SAE J2990 HYBRID & EV FIRST AND SECOND RESPONDER RECOMMENDED PRACTICE OVERVIEW

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Crash Scenario
EV Split in Half

NBC LA Photo

The remains of a car crash involving a Tesla, in West Hollywood, Calif., on Friday. (Photo: Richard Vogel, AP)
Example of an ‘Unplanned Event’ Occurring With an xEV
Unplanned xEV events can be properly managed through:

Knowledge,
Information,
Education, and
Training
WHAT IS J2990?

• J2990 is a collection of recommendations
  • Addressing gaps for first and second responders when encountering an electrified vehicle (xEV)
  • Focused on passenger vehicles

• Provide common practices for response personnel
  • Increase responder safety and confidence with xEVs

• Establishes a foundation from which to build
Process Used:

**Responders**
- Reviewed spectrum of incidents: impact, fires, submersion, etc.
- Examined current response equipment and procedures
- Considered both first and second responders

**Manufacturers**
- Government Regulations
- Surveyed existing designs of hybrid and electric vehicles
- Investigated design constraints for xEVs
Diverse and cross-functional input from representatives of:

- Automotive OEM’s (12)
- NFPA/CTIF
- EMT’s
- Law Enforcement
- Tow & Recovery Personnel
- Salvage Yards
- Battery Manufacturers
- Government (NHTSA, EPA, National Labs)
- Universities

~ 66 Experts and evolving…
## xEV Spectrum:

<table>
<thead>
<tr>
<th>Total Vehicle Power</th>
<th>IC Engine Power</th>
<th>Battery Power</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>&lt;60V DC</td>
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### Start-Stop Hybrid
- eAssist (Mild Hybrid)
  - Engine start / stop at idle
  - Engine off/on deceleration
  - Regen braking
  - Electric assist

### Hybrid (HEV)
- Complete cycle regen braking
- Electric launch
- Engine cycle optimization
- SOC drop during drive
- Charge via grid power

### Plug-In Hybrid (PHEV)
- Battery only operation
- Engine on at low SOC or high power demand

### Extended Range EV (EREV)
- Large ESS
- No on-vehicle charge method
- Energy from stored H2
- Fuel Cell runs at optimum output
- ESS buffers power load

### Battery Electric Vehicle (BEV)

### Fuel Cell Electric Vehicle (FCEV)

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J2990 xEV Spectrum
xEV Growth

Why J2990?

- Electrified vehicles (xEVs) are entering the market
- Battery energy size increasing with greater vehicle electrification
- New potential hazards for responders
  - Electrical
  - Chemical
  - Thermal

VEHICLE INFORMATION

IMMOBILIZE VEHICLE
1. Check the wheels.
2. Set parking brake.
3. Place vehicle into park.

DISABLE VEHICLE

PRIMARY PROCEDURE
1. If ON, turn off ignition (push-button, center console). Remove key.
2. Cut the 12V positive battery cable at the yellow tag cut position (behind left rear panel in rear cargo compartment).

ALTERNATE PROCEDURE 1
1. Turn off ignition (push-button, center console).
2. Remove manual service disconnect (located under tray in center console).

ALTERNATE PROCEDURE 2
If Ignition cannot be assessed,
1. Cut the 12V battery red POSITIVE cable at the cut face indicator (behind left rear panel in rear cargo compartment).
2. Remove manual service disconnect (located under tray in center console).

WARNINGs (continues on the next page)

- NEVER cut, breach, or touch orange high voltage components or cabling. Doing so could result in serious injury or death.
- The high voltage system may remain powered for up to 1 minute after the vehicle is shut off.
- The SRS system (airbags, etc.) may remain powered for up to 1 minute after disabling.
- The outboard area of the front seat lower frame houses an additional seat belt pretensioner.
- In the event a Volt is involved in an incident while connected to a charging station, remove the charge cord from the car at the charge port in the left front fender. If that cannot be accomplished, the electrical power to the charge cord should be terminated at the source.
- In the event of a fire involving a charging station, reference the FIRE portion of this guide, and treat it as an emergent electrical fire until power to the charger can be shut down.
Responsible organization provides a Quick Reference Sheet (QRS)

- One page, front and back, with a quick summary of vital responder information

Artwork of HEV or EV provided

- Includes a top & a side view of vehicle in grey or black
- Includes info such as High Voltage (HV) System shown in orange
- Includes SRS systems locations (including inflator locations, etc)
- Includes ultra high-strength steel locations
- Includes vehicle identification if not compliant with J2990 badging & markers

Provides (2) primary High Voltage (HV) shutdown procedures

Lists any special considerations

- Any special fire extinguishment for battery or magnesium parts
- Any special tow and recovery recommendations

Includes contact information for responsible organization
XEV IDENTIFICATION
Goals:
To safely identify vehicle from 50’ (15m) distance
Multiple identification points

Three exterior badges
- Right rear location – one standard location for responders
- Side locations – not specific, allows flexibility
- 1” (25mm) height to allow ID from 50’ approach

OR

One exterior badge (rear right) and one interior marker
- Interior marker in driver compartment near ignition or power button
  - Responder standard response includes power off vehicle and remove keys
  - Height as large as any other markings on panel
  - Needs to be visible when the vehicle is off
Badging or Marker Should Contain:

- ‘Hybrid’, ‘Electric’, or ‘EV’
  - combinations of these are allowed (‘HEV’, ‘PHEV’, ‘Plug-in Hybrid’)
- Colors, designs, fonts, or shapes not specified
- Unique identification allowed
  - Should pass responders comprehension per SAE J2830 or ISO 9186-1:2007
HIGH VOLTAGE SHUTDOWN
Important Terms:

**Automatic Disconnect:** A device in any type of xEV which opens the primary high voltage circuit or circuits of the vehicle, and that is activated by automatic means such as a crash response or the operation of the vehicle ignition switch.

