



SURFACE VEHICLE RECOMMENDED PRACTICE

J2990™

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(R) Hybrid and EV First and Second Responder Recommended Practice

RATIONALE

The document is being updated to: (a) capture references to other complimentary standards published since the original publication of this document, (b) improve recommendations based on learnings from real world crash events, (c) add recommendations for submerged vehicles, (d) improve vehicle identification recommendations, and (e) provide high voltage disabling recommendations when electric vehicle supply equipment (EVSE), super capacitors, or solar panels are involved. The existing appendices were not part of the scope of this revision.

INTRODUCTION

Electrified product offerings by automotive manufacturers have brought renewed attention to the post-crash safety of vehicles containing high voltage electrified powertrains. The first generation of regulations associated with the safety of hybrid and electric vehicles (xEVs) was developed in the early 1990s. Regulations and standards were put in place by both national and international regulatory bodies to service the communities and countries where these vehicles were being introduced. Regulations and standards were developed by bodies such as the International Organization for Standardization (ISO), U.S. National Highway Traffic Safety Administration (NHTSA), and the National Fire Prevention Association (NFPA). These initial vehicles were predominantly full battery electric vehicles (BEV), utilizing high voltage and high energy batteries that provided the single primary energy source for propulsion. Experience was gained in using these standards and practices, with the initial vehicles and the first generation of modern xEVs, which followed on approximately 5 years later. Hybrid electric vehicles have retained the high voltage electrical architecture of the BEVs, but utilized compact batteries with more advanced chemistries, while retaining a conventional internal combustion powertrain. This combination of features led to some initial confusion for first and second responders, in how the post-incident vehicle should be handled.

The most recent generation of xEVs has led to a renewed need for information, by first and second responders, in order to ensure their actions maintain the highest level of safety to individuals and the community. There has been a proliferation in the variety of makes, models, powertrain configurations, and electrified energy storage technologies that has come along with this new vehicle generation. A review of the initial recommendations and the future considerations of this standard and other more recent standards has led to an understanding that there is an opportunity to improve these recommendations, so that the first and second responders may apply a more standardized execution, and be more confident in their outcome. This recommended practice provides first and second responders with the ability to identify an xEV, avoid the hazards associated with the high voltage system, communicate hazard identification to other incident responders, and manage the risks in a manner consistent with best practices utilized by first responders, second responders and by the vehicle manufacturers and other responsible organizations.

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FOREWORD

The initial cross-functional task force examined a baseline crash scenario provided by NFPA (see Appendix A) involving a head-on collision on a two-lane road at approximately 45 mph. The assumed vehicles were a mid-sized sport utility vehicle and a mid-size passenger vehicle. The passenger vehicle contained two occupants that needed attention. The task force contrasted the emergency response of a traditional non-xEV passenger vehicle with an xEV passenger vehicle for the same crash scenario. For the xEV scenario, the passenger vehicle was assumed to be an electric vehicle (EV). This analysis was inclusive of the first responders and second responders up to, and including, vehicle salvage.

Several gaps were identified in the analysis of the response scenario for the xEV and are the focus of SAE J2990 recommendations. The gaps identified are:

1. Consistent emergency response guides (ERG) for xEVs.
2. Consistent identification of xEVs at an incident scene.
3. High voltage system disabling practice.
4. Inspection process post-incident to determine if vehicle poses an abnormal safety risk.
5. Tow and recovery protocols post-crash for xEVs.
6. Communication strategy for ERG and hazard information.

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1. SCOPE

xEVs involved in incidents present unique hazards associated with the high voltage system (including the battery system). These hazards can be grouped into three categories: chemical, electrical, and thermal. The potential consequences can vary depending on the size, configuration, and specific battery chemistry. Other incidents may arise from secondary events such as garage fires and floods. These types of incidents are also considered in the recommended practice (RP). This RP aims to describe the potential consequences associated with hazards from xEVs and suggest common procedures to help protect emergency responders, tow and/or recovery, storage, repair, and salvage personnel after an incident has occurred with an electrified vehicle. Industry design standards and tools were studied and where appropriate, suggested for responsible organizations to implement.

