



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

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SAE International

Prepared by Todd Mackintosh, Chairman SAE Hybrid and EV First
and Second Responder Task Force



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



Crash Scenario – Tesla Roadster

Unplanned xEV events can be properly managed through:

Knowledge,

Information,

Education, and

Training





WHAT IS J2990?

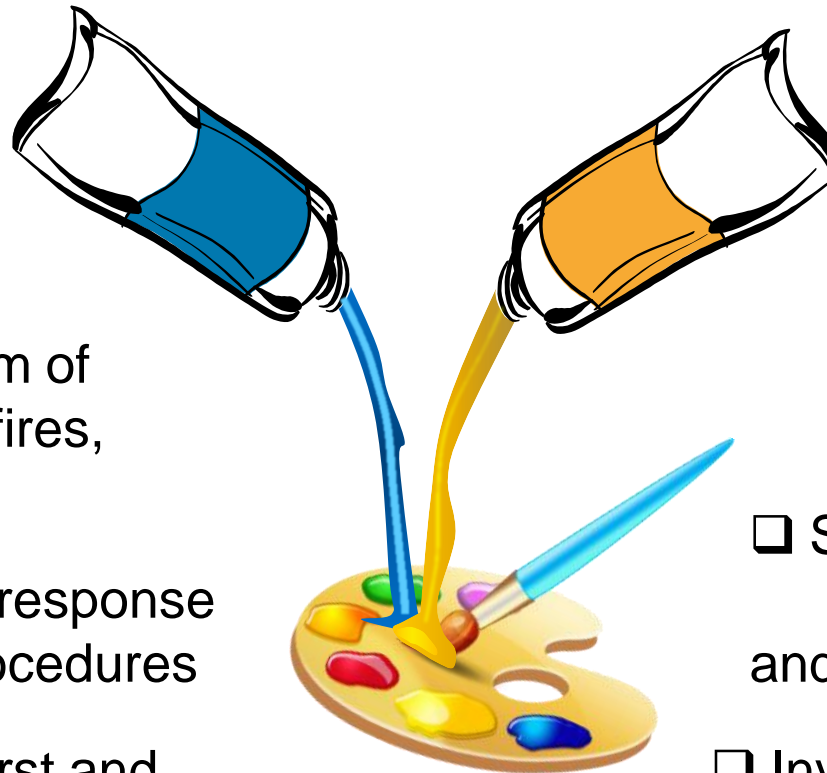
- **J2990 is a collection of recommendations**
 - Addressing gaps for first and second responders when encountering an electrified vehicle (xEV)
 - Focused on passenger vehicles
- **Provide common practices for response personnel**
 - Increase responder safety and confidence with xEVs
- **Establishes 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...

First
Responders

Second
Responders

Balanced needs and desires of all participants to ensure safety while keeping vehicles marketable and attractive to consumers

