Preparing for Electric Vehicle Battery Fires - Overview

Collaboration, Cooperation & Integration

All Services Synchronizing For Strategic Success

- 1 Team - 1 Focus
- Unified Mission
- Building Relationships Prior
- Planning for the Usual & Unusual

"A bad system will beat a good person every time."

Pre Response Planning

- Developing Integrated SOPs
- Partners - Police, Fire, EMS, Haz Mat, Special Operations, OEM, DOT & Tow
- Other partners for complex incidents
- Traffic Incident Management (TIM) Teams (Bucks County)
- Plan for Low frequency complex incidents

Pre Response Planning - cont.

- Determine required training for various responsibilities
- Plan for Low frequency complex incidents
- Train
- Develop curriculum with performance standards
- Initial training
- Tabletops
- Hands On training with all agencies

Car Fire Hazards

Hazards associated with vehicle fires include:

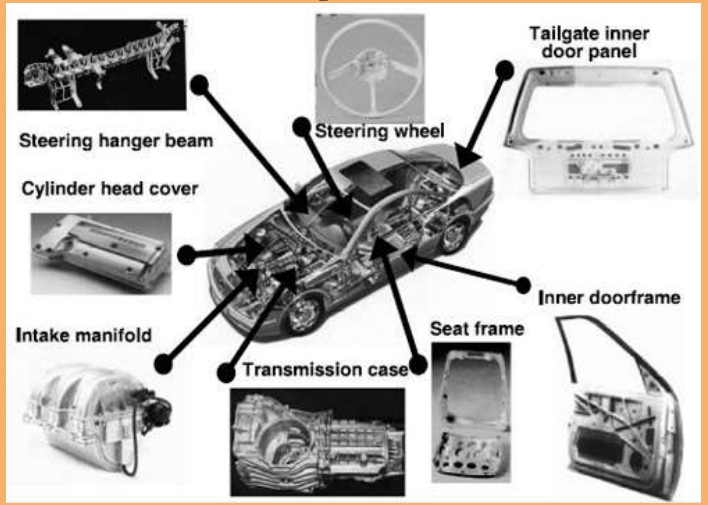
- Intense heat and flames
- Exploding:
  - tires
  - batteries
  - hydraulic pistons
  - bumpers
- melting plastic
- Release or ignition of:
  - gas
  - oil
  - acid
- Burning metals
- Smoke and fumes released from a burning vehicle are extremely hazardous. Hundreds of chemicals from incomplete combustion

Always use self-contained breathing apparatus (SCBA) while working around burning vehicles.

Car Construction Fire Hazards - Burning Metals

Location of Burning Metals:

- ✓ Steering Wheel
- ✓ Steering Column
- ✓ Seat Frame
- ✓ Wheels
- ✓ Front End Structure
- ✓ Motor & Transmission Parts
- ✓ Door Frames]



Lithium Ion Battery

Currently, there are four main kinds of batteries used in electric cars:

- ➔ Lithium-ion
- ➔ nickel-metal hydride
- ➔ Lead-acid
- ➔ Ultracapacitors.

