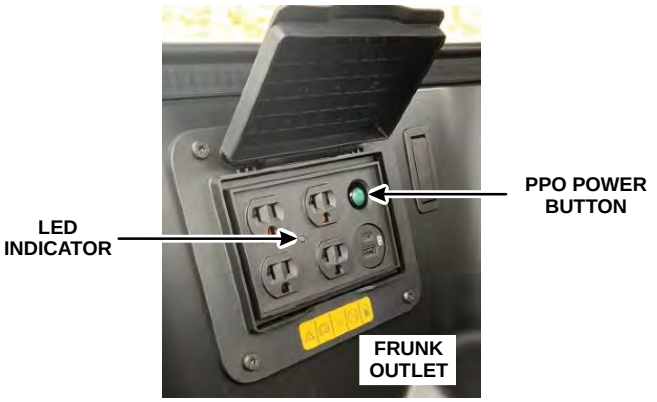
3. Locate the 3 outlet locations on the vehicle. The outlets are in the frunk, cabin, and truck bed.

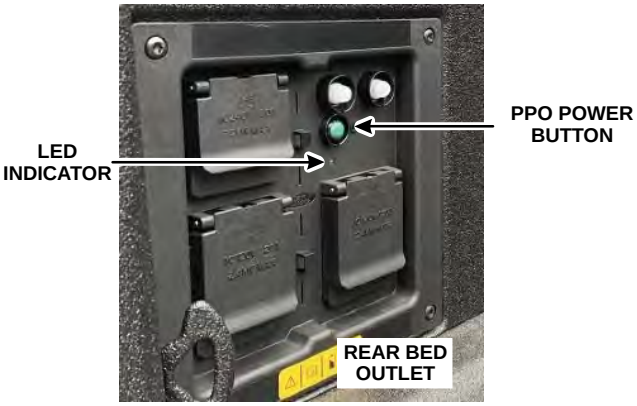
4. Verify that the PPO System is deactivated by checking that the LED indicators are deluminated.

5. If the PPO system is still active, press the PPO hard button in EITHER the bed OR the frunk of the vehicle. Pressing either button will deactivate the entire PPO system.

6. Wait at least 60 seconds for PPO system to be depowered.



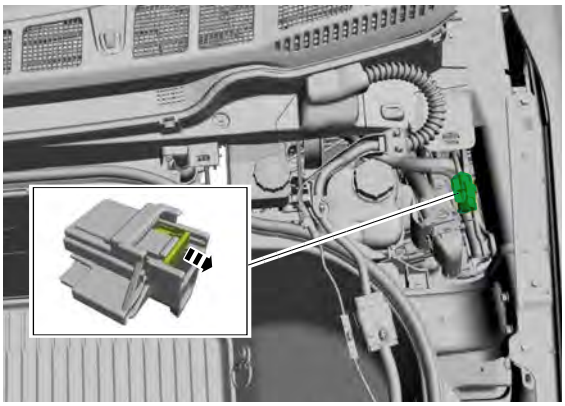




Low Voltage Service Disconnect (Disables High Voltage System)

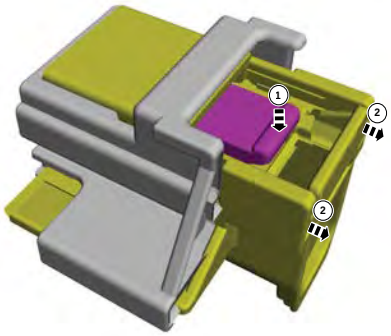
7. Open the hood.

8. Release the Connector Position Assurance (CPA) clip.



9. **NOTE:** The tab must be depressed prior to pushing the connector back in or damage to the connector may result.

Depress the tab while pulling the connector until the hole is completely visible on the top of the connector.



10. Insert a suitable tool inside the connector hole to prevent the connector from closing.

11. Wait a minimum of 5 minutes.

4. Access to the occupants

General Warnings for Extraction Procedures

WARNING:
ALWAYS ASSUME THE VEHICLE'S HIGH VOLTAGE SYSTEM IS POWERED UP! Cutting, crushing, or touching High Voltage components can result in serious injury or death.