Hybrid and EV Responder Task Force SAE Alignment

SAE International

Ground Vehicle Standards Committees

Motor Vehicle Council			Truck & Bus Council	Materials, Processes & Parts Council	Construction, Agricultural & Off-Road Machinery Council
Chassis Systems Group Chassis Controls Technical Committee Automotive Brake and Steering Hose Standards Brake Fluids Standards Hydraulic Brake Components Standards Vehicle Dynamics Standards Wheel Standards Highway Tire Forum Steering Cmt Brake Forum Steering Cmt Brake Linings Standards Brake NVH Standards Brake Dynamometer Standards	Vehicle Engineering Systems Group Comfort & Convenience Adaptive Devices Controls & Displays Cooling Systems Dedicated Short Range Communications Human Accommodations and Design Devices Interior Climate Control Volatile Organic Compounds Heated Seat Exterior and Performance Dynamical Modeling and Simulation Glazing Materials Light Duty Vehicle Performance & Economy Measurements Light Vehicle Exterior Sound Road Vehicle Aerodynamics Speedometer & Odometer Tow Vehicle Trailer Rating WDWMI Wiper Standards	Electrified Powertrain Groups EV/HEV Steering Committee Hybrid/EV Technical Committee Hybrid Connector Task Force Hybrid Communication and Interoperability Hybrid Power Quality Task Force Hybrid Wireless Charging Task Force Powertrain Technology Task Force Hybrid and EV 1st and 2nd Responder TF Powertrain Technology Task Force Interface Workgroup Safety Workgroup 2009/1 Fuel Cell Responder Battery Standards Steering Committee Labeling Battery Transportation Testing Battery Recycling Safety Starter Battery E-Fuel Gauge Battery Field Discharge Small Tank Battery Battery Terminology Secondary Battery Use Truck and Bus Battery Battery Test Equipment Battery Materials Testing Battery Size Standardization Advanced Battery Concepts Battery Disconnect and Discharge Proc. Capacitive Energy Storage Cell and Module Connections	Work Truck Safety Committee Advanced & Hybrid Powertrain SC Alternative Fuels Hybrid Safety Hydraulic Hybrids Body & Occupant Environment SC Truck Crashworthiness Windshield Wipers & Climate Control Human Factors Electrical/Electronic Steering Cmt Low Speed Communications Network Control and Communications Network 71939 Task Forces Event Data Recorder Electrical Systems Brake and Stability Control SC Active Safety Systems Foundation Brake Brake Actuator Brake Systems Hydraulic Brake Wheel Stability Control Systems Air Brake Tubing & Tube Fittings Brake Supply and Control Components Total Vehicle Steering Cmt Tire Pressure Management Systems Corrosion Aerodynamics/Fuel Economy Tire	Light Weight Vehicle Design Mat'l's and Assy. Tech. Squeak and Rattle Compatibility Task Force Automotive Corrosion & Prevention Automotive Adhesives & Sealants Acoustical Materials Fasteners Cures on Automotive Rubber Specs Surface Enhancement Spline B92 Non-Hydraulic Hose Hose Clamp Performance & Compatibility Ground Vehicle Reliability Terrain Modeling Task Force Unmanned Ground Vehicle Reliability TF Software System Reliability SC CBM (Condition Based Management) SC Metal Technical Executive Steering Cmt Carbon & Alloy Steels Metals Test Procedures Automotive Iron & Steel Castings Sheet & Strip Steel Elevated Temp Prop of Ferrous Metals Spring Steering Cmt Coil Spring Leaf Spring Pneumatic Spring Torsion Bar Spring & Stabilizer Bars Fluid Conductors/Connectors SC C1 Hydraulic Tube Fitting C2 Hydraulic Hose & Hose Fittings C3 Hydraulic Hose & Hose Fittings C5 Hydraulic Hose & Hose Fittings Fatigue Design & Eval. Advisory Group Material Properties Structural Analysis Fatigue Lifetime Predictions Road Load Data Acquisition Component Testing & Simulation	Common Tests Technical SC Hydraulics Electrical Components Human Factors Technical Adv. Grp Machine Controls - Operator Machine Displays and Symbols Operator Seating and Ride Operator Accommodation Machine Technical Steering Cmt Loaders, Crawlers, Scrapers & Attachments Sweeper, Cleaner & Machinery Forestry & Logging Equipment Excavator Roadbuilding Machinery Tire & Rim Trenching & Boring Operator Protection Tech Adv. Grp Personal Protection (General) Braking Lighting and Sound Protective Structures