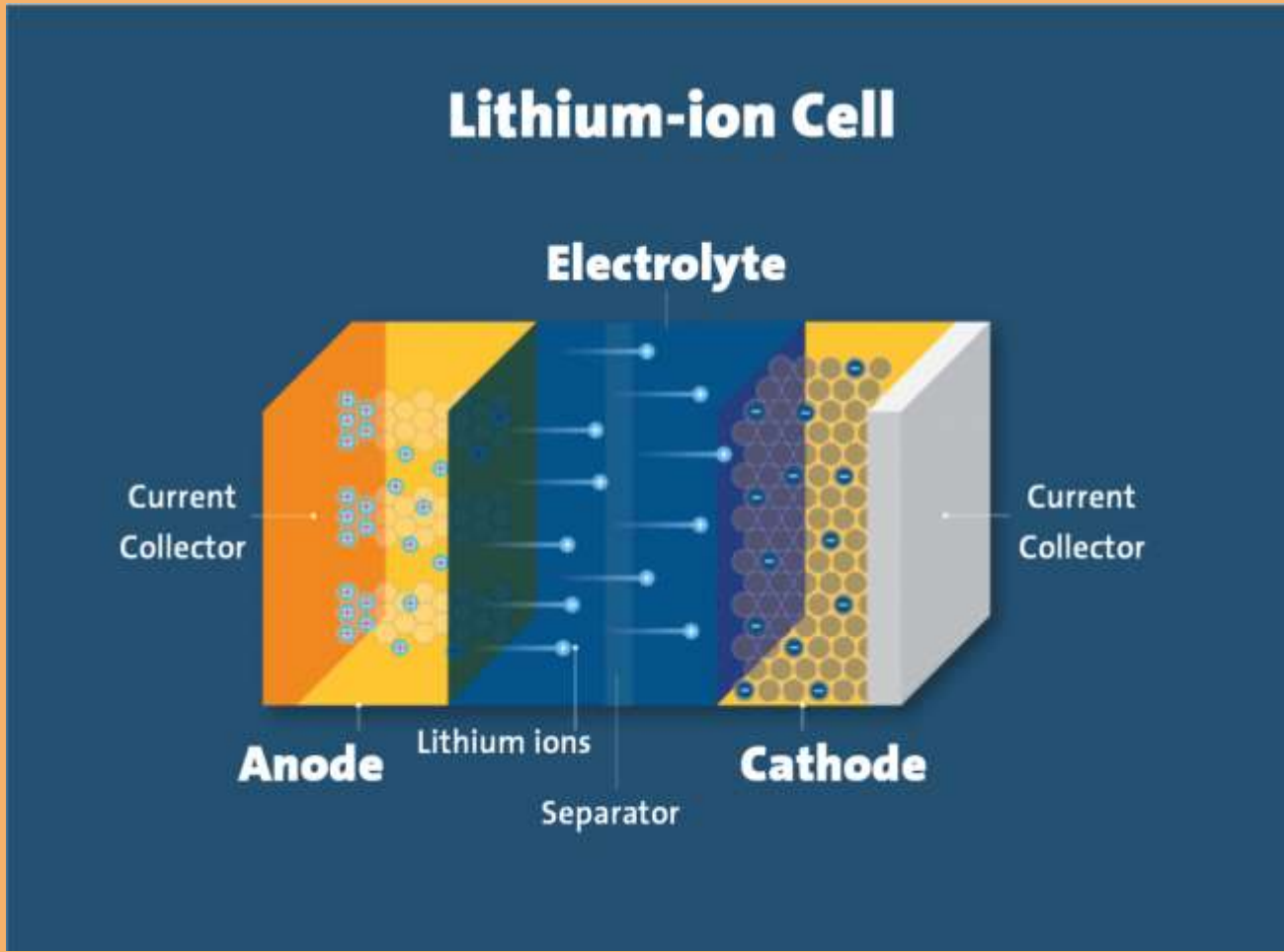
The most common kind EV battery - Lithium Ion (Li Ion)

The two main parts of a battery are the cathode and anode. The cathode acts as the battery's **positive** side, while the anode is the **negative** side.

A chemical solution called an electrolyte permits the flow of electrical charge between the cathode and anode. Positively charged particles of lithium, known as ions, move through the electrolyte traveling from the anode to the cathode. This movement creates a continuous flow of electrons to provide electricity.

When a rechargeable lithium-ion battery is charged, the chemical reactions happen in the opposite way. This means the lithium ions travel from the cathode back to the anode.

Lithium ion battery Cell



Thermal Runaway Initiation

When a battery short circuits, the cell heats up

If a cell is abused, e.g. by heating, crushing, penetration or overcharge, chemical reactions replace the normal electrochemical reactions: the former generate heat and toxic & flammable gases. The heat speeds up these exothermic reactions producing more heat and gases.

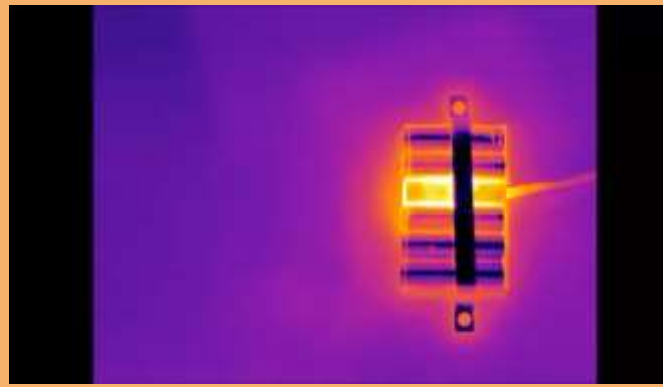
Heating starts to affect other cells

Cell heating will continue until the rise in temperature exceeds the heat that can be dissipated to the cell's surroundings. This released heat will start to affect other nearby battery cell

Progression Into Thermal Runway

The cell goes into thermal runaway

When the generation of heat becomes self-sustaining - the heat releases energy, & the energy in turn releases more heat - the cell is experiencing thermal runaway. When thermal runaway occurs, the cell is undergoing an unstable chemical reaction that is hard to bring under control.



