



# EVs for EVs

## The Basics of Electrified Vehicles for First Responders and Emergency Services

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# Electrified Vehicles

- An **Electrified Vehicle** is *any* vehicle that...
  - Has an electrical energy storage device (batteries, ultra-capacitors, etc)
  - Is propelled by and/or recovers energy through an electric motor



Tesla Model S Powertrain (Dual Motor)

Image Source:  
Tesla Model S Powertrain: Author

# Electrified Vehicles - Hybrids

- A **Hybrid Vehicle** is a vehicle where the powertrain is driven by a combination of an internal combustion (IC) engine AND an electric motor
  - Hybrid Vehicles automatically switch between IC-only mode, electric-only mode, or both the IC engine and electric motor providing torque to the drive wheels at the same time (also known as a 'Parallel Hybrid')
  - Vehicles with auto start/stop features (i.e. the IC engine turns off at a stop light) are considered 'Mild Hybrid Vehicles'

## Parallel Hybrids:



Toyota Prius



McLaren P1

## Mild Hybrids:



AMG E 53  
(48V Mild Hybrid)



Chevy Malibu  
Hybrid

Image Sources:

Toyota Prius: [www.caranddriver.com/toyota/prius](http://www.caranddriver.com/toyota/prius) (22-Mar-2020)

McLaren P1: Author

Chevy Malibu Hybrid: [www.caranddriver.com/reviews/a15100616/2016-chevrolet-malibu-hybrid-test-review/](http://www.caranddriver.com/reviews/a15100616/2016-chevrolet-malibu-hybrid-test-review/) (22-Mar-2020)

AMG E 53: [https://www.motorauthority.com/news/1116478\\_2019-mercedes-amg-e53-mild-hybrid-arrives-in-late-2018-to-replace-the-e43](https://www.motorauthority.com/news/1116478_2019-mercedes-amg-e53-mild-hybrid-arrives-in-late-2018-to-replace-the-e43) (23-JAN-2021)

# Electrified Vehicles - Electrics

- An **Electric Vehicle** is a vehicle where the powertrain is driven solely by one or more electric motors
  - Most commercially available electric vehicles are Battery Electric Vehicles (BEVs) since their drive energy is stored in a battery.
  - Some BEVs have internal combustion “range extenders” that recharge the battery *but do not connect to the drive wheels* (also known as a ‘Series Hybrid’)

## Fully Electric:



Tesla Model 3

Chevy Bolt EV



## Electric with IC Range Extenders:



Audi RS Q E-tron  
(2022 Dakar Rally)

Chevy Volt



Image Sources:  
 Tesla Model 3: <https://www.caranddriver.com/tesla/model-3> (28-Mar-2020)  
 Chevy Bolt EV: Author

Audi: <https://hypebeast.com/2021/7/audi-rsq-e-tron-off-roader-2022-dakar-rally-model-revealed> (29-Jan-2022)  
 Chevy Volt: <https://www.caranddriver.com/chevrolet/bolt-ev> (28-Mar-2020)

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# Electrified Vehicles – What YOU Care About...

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**If it has an electric motor,  
it is an Electrified Vehicle**



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# Identifying Electrified Vehicles