Vehicle Safety Systems Group Occupant Protection & Biomechanics SC Restraints System Standards Child Restraints Seat Belt Systems Inflatable Restraints Impact & Rollover Test Procedures Standards Safety Test Instrumentation Standards Human Biomechanics and Simulation Standards Dummy Testing & Equipment Committee Driver Assistance Systems SC Active Safety Systems On-Road Autonomous Vehicle Driver Perception Steering Committee Driver Vision Standards Safety & Human Factors Vehicle Sound for Pedestrians (VSP) Driver Vehicle Interface Lane Keeping Assistance Systems Adaptive Cruise Control & Forward Collision DRPOD Driving Performance Oper. Definition Crash Data Collection and Analysis SC Data Analysis Cross-cutting issues Data collection & Archiving	Electrical Systems Group Vehicle E/E Systems Diagnostic Electronic Design Automation Standards Vehicle Architecture for Data Communications Vehicle Electric Power Supply Systems Embedded Software Standards Automotive Electronic Systems Reliability Vehicular Flat Panel Display Standards Electromagnetic Compatibility (EMC) Circuit Protection & Switch Devices Functional Safety Automotive OEM EMC Event Data Recorder Vehicle Electrical System Security Electrical Distribution Systems SC Connector Systems Cable Standards Harness Covering	IC Powertrain Groups IC Powertrain Steering Committee Automatic Trans Transaxle Automatic Trans Friction All-Wheel Drive Emissions Engine Power Test Code Bell Drive Air Cleaner Test Code Piston and Ring Standards Filter Test Methods Gasoline Fuel Injection Ignition Standards Fuel System Standards Spark Arrestor Driveline Standards	Fuels & Lubricants Council TC 1 - Engine Lubrication TC 2 - Industrial Lubricants TC 3 - Driveline & Chassis Lubrication TC 7 - Fuels	Specialized Vehicle & Equipment Council Personal Watercraft Small Engine & Powered Equip Snowmobile Special Purpose Vehicle Trailer Gooseneck & Fifth Wheel TF Trailer Dynamics TF Conventional Towing System TF Motorcycle Technical Steering Cmt Motorcycle Sound Level Electric Motorcycle Marine Technical Steering Cmt Marine Engine Fuel Systems Marine Electrical Systems Ship Systems Technical Steering Cmt Ship Fluid Systems Fasteners	
Lighting Systems Group Heavy Duty Lighting Standards Road Illumination Devices Standards Signaling and Marking Devices Standards Test Methods and Equipment Standards Emergency Warning Lights and Devices Lighting Materials Standards Lighting Standard Practices Standards International Cooperation International Lighting Advisory Group	Green Technology Groups Green Technology Steering Committee Green Bio-Materials Task Force Green Terminology Task Force	Automotive Quality & Process Improvement Committee Jill Kqiraj - jkqiraj@sae.org Nikki Ammerede - nimmerede@sae.org	Standards Derivative Programs Hespapower Certification 12746 Software Assessment Repository On Board Diagnostics Database MAC Equipment Conformance	Cooperative Research Projects High Spin Rate Plastics DAC ITS Projects CAESAR Ergonomics Onologic Trauma	RESS Safety EV/HEV Interoperability Truck Cab Anthropometric Study Emergency Vehicle Lighting Vehicle Sound Level for Pedestrians Plastics Suitable for use with H ₂
Service Development Steering Committee Service Collision Repair Towability Graphics Based Service Info	Jack Polkzywa - jpolkzywa@sae.org Gary Pollak - gpollak@sae.org Kara Widdall - kwiddall@sae.org Peter Dyk - peterdyk@sae.org Keith Wilson - kwilson@sae.org	Patricia Ebejer - pebejer@sae.org Jana Wright - jwright@sae.org Mary Doyle - mdoyle@sae.org Lone Featherstone - lfeatherstone@sae.org Roxanne Loeffler - rloeffler@sae.org	MAC Refrigerant Blends (MRB CRP) Alternative Refrigerants CRP124v4 Air Refrigerant Assessment CRP150 Low GWP Air Refrigerant Assessment High Temperature Brake Study Gase R&R of HPM H, Fuel Cell Station Breakaways, Hoses, Fittings and Nozzles	H-Pint Machines WMI VDI WMC/PDN Wheel Conformance	
Contact Information: SAE International (248) 273-2455 www.sae.org					