WARNING:
Always use appropriate tools, such as a hydraulic cutter, and always wear appropriate personal protective equipment (PPE) when cutting. Failure to follow these instructions can result in serious injury or death. Pyrotechnic Device Health and Safety Precautions

WARNING:
Pyrotechnic components are very hot immediately after deployment and might be covered with pyrotechnic residuals. Do not handle pyrotechnic components immediately after deployment. Always wear protective gloves, safety glasses and breathing protection to prevent skin contact and inhaling of pyrotechnic residuals. Failure to follow this instruction may result in serious personnel injury.

WARNING:
Always carry a live airbag with the deployment door, trim cover or tear seam pointed away from the body. Do not place a live airbag down with the deployment door, trim cover or tear seam facing down. Failure to follow these instructions may result in serious personal injury in the event of an accidental deployment.

WARNING:
Always carry a live Safety Canopy or side air curtain assembly with the tear seam pointed away from your body. Failure to follow this instruction may result in serious personal injury or death in the event of an accidental deployment.

WARNING:
Never disassemble or tamper with seat belt deployable components, including pretensioners, load limiters and inflators. Never back probe deployable device electrical connectors. Tampering or back probing may cause an accidental deployment and result in personal injury or death.

WARNING:
Never probe the electrical connectors on airbag, Safety Canopy or side air curtain assemblies. Failure to follow this instruction may result in the accidental deployment of these assemblies, which increases the risk of serious personal injury or death.

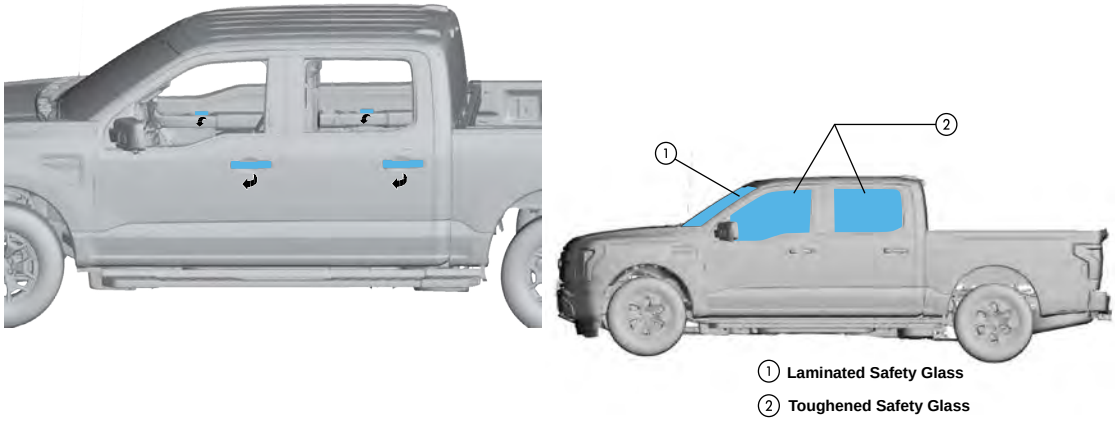
WARNING:
Do not handle, move or change the original horizontal mounting position of the restraints control module (RCM) while the RCM is connected and the ignition switch is ON. Failure to follow this instruction may result in the accidental deployment of the Safety Canopy and cause serious personal injury or death.

WARNING:
Service and handling of Pyrotechnic Components is restricted to qualified personnel. The required qualifications vary by region. Always observe local laws and legislative directives regarding Pyrotechnic Components service and handling. Failure to follow this instruction may result in serious personal injury or death.