**Tesla Badge**



**Badging or Markings**



**ISO 17480-4  
Marker for High  
Voltage Propulsion**



**Orange Conduit, Cables, or Connectors  
(HV Cabling)**

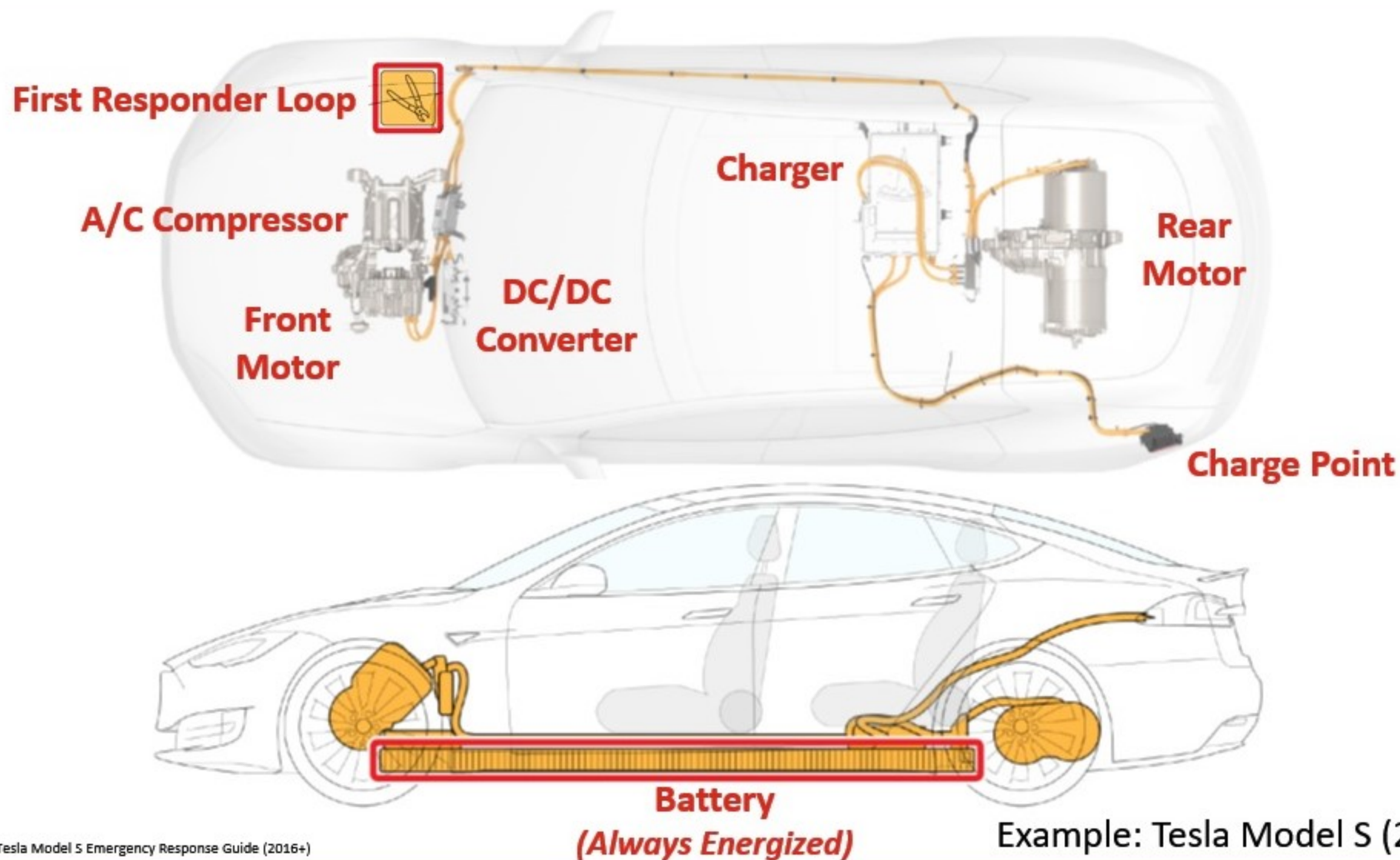
**SCCA is working to standardize EV identification**

Image Sources:

Tesla Model Y: <https://cleantechnica.com/files/2019/07/Tesla-Model-Y-White-Purple-Side-CleanTechnica-Kyle-Field.jpg> (23-JAN-2021)

Hyundai Ioniq: <http://www.cleanmpg.com/community/index.php?media/31672/> (23-JAN-2021)