**Manual Disconnect (MD):** A device in any type of electric vehicle which opens the primary high voltage circuit or circuits of the vehicle, and that is only activated by non-automatic means.

**12V DC/DC Converter:** A device to convert high voltage electricity into 12V power to charge the 12V battery and to supply conventional vehicle electrical loads.
Even with both disconnects open, high voltage generally exists inside the RESS.
High Voltage Shutdown Methods:

Vehicle OEMs should provide a minimum of two methods of initiating the disconnection the propulsion system from high voltage sources on electrified vehicles. To comply with this requirement, the following methods of initiating the disconnection are allowed:

1. Automatic shutdown of the high voltage system based on the detection of a significant vehicle impact.  
   < 5 seconds

2. Switching the vehicle’s ignition switch or power button to the OFF position.  
   < 10 minutes

3. Cut positive/negative 12V battery and the 12V DC-DC converter cables.  
   < 10 minutes

4. Remove the manual disconnect if certain criteria are met (not recommended).  
   < 10 minutes
Manual Disconnect Considerations:

Removing the manual disconnect (MD) should not be one of the primary methods for first responders to disable the vehicle’s high voltage circuits. This position is based on the following considerations:

- Because there are a variety of MD designs, as well as MD mounting locations, it is often not time efficient for first responders to locate and activate the MD.

- First responders do not always have the Personal Protective Equipment (PPE) that may be required to activate the MD.

- The MD may not be accessible because of impact damage or because vehicle cargo may block access.

- The MD is primarily used for vehicle service.
Manual Disconnect Usage:

If the vehicle manufacturer selects to use the MD as a method of high voltage shutdown, the following MD design considerations should be complied with:

- No personal protective equipment required to operate the MD, but it can be activated via a gloved hand.
- Activation should not expose responder to arch flash.
- Ten minute or less high voltage shutdown time.
- Should be orange in color.
- Tools should not be required to access or activate unless available on the vehicle.
- Vehicle should have a label showing steps for removal or disconnect.

Note: J2990 does list different subsets of the above requirements for first and second responders.
2ND RESPONDERS
TOW & INSPECTIONS
Recovery

• Wheels and motors may be connected
  – Can generate high voltage when wheels moving
  – Slow speeds recommended
  – Flat bed encouraged when not sure which wheels are connected to motors

Caution when towing vehicle with suspected high voltage damage

• Make plans for towing immediately and directly to offsite location
• Offload and isolate vehicle once at site
Post – Crash Isolation:

• Defines requirements for vehicle isolation until proven vehicle poses no greater risk
  – Open perimeter option (50’)
  OR
  – Barrier option constructed of earth, steel, concrete but not fully enclosed

Post – Crash Vehicle Inspection:

• 2 inspections recommended: At scene and in isolation
• Inspection largely relies on sense of smell, sound, and sight
  – Avoids tools and PPE except in specific circumstances
• Goal is to ensure vehicle poses no greater risk than a traditional vehicle
  – If issues are noted, directs inspector to “Battery Depower Assessment”
J2990 - Inspection Steps

- Fire
- Leaks
- Mechanical Damage
- Vehicle Diagnostics

TOOLS

The Ear
The Ear
The Nose
J2990 – Inspection Steps

Fire

Look, Smell, Hear…

• Evidence of Fire or Arcing
• Past or Present
  – Flames, Smoke, Residue, Charring
J2990 – Inspection Steps

Leaks

Look, Hear…

• Evidence of leaks in battery system
• Examples:
  – Puddles under vehicle
  – Low coolant level
  – Bubbling or gurgling sounds
Look…

• Damage to the high voltage system
• Examples:
  – Crushed or pinched orange cables
  – Battery housing damaged
  – Airbag deployment
Only required if previous inspection steps raise concerns

- Advanced inspection requiring higher skill, training
- Requires interfacing with energy storage system
  - High Voltage training & PPE
  - OEM specific tools
Inspection indicates need for a Battery Depower Assessment

- To be conducted in consultation with OEM or via an authorized service organization
  - OEM to provide procedures and equipment
  - OEM determines safe energy level for the battery system
    - Battery systems are unique and proprietary to OEMs
    - Based on individual incident scenarios and facts obtained through the assessment
    - And based on OEM’s knowledge of battery system and failure modes
Information Report:

• Describes general safety systems and practices employed by OEM’s
• Help assure the general public of the xEV safety
• Explain why these safety systems and practices do help protect against high voltage contact
Topics Covered:

- Electrical Safety
  - High Voltage Vs. Low Voltage
  - A.C. Vs. D.C.
- Electrical Isolation
- Typical xEV High Voltage System Overview

Protection Methods Described:

- Enclosures
- Labels & Identification
- User and Service Instructions
- Automatic Disconnects
- Hazardous Voltage Interlock Loop
- Crash Detection / Automatic Shutdown
- Manual Shutdown Process

“All About Circuits” [http://www.allaboutcircuits.com](http://www.allaboutcircuits.com)
SAE xEV Responder Task Force
Work In Progress

J2990

J2990/1
Hydrogen Vehicles

Recommended xEV
Responder Labels

J2990 Review

Expect to Ballot
Early 2015

New focus for 2015
- Battery location
- Disconnect location

Todd Mackintosh, General Motors, ISO Meeting, Brussels, February 2015
THANK YOU!

Questions?

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