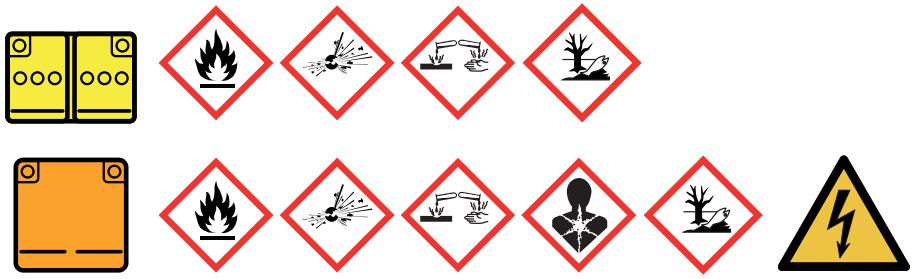
If occupant removal is necessary, always use caution when cutting near the vehicle High Voltage system components. Do not cut any of the High Voltage under vehicle or under hood cabling (all High Voltage cabling is orange). High voltage cabling runs underneath the vehicle, from the High Voltage battery under the left hand side of the vehicle to the underhood compartments. Refer to the diagram on page 1 for no cut zones.

NOTE: After a collision vehicle components may not function properly such as the steering wheel, power seats, and other electrical and mechanical components. If these components are not functioning properly and prevent access to occupants extraction may be required.

The illustration below shows the exterior and interior door handle positions and vehicle glass.



5. Stored energy / liquids / gases / solids



Refer to the vehicle overview illustration on Page 1, for location reference of the high voltage battery, 12V battery, and other vehicle component locations.

6. In case of fire

Follow Existing Training and Incident Commander Direction

WARNING:
ELECTRIC VEHICLES WITH DAMAGED HIGH VOLTAGE BATTERIES REQUIRE SPECIAL HANDLING PRECAUTIONS. INSPECT THE VEHICLE CAREFULLY FOR LEAKING BATTERY FLUIDS, SPARKS, FLAMES, AND GURGLING OR BUBBLING SOUNDS. CONTACT EMERGENCY SERVICES IMMEDIATELY IF ANY OF THESE PROBLEMS ARE OBSERVED. FAILURE TO FOLLOW THESE INSTRUCTIONS MAY RESULT IN A VEHICLE FIRE AND PERSONAL INJURY OR DEATH.

WARNING:
FIRES IN CRASH-DAMAGED ELECTRIC VEHICLES MAY EMIT TOXIC OR COMBUSTIBLE GASSES. SMALL AMOUNTS OF EYE, SKIN OR LUNG IRRITANTS MAY BE PRESENT. WEAR PERSONAL PROTECTIVE EQUIPMENT (PPE) AND SELF-CONTAINED BREATHING APPARATUS WHEN WORKING IN CLOSE PROXIMITY OR IN A CONFINED AREA, SUCH AS A TUNNEL OR GARAGE. VENTILATE THE VEHICLE INTERIOR BY OPENING VEHICLE WINDOWS OR DOORS. VENTILATE THE WORKING AREA. FAILURE TO FOLLOW THIS INSTRUCTION MAY RESULT IN SERIOUS PERSONAL INJURY OR DEATH.

If the vehicle is on fire, use a Class ABC powder-type extinguisher to contain and smother the flames. If water is being used, LARGE amounts of water is required to extinguish the flames. A fire-hydrant or dedicated fire hose can supply the needed amount. Water can cause some degree of arcing/shorting across the cell and/or battery terminals; it can also react with the electrolyte from the cells to generate additional combustible gas and other byproducts such as hydrofluoric acid. However, the cooling and smothering effects of flushing the affected article with large amounts of water and/or other fire suppression material is still beneficial for minimizing the severity of the event.

This guide provides only supplemental information as it pertains to these vehicles. The same rules apply when approaching any potential High Voltage situation. Always follow your High Voltage safety training. Some precautions to observe in a High Voltage situation include:

Wear the necessary PPEs such as High Voltage rubber gloves, face shield, insulated boots, protective raincoat and apron.

Bring the following equipment:

Class ABC powder-type fire extinguisher.

A non-conductive object, about 1.5 m (5 ft) long, to safely push someone away from the vehicle if they accidentally come in contact with a damaged electric vehicle.