At some point, the separator structure collapses and the electrodes touch, causing an internal short circuit and masses of heat, catapulting the cell to ever higher temperature.

Eventually, the gases are vented, either via blast caps on cylindrical and prismatic cells or when pouch cells burst. Initially, heavy metal dust particles from the cathode will present as a dark cloud, which is followed by a white vapour cloud as the gases take with them fine droplets of the solvent.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NIGHTLY
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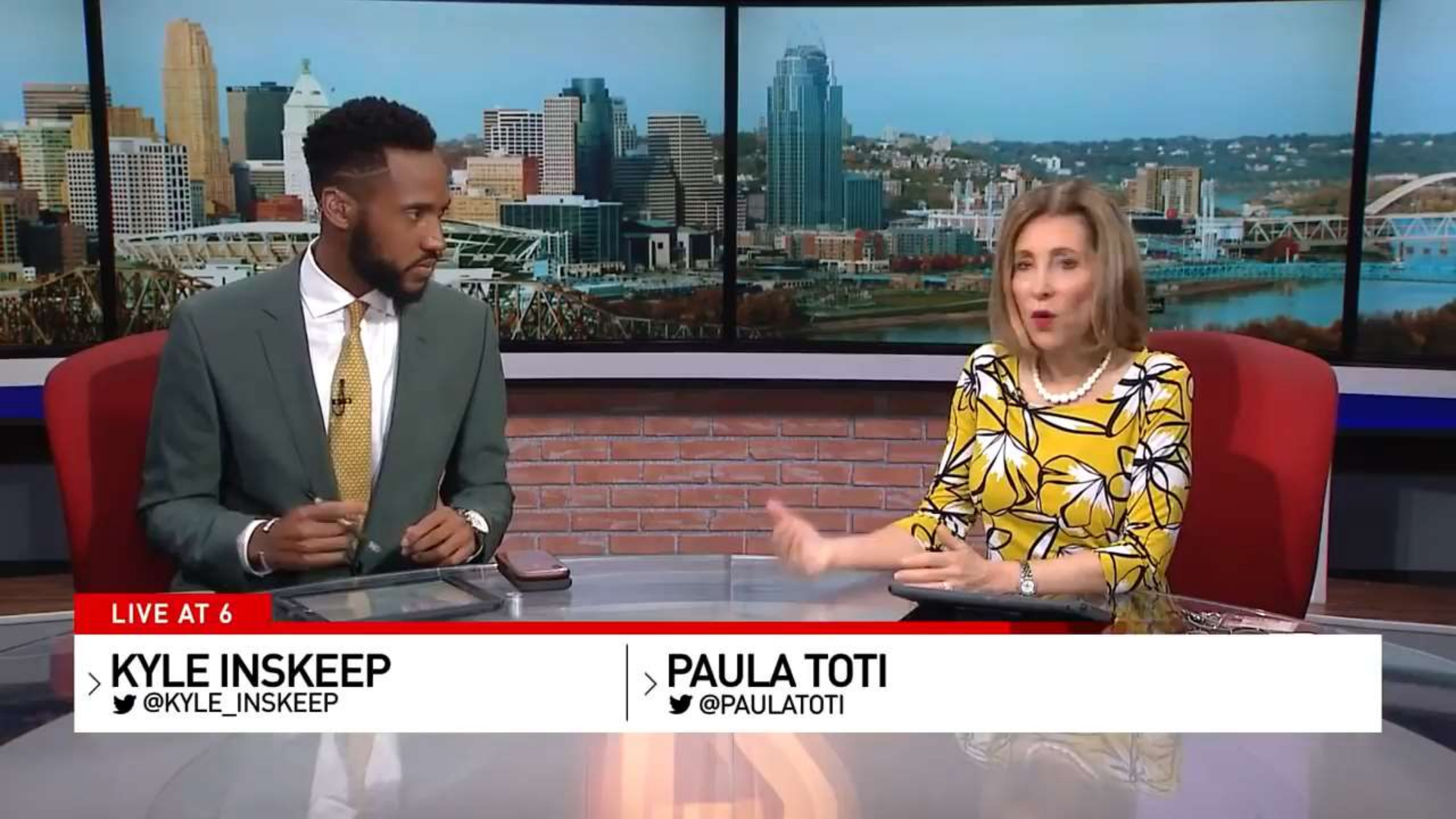
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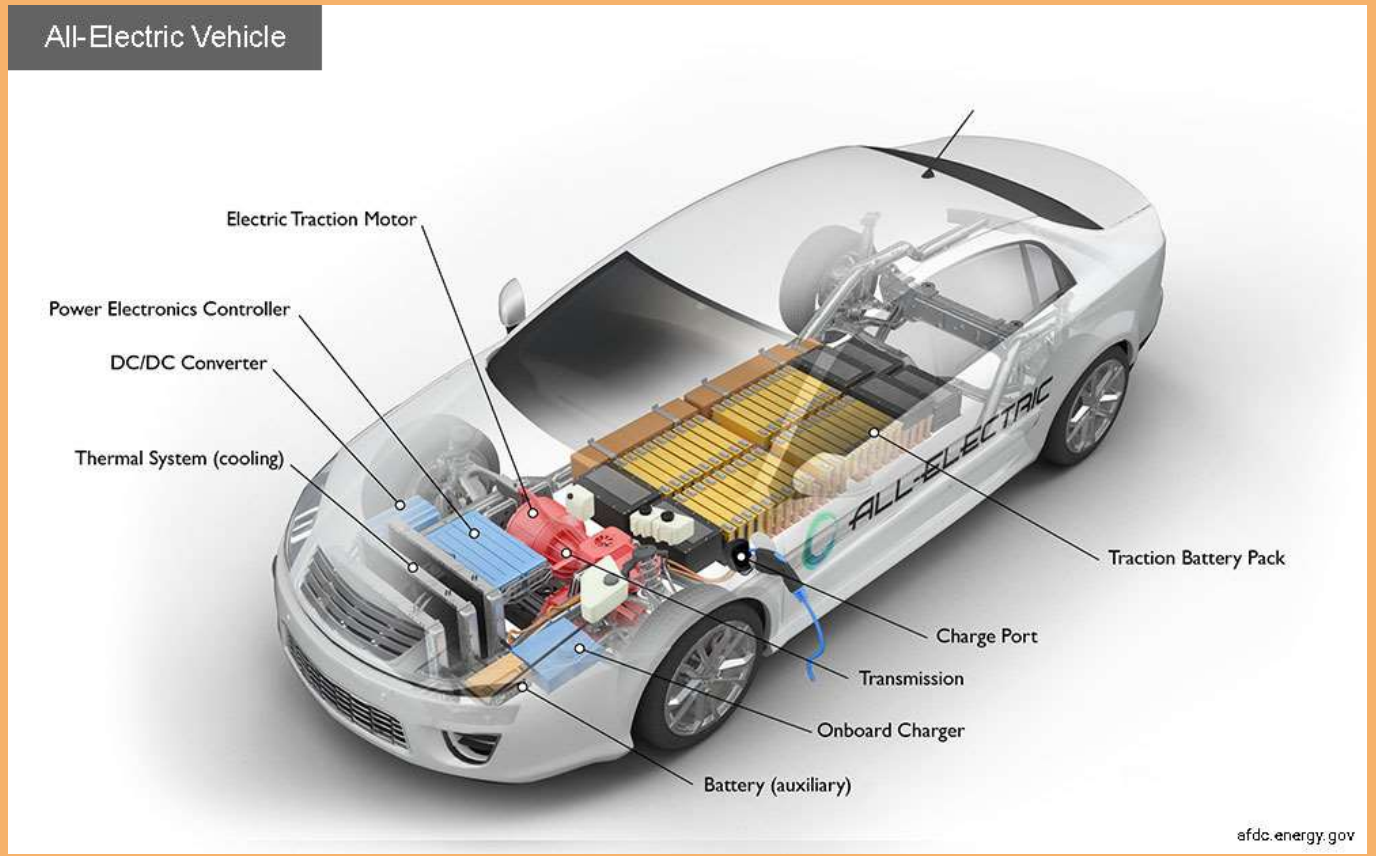
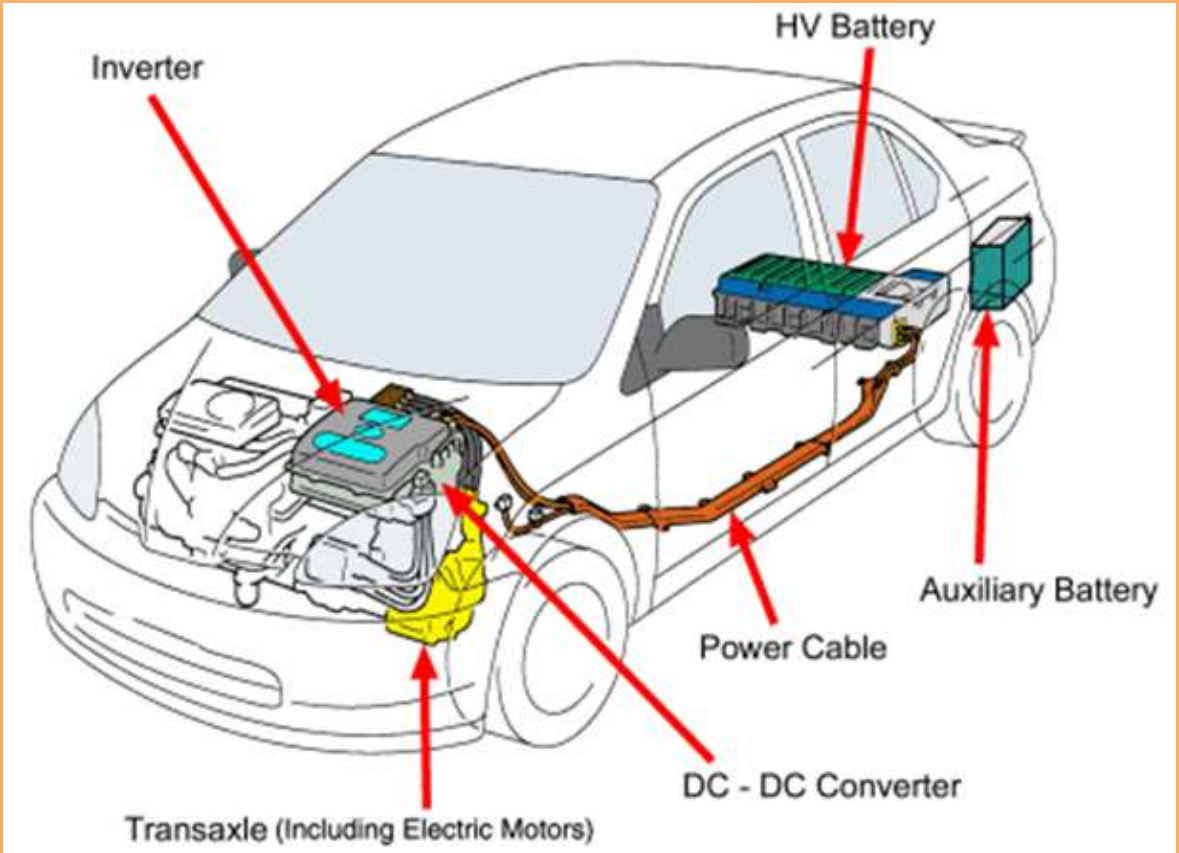
NEWSNATION
RUSH HOUR