02/11/13



SAE Int'l

Ground Vehicle Standards

Motor Vehicle Council

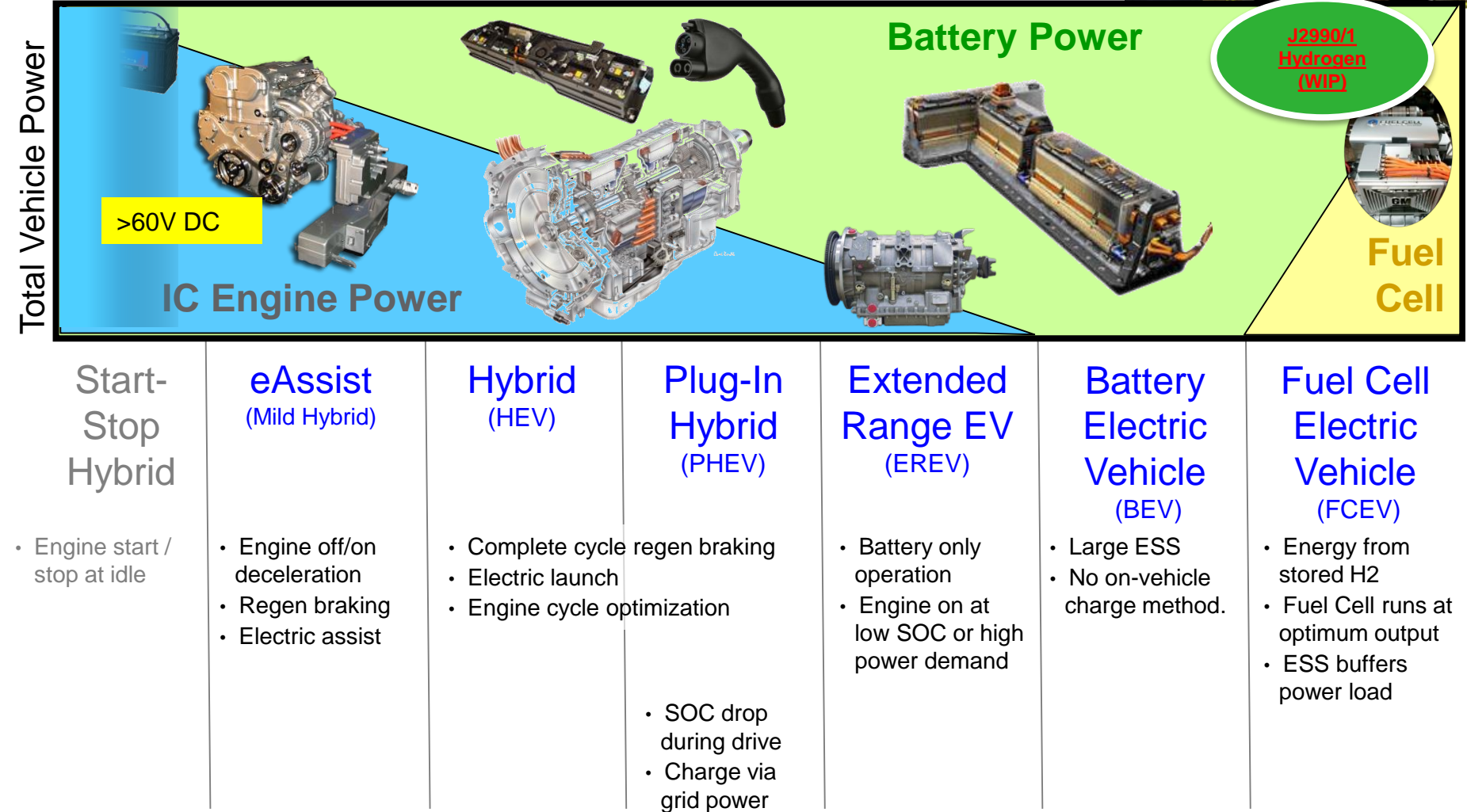
Hybrid Technical Committee

1st & 2nd Responder Task Force

• Initiated October, 2011



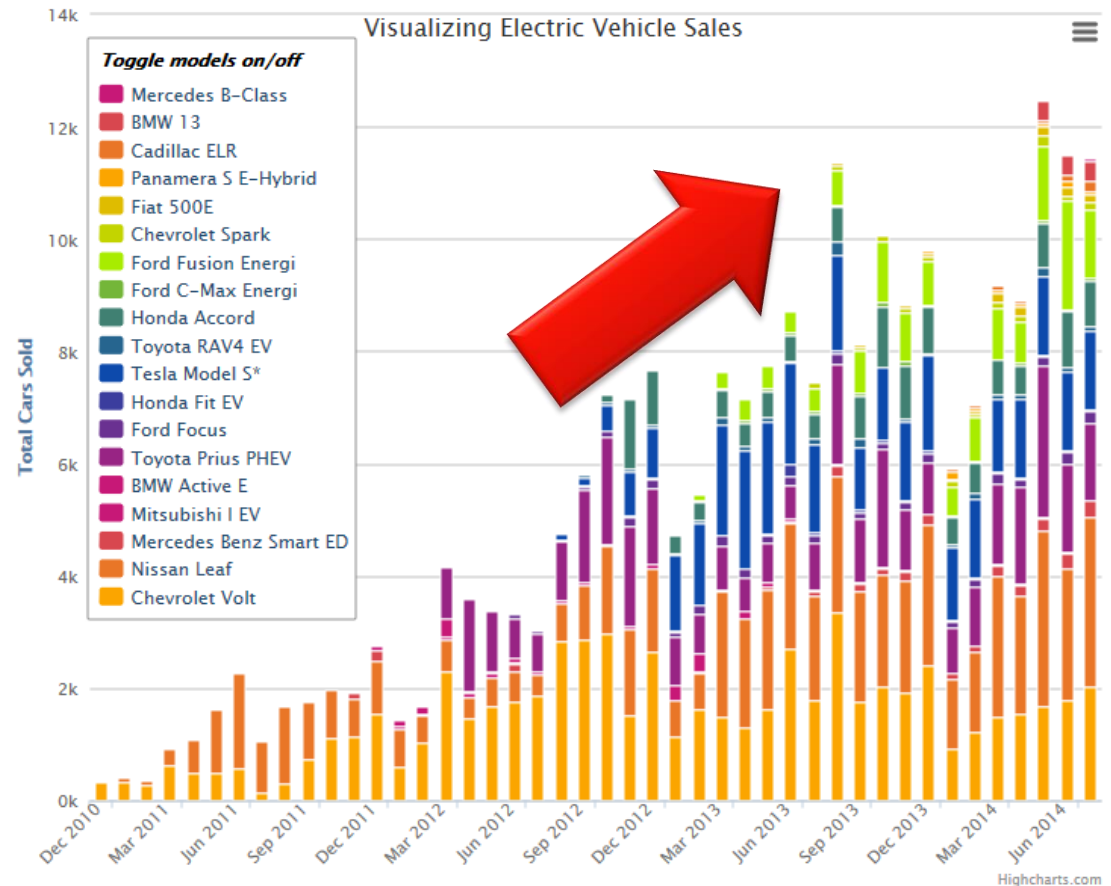
xEV Spectrum:



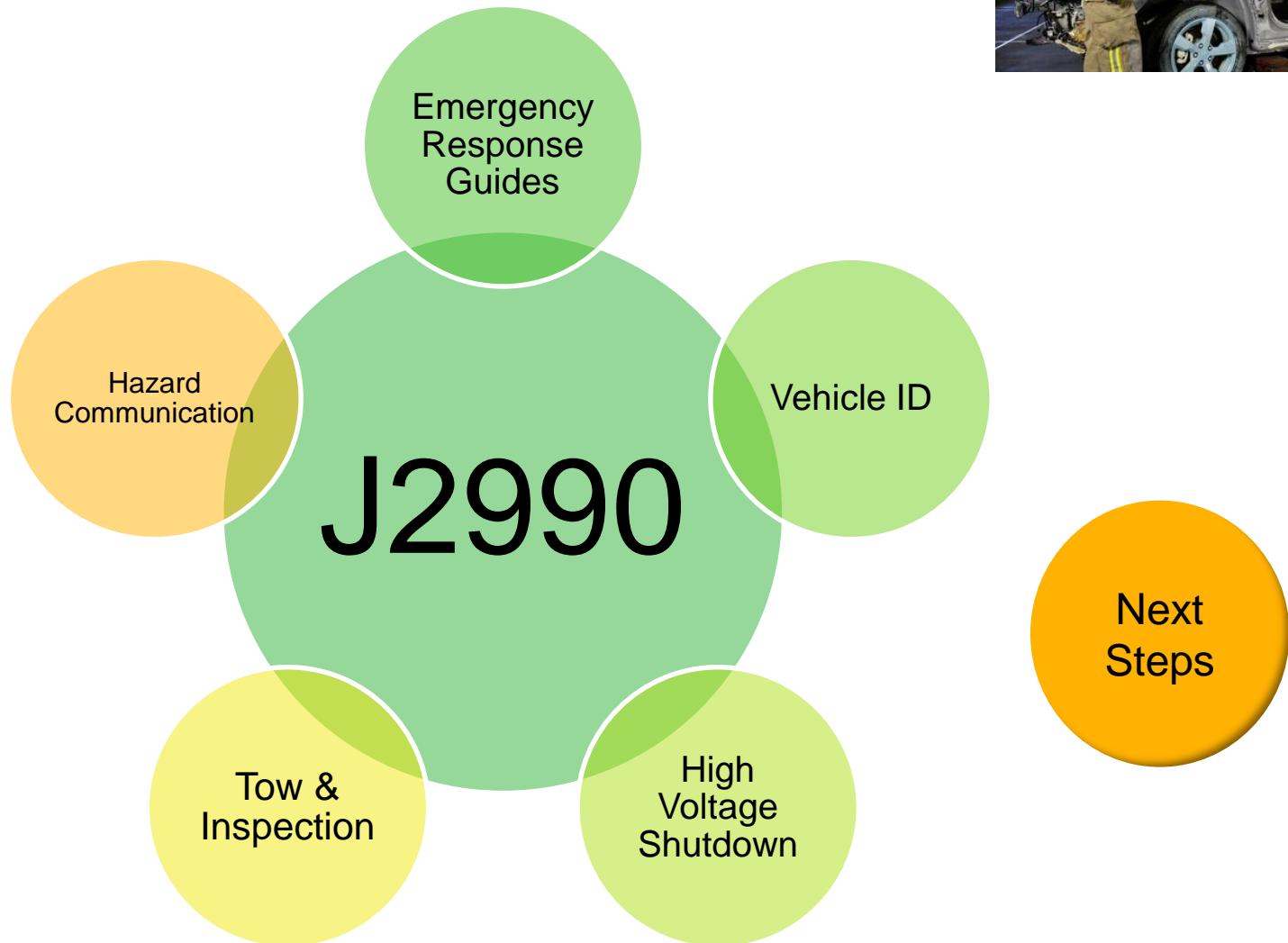


Why J2990?