Lithium ion (Li-ion) batteries used for vehicle propulsion power are the assumed battery system of this RP. This chemistry is the prevailing technology associated with high voltage vehicle electrification today and the foreseeable future. The hazards associated with Li-ion battery chemistries are addressed in this RP. Other chemistries and alternative propulsion systems including hydrogen fuel cells are not considered in this version of SAE J2990. Recommendations for hazards associated with hydrogen vehicles can be found in SAE J2990/1.

1.1 Purpose

This SAE RP provides guidelines and education to first and second responders of incidents associated with xEVs and high voltage batteries. The RP is not intended to replace an emergency response guide or to be referenced at the scene of an emergency incident. Automotive OEMs are encouraged to reference this RP for industry design guidance when creating vehicle requirements and Emergency Response Guides (ERGs).

This RP is not intended to address battery specific hazards, but rather vehicles which contain aforementioned batteries. The RP does, however, consider batteries that may become separated from a vehicle as a result of a crash event or at storage and repair facilities where responders are involved. SAE J2990/2 provides an overview of a typical xEV and the associated on-board safety systems typically employed by OEMs to protect these high voltage systems.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

NOTE: Users should ensure that the latest revision and legislative updates of these documents is being referenced.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J1715	Hybrid Electric Vehicle (HEV) and Electric Vehicle (EV) Terminology
SAE J1766	Recommended Practice for Electric, Fuel Cell, and Hybrid Electric Vehicle Crash Integrity Testing
SAE J2830	Process for Comprehension Testing of in-Vehicle Symbols
SAE J2990/1	Gaseous Hydrogen and Fuel Cell Vehicle First and Second Responder Recommended Practice
SAE J2990/2	Hybrid and Electric Vehicle Safety Systems Information Report
SAE J3108	xEV Labels to Assist First and Second Responders, and Others

2.1.2 FMVSS Publications

Available from the Superintendent of Documents, U.S. Government Printing Office, Mail Stop: SSOP, Washington, DC 20402-9320, <https://www.govinfo.gov/app/collection/cfr/>.

FMVSS 208 Occupant Crash Protection

FMVSS 305 Electric Powered Vehicles: Electrolyte Spillage and Electrical Shock Protection

2.1.3 ISO Publications

Available from International Organization for Standardization, ISO Central Secretariat, 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland, Tel: +41 22 749 01 11, www.iso.org.

ISO 9186-1 Graphical Symbols - Test Methods - Part 1: Methods for Testing Comprehensibility

ISO 17840-1 Road Vehicles - Information for First and Second Responders - Part 1: Rescue Sheet for Passenger Cars and Light Commercial Vehicles

ISO 17840-3 Road Vehicles - Information for First and Second Responders - Part 3: Emergency Response Guide Template

ISO 17840-4 Road Vehicles - Information for First and Second Responders - Part 4: Propulsion Energy Identification

2.1.4 U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration Publications

Available from Hazardous Materials Training Program, 1200 New Jersey Avenue, SE, Washington, DC 20590, United States. Tel: 202-366-4900, <https://www.phmsa.dot.gov/hazmat/erg/emergency-response-guidebook-erg>.

2016 Emergency Response Guidebook, "A Guidebook for First Responders During Initial Phase of a Dangerous Goods/Hazardous Materials Transportation Incident."

2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

2.2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J1142 Towability Design Criteria and Equipment Use - Passenger Cars, Vans, and Light-Duty Trucks

SAE J2069 Recovery Attachment Points for Passenger Cars, Vans, and Light Trucks

SAE J2344 Guidelines for Electric Vehicle Safety

SAE J2464 Electric and Hybrid Electric Vehicle Rechargeable Energy Storage System (RESS) Safety and Abuse Testing

SAE J2929 Safety Standard for Electric and Hybrid Vehicle Propulsion Battery Systems Utilizing Lithium-Based Rechargeable Cells

SAE J2950 Recommended Practices (RP) for Shipping Transport and Handling of Automotive-Type Battery System - Lithium Ion

2.2.2 National Fire Protection Agency Publications

Available from NFPA, 1 Batterymarch Park, Quincy, MA 02169-7471, Tel: 617-770-3000, www.nfpa.org.