Electric Vehicle Design



Electric Vehicle Design

Electric Vehicle Design - Hybrid

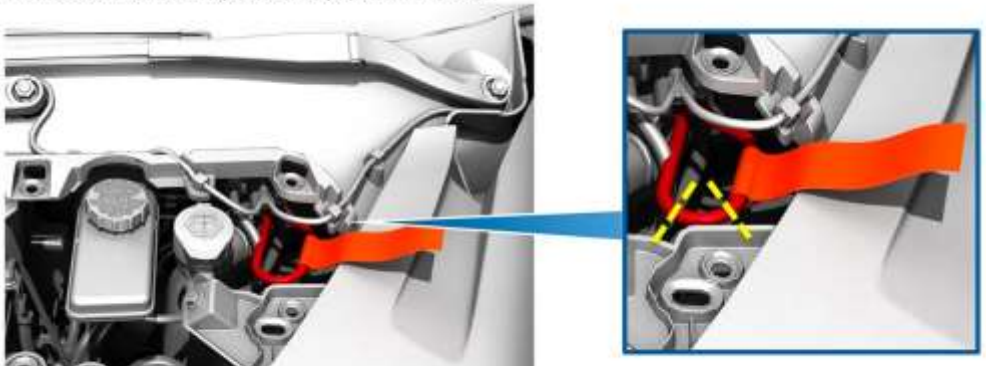


Electric Vehicle Design - High Voltage Wiring

Electric Vehicle Design - High Voltage Wiring

Electric Vehicle Design - Emergency disconnect / cut

3. Double cut the first responder loop (shown in red).



Electric Vehicle Design - Emergency Disconnect / Cut

Electric Vehicle Design - wireless car start

50 foot range

Initial Response and Arrival Considerations

Comprehensive Incident Action Plan - (IAP)

Resources

- ➔ Fire
- ➔ Hazmat
- ➔ EMS
- ➔ Additional Water
- ➔ Additional Traffic Resources

- ➔ NFPA ERGS: https://www.nfpa.org/Training-and-Events/By-topic/Alternative-Fuel-Vehicle-Safety-Training/Emergency-Response-Guides

Initial Response and Arrival Considerations

Resources

- ➔ Hazmat
- ➔ EMS
- ➔ Additional Water
- ➔ Additional Traffic Resources

Where is the battery tray located?

- Most common location for passenger vehicles is the entire floor pan !
- On some commercial vehicles, such as buses, the battery is located on the roof.

EV Battery Fires - Traffic Management

High Level Of Situational Awareness

Plan for a long duration incident 1-6 hours

Plan Ahead with your TIM partners

- ➔ Traffic Detours
- ➔ Extended Firefighting
- ➔ Toxic Smoke & Runoff (HF)

Plan to use 1,000 - 10,000 gallons of water

- ➔ Water Sources / Resources
- ➔ Impact on traffic
- ➔ Staging

Firefighting

Full PPE

Obtain Vehicle information Via ERG

Firefighting - Li-ion Fires can be over 4900 degrees

- ➔ Secure a Continuous Water Supply
- ➔ Extinguishment - up to 10,000 Gallons
- ➔ Consider other firefighting agents and tools
- ➔ Chock Wheels
- ➔ Disable Powertrain / Cut Power Source - Cut 12v Battery Cable, NOT ORANGE!
    - ◆ Isolate key fob, at least 50” or Faraday Bag
    - ➔ Consider other firefighting hazards due to car construction