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




Source: US Department of Energy,
<http://www.energy.gov/articles/visualizing-electric-vehicle-sales>, January 16, 2015



J2990 EMERGENCY RESPONSE GUIDES



2011-13



VEHICLE INFORMATION

IMMOBILIZE VEHICLE

1. Chock the wheels.
2. Set parking brake.
(push/pull switch,
center console)
3. Place vehicle into park.
(center console)

DISABLE VEHICLE

Determine if vehicle is ON by illumination of the instrument displays.

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).

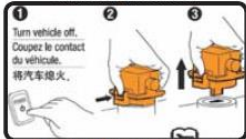
ALTERNATE PROCEDURE 2

If ignition cannot be accessed,

1. Cut the 12V battery red POSITIVE cable at
the cut-tape indicator (behind left rear
panel in rear cargo compartment).
2. Remove manual service disconnect
(located under tray in center console).



Cut through the positive 12V cable on
each side of the tag to remove a section
of the cable to ensure the cables cannot
inadvertently reconnect.



1 Turn vehicle off.
2 Coupez le contact
du véhicule.
3 将汽车熄火。

Manual High Voltage Disconnect
Located Under Center Console

WARNINGS (continued 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 energized electrical fire until power to the charger can be shut down.

EREV

CHEVROLET

VOLT

CHEVROLET



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



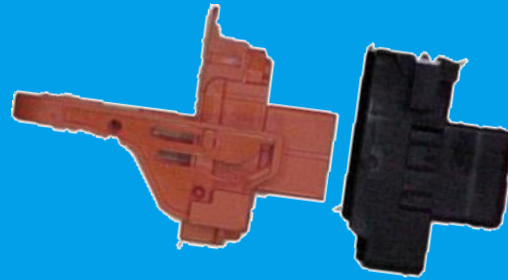


Badging or Marker Should Contain:

- '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

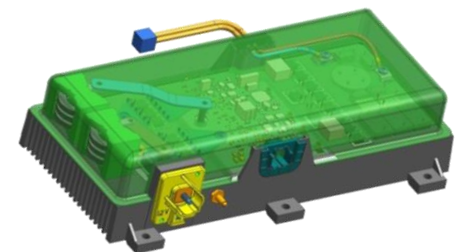


Important Terms:

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.

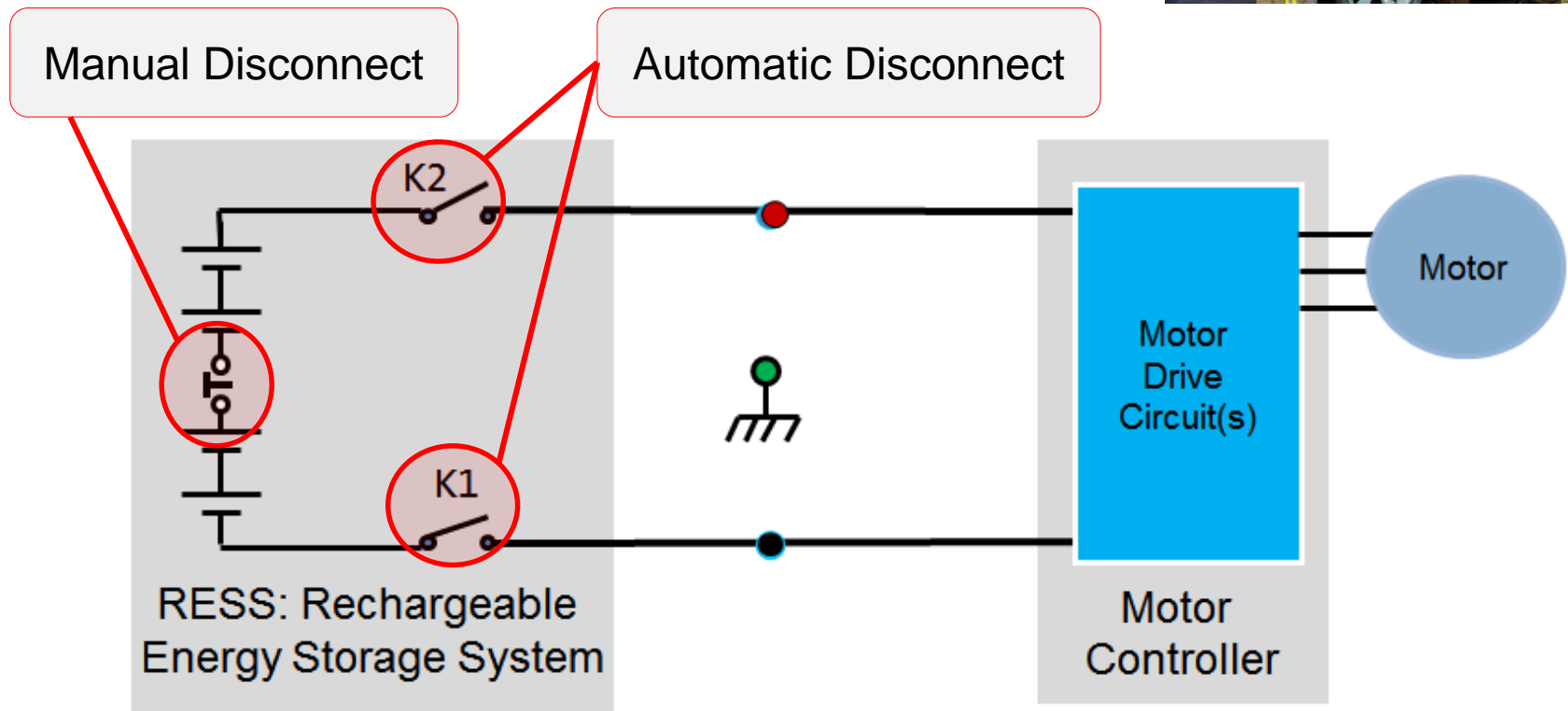
Manual Disconnect (MD): A device in any type of electric vehicle which opens the primary high voltage circuit or circuits of the vehicle, and that is only activated by non-automatic means.