Electric Vehicle Emergency Field Guide (2012)

U.S. Vehicle Fire Trends and Patterns (2010)

NFPA 52 Vehicular Gaseous Fuel Systems Code

NFPA 70 National Electric Code

NFPA 704 Identification of Materials by Hazard Rating System

NFPA 1971 Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting

2.2.3 U.S. Government Publications

Copies of these documents are available online at <https://quicksearch.dla.mil>.

National Highway Traffic Safety Administration. (2009) TRAFFIC SAFETY FACTS 2009: A Compilation of Motor Vehicle Crash Data from the Fatality Analysis Reporting System and the General Estimates System.

United States Census Bureau. (2012) Statistical Abstract of the United States: 2012.

DOT HS 811 574 Interim Guidance for Electric and Hybrid Electric Vehicles Equipped with High Voltage Batteries

2.2.4 FIA Publications

Available from FIA Foundation for the Automobile and Society, 60 Trafalgar Square, London, WC2N 5DS, Tel: 44 (0) 207 930 3882, <http://www.rescuesheet.info/index.html>.

The On-Board Rescue Sheet: Helping the Rescuers (2010)

2.2.5 Jones and Bartlett Publications

Available from Jones and Bartlett Learning, 5 Wall Street, Burlington, MA 01803, Tel: (800) 832-0034, www.jblearning.com.

Fundamentals of Firefighter Skills

3. DEFINITIONS

Except as noted below, all definitions are in accordance with SAE J1715.

Additional definitions:

3.1 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.

3.2 BADGING

Describes a durable emblem, insignia, or label securely affixed on the exterior surface of the xEV.

3.3 CURRENT INTERRUPT DEVICE

A device designed to interrupt the flow of electrical current during abusive conditions. Examples include circuit breaker, fuse, thermal cut-off, etc.

3.4 DIAGNOSTIC TROUBLE CODE

Information provided by an on-board diagnostic system for operators and repair technicians.

3.5 DRAIN DOWN TIME (12 V)

Refers to the discharge time for any reserve energy within the airbag/SRS system. It is the time it takes the airbag/SRS system to become inert after powering down the low voltage system by shutting off a vehicle's ignition and disconnecting the 12 V (auxiliary) battery. See also 3.13.

3.6 FIRE

The emission of flames from a battery (approximately more than 1 second). Sparks are not flames.

3.7 ELECTRICAL PPE

See 3.24.

3.8 EMERGENCY FIELD GUIDE

A quick reference guide summarizing multiple OEM Emergency Response Guide information for easy access in the field.

3.9 EMERGENCY RESPONSE GUIDE

Summary of steps to perform in emergency situations involving a vehicle or hazardous materials.

NOTE: There is a hazardous materials ERG independent of ERGs produced by automotive OEMs.

3.10 FIRST RESPONDERS

Includes, but is not limited to, fire department, rescue squads, emergency medical, law enforcement, and, in some instances, military, where the personnel are trained in assessing and treating injuries.

3.11 GVWR

Gross vehicle weight rating.

3.12 HAZARDOUS MATERIALS

Goods that can harm persons, property, or environment and specified by law for identification, packaging for transport, use, storage, and/or disposal (also known as hazmat or dangerous goods).

3.13 HIGH VOLTAGE DRAIN DOWN TIME

Refers to the discharge time for any reserve energy within segments of the vehicle high voltage system. It is the time it takes a segment of the high voltage system to fall below the level of high voltage after sources of high voltage energy are disconnected from the system. See also 3.5.

3.14 HIGH VOLTAGE SYSTEM

A vehicle system inclusive of the battery system and high voltage components (e.g., inverter modules, high voltage cables, etc.) powered by the battery system.

3.15 LEAKAGE

The visible escape of electrolyte or other liquids from a cell or battery system (derived from SAE J2950).

3.16 LI-ION

Lithium-ion battery or cell.

3.17 MANUAL DISCONNECT

Manual disconnect (MD) is 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.

3.18 MARKER

Describes a durable emblem, insignia, or label securely affixed on an interior surface within the passenger compartment of the xEV.