7. In case of submersion

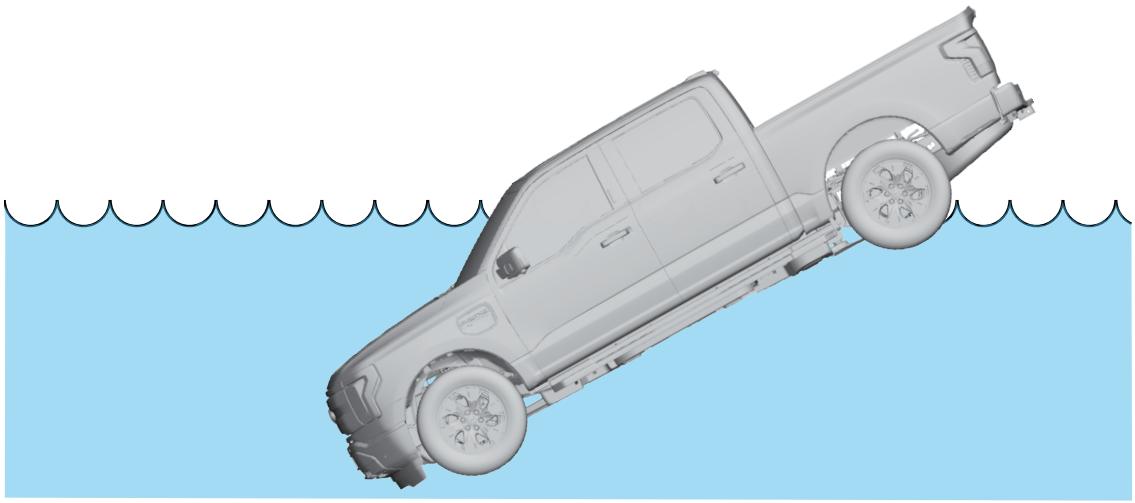
WARNING:
DAMAGED ELECTRIC VEHICLES SUBMERGED IN WATER PRESENT A POTENTIAL HIGH VOLTAGE ELECTRICAL SHOCK HAZARD. EXERCISE CAUTION AND WEAR APPROPRIATE PERSONAL PROTECTIVE EQUIPMENT (PPE) INCLUDING HIGH VOLTAGE SAFETY GLOVES AND BOOTS. REMOVE ALL METALLIC JEWELRY, INCLUDING WATCHES AND RINGS. DO NOT ATTEMPT TO EXTRACT THE VEHICLE UNTIL THE HIGH VOLTAGE BATTERY HAS DISCHARGED INDICATED BY THE ABSENCE OF BUBBLING OR FIZZING. FAILURE TO FOLLOW THESE INSTRUCTIONS MAY RESULT IN SERIOUS PERSONAL INJURY OR DEATH.

If the vehicle is submerged in water, varying degrees of arcing/shorting within the battery will take place. Do not touch any High Voltage components or orange cables while removing the occupant(s). Do not remove the vehicle until you are sure the High Voltage battery is completely discharged. A submerged High Voltage battery may produce a fizzing or bubbling reaction to the water. If fizzing or bubbling is observed, the High Voltage battery will be discharged when the fizzing or bubbling has completely stopped. The battery should still be treated as if it is not discharged.

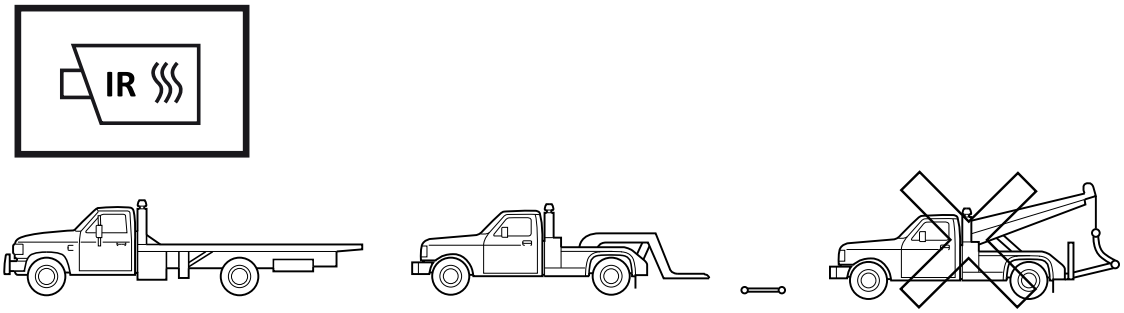
Battery Electric and Hybrid vehicles when submerged should only be handled while wearing the appropriate Personal Protective Equipment (PPE) for water rescue and vehicle extraction.