# Hazards – Electric Shock

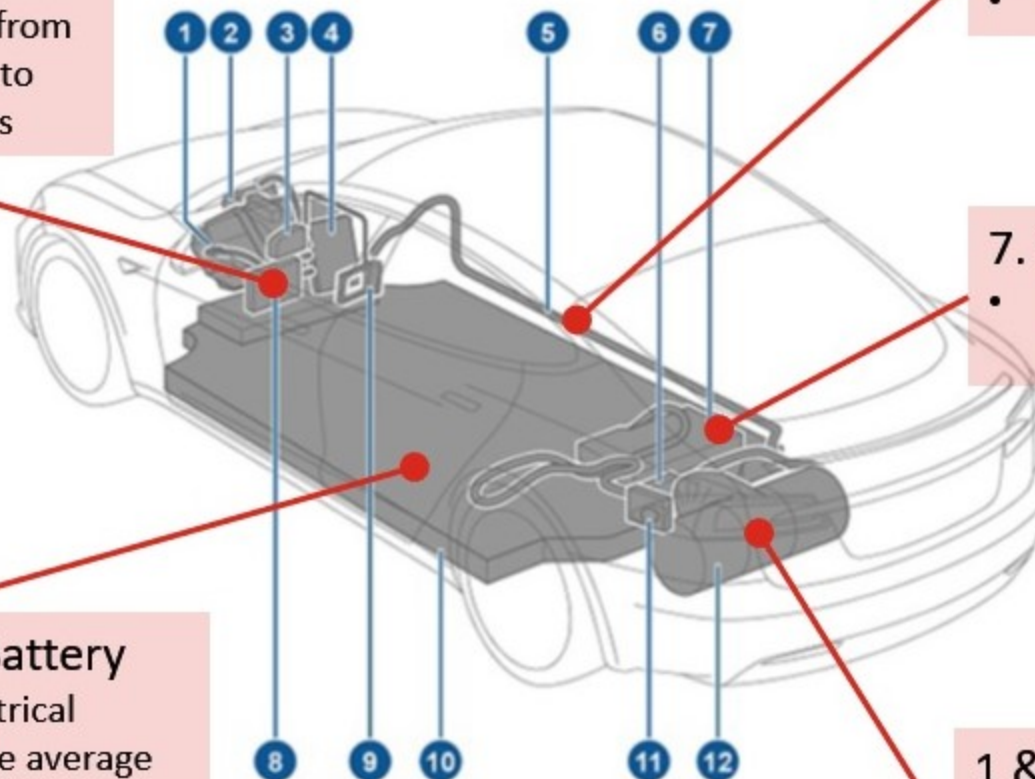


Source: Tesla Model S Emergency Response Guide (2016+)

# Hazards – Electric Shock

## 8. DC-DC Converter

- Converts high voltage from battery to low voltage to power +12V LV systems



## 5. High Voltage Wiring

- Always ORANGE in color

## 7. Charger

- Charges battery from external power source

## 10. High Voltage Battery

- Stores enough electrical energy to power the average home for 1-3 days.
- Generally in floor of vehicle

## 1 & 12. Motors/Drive Units

- Converts electrical energy to torque on the drive wheels
- Multiple motors possible

Example: Tesla Model S (2016+)

Source: Tesla Model S Emergency Response Guide (2016+)



# Hazards – Electric Shock

- Tractive System (High Voltage) cabling is **ORANGE** in color
- Orange cables have special insulation and shielding to protect against electrical shock
- Always assume an orange cable is energized.
- Cutting an energized orange cable can be lethal!!!
- Do NOT assume that a “thin” orange cable is less dangerous than a “thick” one



**NEVER CUT AN ORANGE CABLE IN AN EV!**

Image Sources: <https://chargedevs.com/newswire/formula-e-attracting-new-powertrain-manufacturers-for-second-season/> (29-JAN-2022)

# Hazards – Electric Shock

- Electrified Vehicles have multiple systems to prevent electrical hazards, even in a crash
  - Electrical energy isolated to inside the HV battery until vehicle is powered-on or a fault/crash is detected
  - In general, two or more electrical faults are required for vehicle to become a HV electrical hazard
  - There has been ZERO documented cases of electrical shock or transfer of electrical charge to a person in a crash<sup>1</sup>
- Class 0 (1000V) Rubber Insulated Electrical Gloves help protect against electrical shock
  - Check condition daily prior to use
  - Periodic electrical re-test/re-certification is recommended.



Image Sources: <https://www.criticaltool.com/PHOTOS/media/catalog/product/irg-011-bk.jpg> (23-JAN-2021)

1: Dalrymple, Dave – SAE Board, Electric Vehicles. Web Video (1h 29 minute mark): <https://www.facebook.com/jason.defosse.3/videos/10159018776985575> (29-MAR-2021)

# Electric Shock – What YOU Care About...

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**NEVER Cut ORANGE Cables!**

**NEVER Cut Into High Voltage  
Battery Compartments**

**When in doubt, wear  
High Voltage Safety Gloves**

# Hazards – HV Battery Fire



**ABC Fire  
Extinguisher will  
NOT put out a RESS  
(HV Battery) fire**

Use ABC extinguishers to:

- Assist driver's egress of vehicle
- Extinguish brake fires
- Extinguish secondary fires (e.g. brush fires)

Image Sources:

<https://upload.wikimedia.org/wikipedia/commons/thumb/d/d9/FireExtinguisherABC.jpg/220px-FireExtinguisherABC.jpg> (23-JAN-2021)

<https://upload.wikimedia.org/wikipedia/commons/thumb/3/31/ProhibitionSign2.svg/150px-ProhibitionSign2.svg.png> (23-JAN-2021)

# Hazards – HV Battery Fire



*It may take an hour (or more) and several thousand gallons of water to extinguish an EV battery fire*

## In cases of RESS (HV Battery) Fire:

1. Ensure driver has egressed from vehicle
2. **DO NOT TRY TO EXTINGUISH VEHICLE FIRE**
  - Call local fire department
  - Keep a safe distance away
  - Extinguish secondary fires (e.g. brush fires)
3. Provide competitor's Emergency Services Guide to Fire Department for their reference in responding to fire
4. Move vehicle *only* once cleared by Fire Department to do so.
5. Store vehicle in an opened paved area (minimum 50 feet from any structure) for 24-48 hours prior to any transporting vehicle off-site