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.





Generic High Voltage System:



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.
2. Switching the vehicle's ignition switch or power button to the OFF position.
3. Cut positive/negative 12V battery and the 12V DC-DC converter cables.
4. Remove the manual disconnect if certain criteria are met (*not recommended*).

< 5 seconds

< 10 minutes

< 10 minutes

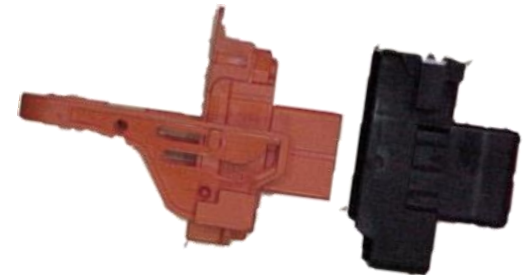
< 10 minutes

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.

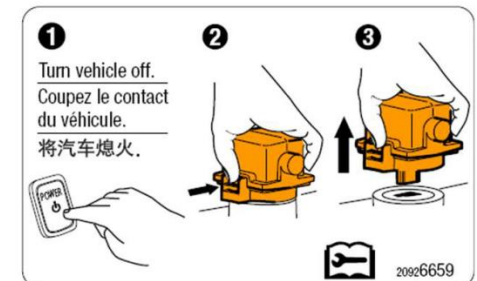




Manual Disconnect Usage:

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



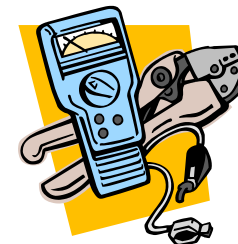
Fire

Leaks

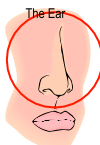
Mechanical
Damage

Vehicle
Diagnostics

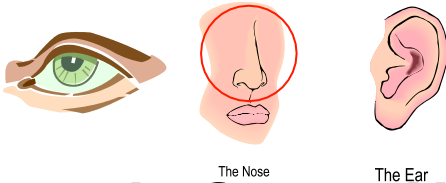
TOOLS



The Ear



The Nose



Look, Smell, Hear...

- Evidence of Fire or Arcing
- Past or Present
 - Flames, Smoke, Residue, Charring



Leaks



The Ear

Look, Hear...

- Evidence of leaks in battery system
- Examples:
 - Puddles under vehicle
 - Low coolant level
 - Bubbling or gurgling sounds





Mechanical Damage



Look...

- Damage to the high voltage system
- Examples:
 - Crushed or pinched orange cables
 - Battery housing damaged
 - Airbag deployment





Diagnostics



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

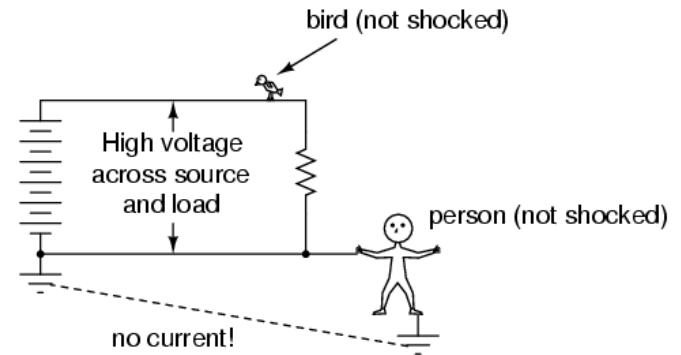
- To be conducted in consultation with OEM or via an authorized service organization
 - OEM to provide procedures and equipment
 - OEM determines safe energy level for the battery system
 - Battery systems are unique and proprietary to OEMs
 - Based on individual incident scenarios and facts obtained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