Vehicles that have been submerged in water may have potential risk of a high voltage electrical battery fire therefore should be handled with increased caution.

Once the vehicle has been removed from the water proceed to the high voltage disable procedure, as outlined in section 3 of this document.



8. Towing / transportation / storage



NOTICE: Do not attempt to pull / tow vehicle with wheels on the ground as this may cause the vehicle to generate electricity and can cause potential damage.

NOTE: Front-wheel and rear-wheel drive vehicles must have their designated drive wheels off the ground. Use tow dollies to prevent damage to the transmission.

NOTE: All-wheel or four-wheel drive vehicles require that all wheels be off the ground using a wheel lift and dollies or flatbed equipment.

Moving Damaged Vehicles - Tow Truck Drivers

IMPORTANT! Be alert. There is a potential for delayed fire with damaged lithium-ion batteries.

NOTICE: Do not attempt to pull / tow vehicle with wheels on the ground as this may cause the vehicle to generate electricity and can cause potential damage.

For additional information, refer to High Voltage System Disable procedures in this manual.

Rather than attempt to discharge a High Voltage battery, an emergency responder, tow truck operator, or storage facility manager should contact experts at the vehicle manufacturer.

Operators of tow trucks and vehicle storage facilities should make sure the damaged vehicle is kept in an open area instead of inside a garage or other enclosed building.

Follow the guidelines in the Wrecker Towing Guide

If you detect leaking fluids, sparks, smoke, flames, increased temperature, gurgling, popping or hissing noises from the High Voltage battery compartment, ventilate the area and call 911.

Be alert. There is potential for delayed fire with damaged lithium-ion batteries.

Call an authorized Ford dealer or vehicle manufacturer representative, if necessary, to determine the additional steps to take to safely recover or transport the vehicle.

Always approach the vehicle from the sides to stay out of potential travel path. It may be difficult to determine if the vehicle is running due to lack of engine noise.

Place vehicle into park, set the parking brake, turn off the vehicle, activate the hazard lights, and remove the key fobs to a distance at least 16 feet from the vehicle until loading the vehicle for transport.

Refer to vehicle manual/recovery guide to locate proper attachment/connection points and transport method.

Avoid contact with orange High Voltage cabling and areas identified as High Voltage risk by warning labels.

Electric and Hybrid Electric Vehicle Considerations

In the event of damage to or fire involving an electric vehicle:

Always assume the High Voltage battery and associated components are energized and fully charged.
Exposed electrical components, wires, and High Voltage batteries present potential HV shock hazards.
Venting/off-gassing High Voltage battery vapors are potentially toxic and flammable.
Physical damage to the vehicle or High Voltage battery may result in immediate or delayed release of toxic and/or flammable gases and fire.

Damaged Vehicle Guidance and Storage

Damaged Vehicle Guidance for Ford Motor Company Electric and Hybrid-Electric Vehicles Equipped with High Voltage Batteries

(Towing and Recovery Operators and Vehicle Storage Facilities)

In the event of damage or fire involving an Electric Vehicle (EV) or Hybrid-Electric Vehicle (HEV):
Always assume the High Voltage battery and associated components are energized and fully charged.

Exposed electrical components, wires and High Voltage batteries present potential High Voltage shock hazards.

Venting/off-gassing High Voltage battery vapors are potentially toxic and flammable.

Physical damage to the vehicle or High Voltage battery may result in immediate or delayed release of toxic and/or flammable gases and fire.