**Always assume an Electric Vehicle fire is a HV Battery Fire**

#### Fire Response Sources:

- NFPA's Alternate Fuel Vehicles Safety Training Program – 2015 Edition (pg. 21 & 22)
- Blanchette, Tom. Director of NHMS & Loudon Fire Department Captain. Email 27-APR-2016
- Model S Emergency Response Guide (2016+) (pg. 23)

Image Source:

<https://caranddriver.com/news/a34335268/electric-car-fire-preparedness-ntsb-report/> (23-JAN-2021)

# Hazards – LV System/First Responder Loop

- Electrified Vehicles use a low voltage system for:
  - Occupant Safety Systems (e.g. airbags)
  - Interior/Exterior Lights
  - Enabling the HV System
- Many Electric Vehicles have a “First Responder Loop” to disable HV and occupant safety systems.
  - Cut loop prior to extrications
  - Perform ‘double-cut’ to remove section of loop and prevent inadvertent reconnection
- Emergency Services Guide will advise if first responder loop should be cut, the LV battery should be disconnected, or both

First Responder Loop

LV Battery



Orange Conduit  
**DO NOT CUT!**

LV Fuse Box

Image Source:  
2020 Chevy Bol EV: Author

# Hazards – What YOU Care About...

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**ALWAYS** assume an Electric Vehicle  
fire is a HV Battery fire

**Disable low voltage system prior to  
extrication**

# Winching/Jacking

- Care must be taken when winching/jacking an electrified vehicle
- Incorrect winching/jacking can result in breach of the RESS (HV Battery)
- Emergency Services Guide must illustrate dedicated winching/jacking locations



**Only winch a vehicle from OEM winch points or GCR tow loops**

Image Sources:

<https://insideevs.com/news/562050/flatbed-truck-damage-battery-report/> (29-JAN-2022)

<https://www.stableenergies.com/Rennline-Race-Tow-Hook-Universal/productinfo/REN-E01/> (29-JAN-2022)

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# Towing

- **NEVER** flat-tow an electrified vehicle
  - Many electrified vehicles cannot disengage the wheels from the electric motor (even if in "Neutral")
  - Hazardous voltages can be generated with wheel spin resulting in component damage, overheating, or a vehicle fire
  - Many BEVs have motors connected to all four wheels



**Only use a tilt-bed or dollies to tow electrified vehicles**

Image Source: <https://insideevs.com/news/403116/evs-harder-tow-depends-manufacturer/> (23-JAN-2021)

# Summary

- If it has an electric motor, it is an Electrified Vehicle
- NEVER cut orange cables
- NEVER cut into high voltage battery compartments
- ALWAYS assume an Electric Vehicle fire is a HV Battery fire
- ABC fire extinguisher will NOT put out a HV battery fire
- Disable low voltage system prior to extrication
- When in doubt:
  - Use High Voltage Safety Gloves
  - Refer to Moditech or manufacturer-specific Emergency Field Guides for guidance



*David Marcus drove a Tesla Model 3 to the B Street title at the 2019 Tire Rack SCCA Solo Nationals Championship  
(Photo Credit: David Cosseboom)*

Image Source: [www.scca.com/articles/2012724-second-set-of-2019-tire-rack-solo-nationals-champs-crowned](http://www.scca.com/articles/2012724-second-set-of-2019-tire-rack-solo-nationals-champs-crowned) (13-MAR-2021)

# Resources

- Manufacturer-Specific Emergency Field Guides:
  - Tesla: [www.tesla.com/firstresponders](http://www.tesla.com/firstresponders)
  - Chevy: [www.gmstc.com/index.php/first-responders/](http://www.gmstc.com/index.php/first-responders/)
  - Nissan: [www.nissan.ie/ownership/nissan-services/first-responders-guide.html](http://www.nissan.ie/ownership/nissan-services/first-responders-guide.html)
  - General: [www.nfpa.org/Training-and-Events/By-topic/Alternative-Fuel-Vehicle-Safety-Training/Emergency-Response-Guides](http://www.nfpa.org/Training-and-Events/By-topic/Alternative-Fuel-Vehicle-Safety-Training/Emergency-Response-Guides)
- [www.evsaftytraining.org](http://www.evsaftytraining.org)
  - NFPA Alternate Fuel Vehicle Emergency Field Guide (Updated 2018, Membership Req'd)
  - NFPA Alternate Fuel Vehicle Online Training for First Responders (Membership Req'd)
- [Moditech](#) (Membership Req'd)
- EV General:
  - [WeberAuto](https://www.youtube.com/user/WeberAuto): <https://www.youtube.com/user/WeberAuto>
  - Consumer Reports: <https://www.consumerreports.org/hybrids-evs/electric-cars-101-the-answers-to-all-your-ev-questions/>
  - Formula E: <https://www.fiaformulae.com/en/discover/cars-and-technology>