Information Report:

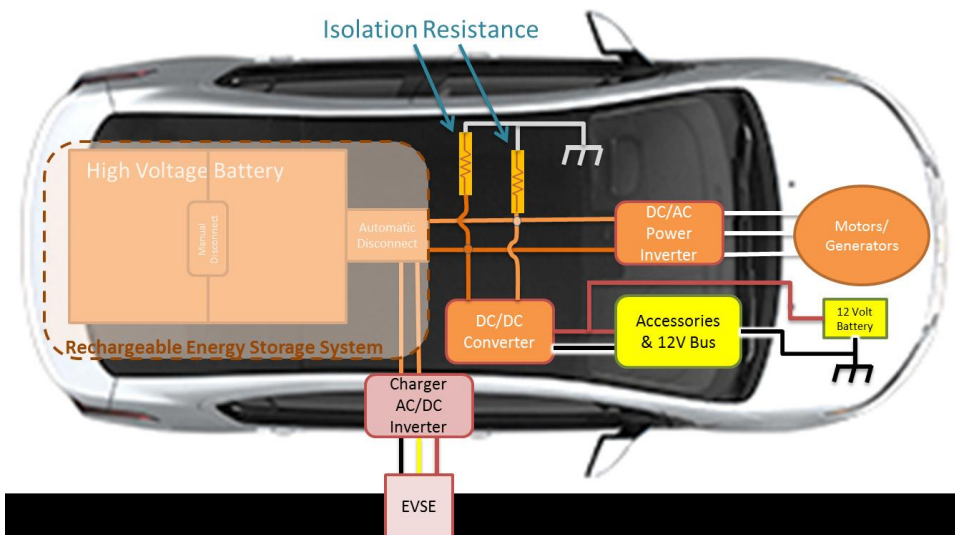
- Describes general safety systems and practices employed by OEM's
- Help assure the general public of the xEV safety
- Explain why these safety systems and practices do help protect against high voltage contact

Topics Covered:

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

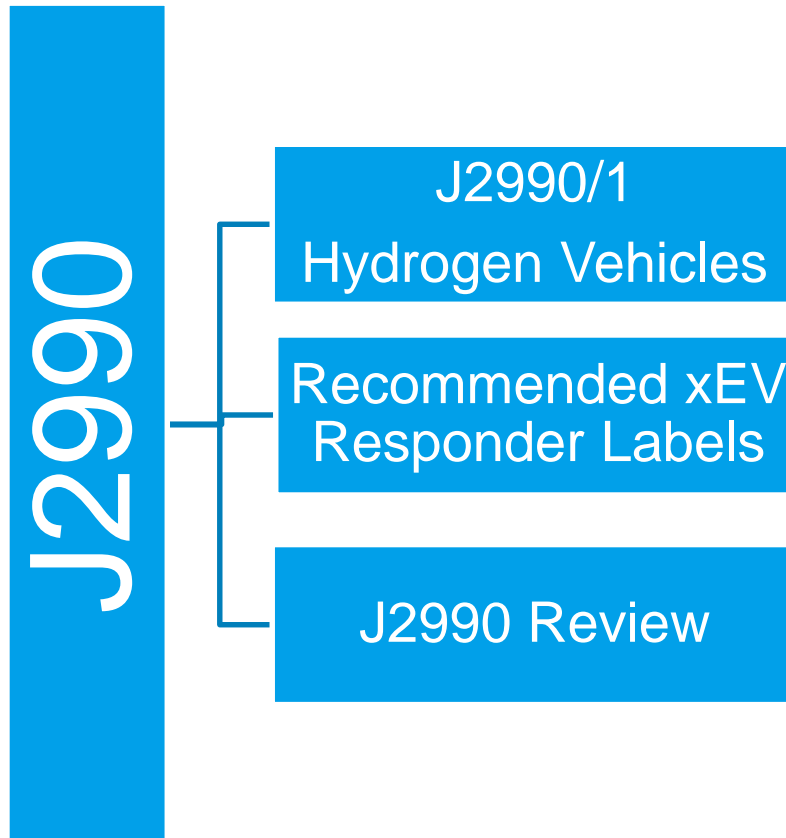


"All About Circuits" <http://www.allaboutcircuits.com>.



Protection Methods Described:

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



Expect to Ballot
Early 2015

New focus for 2015

- Battery location
- Disconnect location

THANK YOU!

Questions?

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