Identifying Vehicle for High Voltage System Disabling and Vehicle Shutdown

Determine if the vehicle is an electric or hybrid-electric vehicle, and if it is, advise your dispatch and all other responders that an electric or hybrid-electric vehicle is involved.

To identify potential symptoms of a damaged High Voltage system, contact an authorized service center or vehicle manufacturer representative. Refer to the vehicle Owner Manual, Emergency Placard (included in the vehicle Owner Manual) and/or the Emergency Response Guide for appropriate contact information.

If you detect leaking fluids, sparks, smoke, flames, increased temperature, gurgling, popping or hissing noises from the High Voltage battery compartment, ventilate the passenger area (such as, roll down windows or open doors) and call 911.

Vehicle Recovery/Transportation

Call an authorized service center or the vehicle manufacturer, if necessary, to determine additional steps that should be taken to safely recover or transport the vehicle.

Always approach the vehicle from the sides to stay out of potential travel path. It may be difficult to determine if the vehicle is running due to lack of engine noise.

Place vehicle into park (P), set the parking brake, turn off the vehicle, activate hazard lights, and remove the keys to a distance at least 5 m (16 ft) from the vehicle until loading the vehicle for transport.

Refer to the vehicle owner manual/recovery guide to locate proper attachment/connection points and transport method.

Avoid contact with orange High Voltage cabling and areas identified as High Voltage risk by warning labels.

Vehicle Storage

Contact an authorized Ford or Lincoln Dealer as soon as possible as there may be additional steps necessary to secure,discharge, handle, and/or store the High Voltage battery and vehicle.

Do not store a severely damaged vehicle with a lithium-ion battery inside a structure or within 15 m (50 ft) of any structure or vehicle.

Make sure the passenger and cargo compartments remain ventilated.

Prior to placing vehicle in storage, and while located in storage area/tow lot, continue to inspect vehicle for leaking fluids, sparks, smoke, flames, gurgling or bubbling sounds from the High Voltage battery and call 911 if any of these are detected.

Maintain clear access to stored vehicles for monitoring and emergency response if needed.

For specific information and safety preparation regarding the High Voltage system, refer to WWW.MOTORCRAFTSERVICE.COM, select quick guides for the appropriate vehicle emergency response guide.

For First Responder Resources, refer to https://www.ford.com/firstresponder/

WARNING:
ELECTRIC VEHICLES DAMAGED BY A CRASH MAY HAVE COMPROMISED HIGH VOLTAGE SAFETY SYSTEMS AND PRESENT A POTENTIAL HIGH VOLTAGE ELECTRICAL SHOCK HAZARD. EXERCISE CAUTION AND WEAR APPROPRIATE PERSONAL PROTECTIVE EQUIPMENT (PPE) INCLUDING HIGH VOLTAGE SAFETY GLOVES AND BOOTS. REMOVE ALL METALLIC JEWELRY, INCLUDING WATCHES AND RINGS. ISOLATE THE HIGH VOLTAGE SYSTEM AS DIRECTED BY THE FORD EMERGENCY RESPONSE GUIDE FOR THE VEHICLE. FAILURE TO FOLLOW THESE INSTRUCTIONS MAY RESULT IN SERIOUS PERSONAL INJURY OR DEATH.