HF smoke and runoff can be toxic and hazardous -Measure for HF

EMS

Monitor for Chemical and Smoke Exposure

Special Consideration Hydrogen Fluoride (HF) / Hydrofluoric Acid

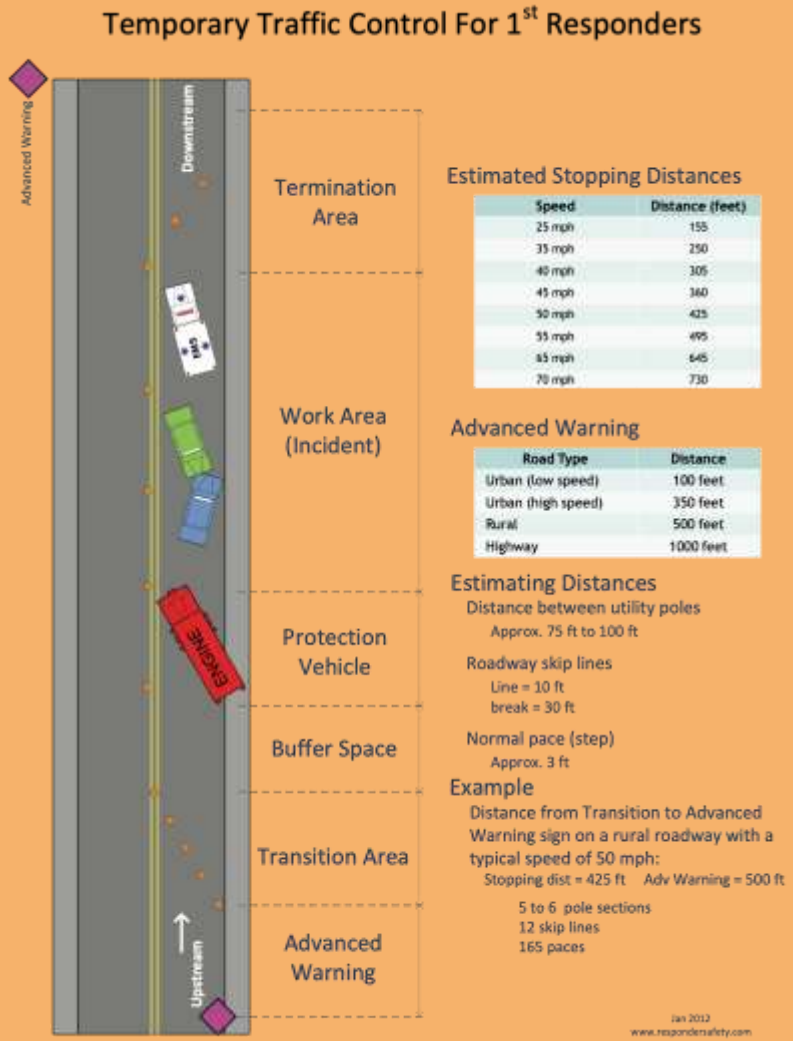
- Exposure:
    - Inhalation, Ingestion, Absorption, Injection
- HF smoke and runoff can be toxic and hazardous -Measure for HF
- Absorption can be localized and systemic
- Antidotes: Tums, (Antacids with Calcium), Calcium Gluconate Gel, Calcium, Gluconate Infusion

- Rehab and medical monitoring - Long Term Incident

Law Enforcement / Traffic Control

Traffic and Crowd Control

Plans for Long Term Road Closures and detours



Hazmat

- Provide Advice - Hazmat Lite
- Monitor Smoke / Air
- Monitor Runoff

Overhaul

- ➔ Battery can still be in Thermal Runaway even if flames are not visible, (24 hours)
- ➔ Lift Vehicle at least 24” to expose, keep cooling and monitor Cooling with TI
- ➔ Contain runoff

Once fire is out and battery cooled, Decon firefighters thoroughly

Demobilization

- Face to Face with Tow truck operator - Flatbed only
- Where is he going?
- Where will place the vehicle in the yard?

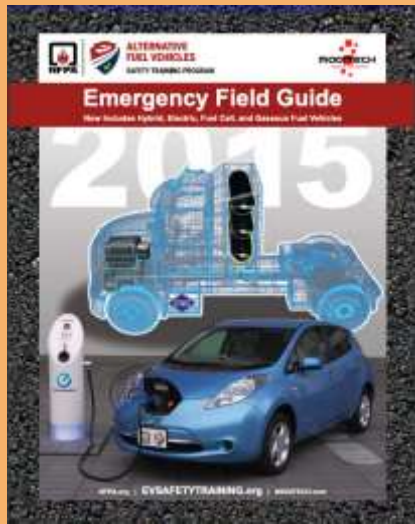
Other Extinguishment Methods

Emergency ResponseGuides (ERG)

NFPA - https://www.nfpa.org/Training-and-Events/By-topic/Alternative-Fuel-Vehicle-Safety-Training/Emergency-Response-Guides

ESA - https://energysecurityagency.com/erg/

MODITECH - https://www.moditech.com/



Future

Keep up on technology and firefighting practices. What we do today, will change tomorrow

Expect more vehicles

Expect Autonomous Vehicles

Expect Larger Vehicles

Expect Retrofit

After Action Review (AAR)

Introduction to AAR and ground rules.
Start with a short background on what was known at the beginning of the incident.
What happened?
What was supposed to have happened?
What was done well? How can we sustain that level?
What was not done well? How can we improve?
Discussion of key issues. Administrative/Policy Communication/Intelligence Training tactics, techniques and procedures. Equipment Safety
SUMMARY:

After Action Review

1. **What was our mission?**
   - Had we planned for this event?
   - Were there any gaps in our planning?
2. **What went well?**
   - Did we have the resources for conducting this event?
   - Did we do all we could to make this a successful operation?
3. **What could have gone better?**
   - Did we see any unsafe behaviors?
   - Did our training prepare us?
4. **What might we have done differently?**
   - If you ran the same incident today what would be done differently?
5. **Who needs to know?**
   - What needs to be fixed?