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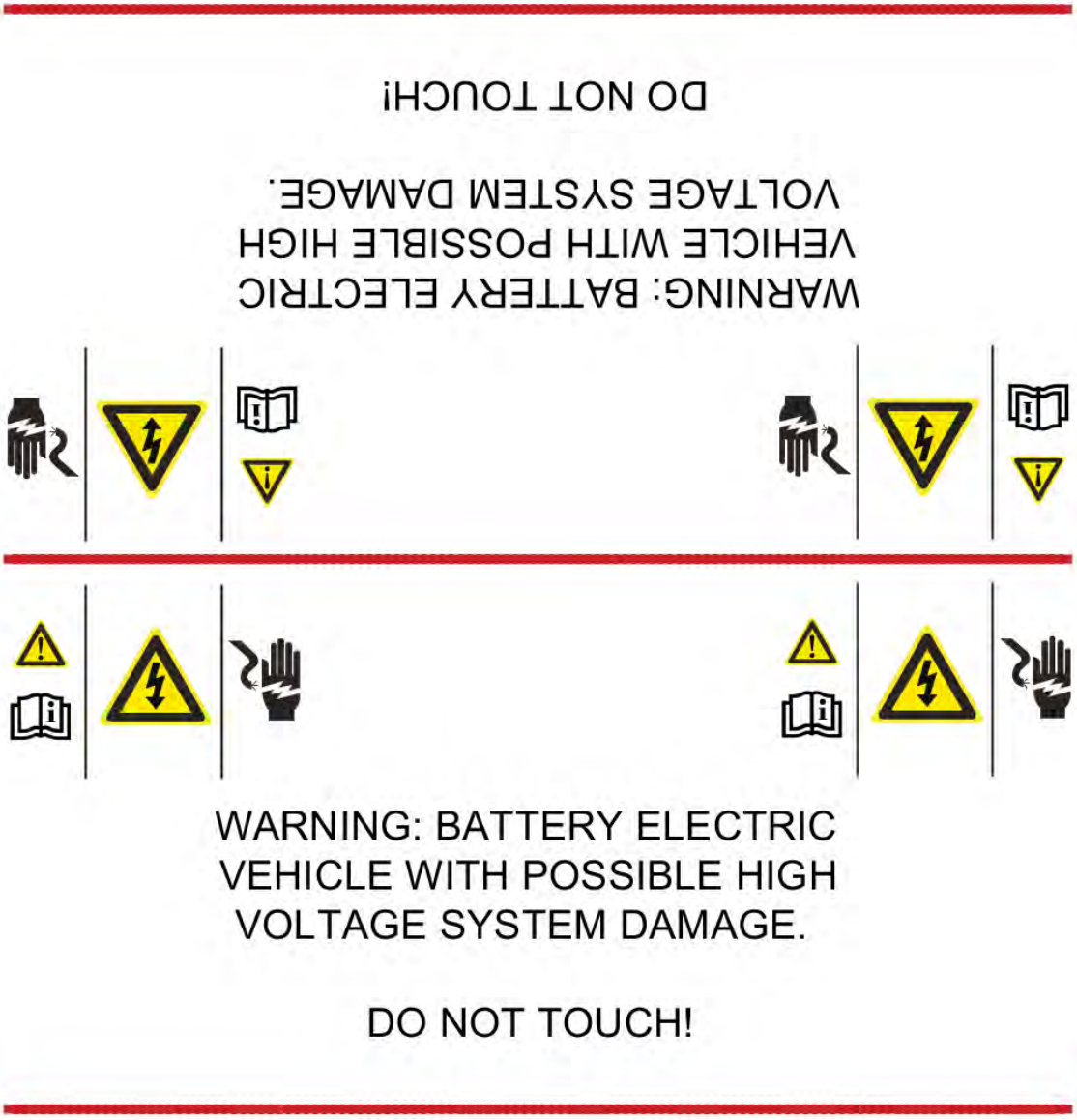
If the vehicle and/or battery High Voltage system is damaged, place a sign indicating that it is a battery electric vehicle with potentially dangerous High Voltage. See example below:



9. Important additional information

For specific information and safety preparation regarding the High Voltage system, refer to: https://www.motorcraftservice.com, select quick guides for the appropriate vehicle emergency response guide.

For First Responder Resources, refer to https://www.ford.com/firstresponder/

10. Explanation of pictograms used

Flammable

Explosive

Corrosives

Hazardous to the human health

Environmental hazard

Use water to extinguish the fire

Use ABC powder to extinguish the fire

General warning

Warning, Electricity

Use infrared thermometer / Thermal Infrared camera

U.S. Fire Administration

Working for a fire-safe America

16825 South Seton Ave.
Emmitsburg, MD 21727
usfa.fema.gov

July 2025