3.19 MOBILE APPLICATION

Software that runs on a smart phone, mobile phone, tablet, or portable device. Also referred to as mobile apps.

3.20 MOBILE DATA TERMINAL

Mobile electronic device such as a laptop or tablet computer mounted in emergency responder vehicle such as a fire apparatus, ambulance, truck, or patrol car.

3.21 NATFC

National Alternative Fuels Training Consortium.

3.22 NiMH

Nickel metal hydride battery or cell.

3.23 ON-BOARD DIAGNOSTICS

Refers to a vehicle's self-diagnostic and reporting system.

3.24 PERSONAL PROTECTIVE EQUIPMENT

Any of various safety equipment that workers wear or use to prevent injury when working around hazards, such as high voltage electrical energy, chemicals, and/or fire.

3.25 RESPONSIBLE ORGANIZATION

The organization which is responsible for providing emergency response information. Examples are vehicle, battery system manufacturers, or third party suppliers of aftermarket conversion(s) including do-it-yourself conversions.

3.26 RUPTURE

The mechanical failure of a cell container or battery case induced by an internal or external cause, resulting in exposure or spillage, but not ejection of solid materials.

3.27 SDS

Safety data sheet.

3.28 SECONSD RESPONDERS

Include but not limited to tow/recovery personnel, vehicle storage operators, repair/service technicians, dismantlers, and auto salvage personnel.

3.29 SMARTPHONE

A cellular telephone with built-in applications and Internet access. In addition to digital voice service, modern smartphones provide text messaging, e-mail, web browsing, still and video cameras, MP3 player, video playback, and calling. In addition to their built-in functions, smartphones run myriad free and paid applications, turning the once single-minded cellphone into a mobile personal computer.

(From PC Magazine Encyclopedia, http://www.pcmag.com/encyclopedia_term/0,2542,t=Smartphone&i=51537,00.asp.)

3.30 SUBJECT MATTER EXPERTS

An individual who is experienced in a specific area or topic and offers in depth knowledge.

3.31 SRS

Supplementary restraint system (SRS) is the passive vehicle occupant safety systems in a vehicle (e.g., airbags) which supplement the use of seat belts.

3.32 TELEMATICS

Technology of sending and receiving information via telecommunication devices in vehicles.

3.33 VENTING

The release of excessive internal pressure from a battery system cell, module, or pack in a manner intended by design to preclude rupture or explosion.

3.34 xEV

Any electrified propulsion vehicle with a high voltage system, including, but not limited to, HEV, PHEV, PEV, BEV, FCV, and EV (refer to SAE J1715 for acronyms).

3.35 TERMINOLOGY

The following shall apply to the use of these words:

3.35.1 SHALL

"Shall" is to be used wherever the criterion for conformance with the specific recommendation requires that there be no deviation. Its use shall not be avoided, on the grounds that compliance with the SAE Technical Report is considered voluntary.

3.35.2 SHOULD

"Should" is to be used wherever noncompliance with the specific recommendation is permissible. "Should" shall not be substituted for "shall," on the grounds that compliance with the SAE Technical Report is considered voluntary.

4. RECOMMENDATIONS FOR XEV EMERGENCY RESPONSE GUIDES (ERG)

4.1 ERG Background

Manufacturer provided information and guidance to first and second responders varies greatly between manufacturers and often not used in the field due to complexity. A summary of issues and known alternatives are captured in Appendix B.

4.2 ERG Summary

There are many existing methods of communicating emergency hazards to responders, including OEM manuals, rescue cards or sheets, emergency field guides, mobile applications, and database systems. These multiple solutions bring unique attributes but lacked global consistency in format and content for the responder communities.

Recently, ISO has published several standards to assist in providing consistency in format and content of emergency response information. ISO 17840 parts 1, 3, and 4 provide standardized methods to document necessary information to first and second responders. A description of the applicable parts of ISO 17840 are described in the following paragraphs.

Part 1: Rescue Sheet for Passenger Cars and Light Commercial Vehicles. This standard provides for quick reference rescue sheets by providing a standardized template layout and includes standardized color codes and standardized pictograms.

Part 3: Emergency Response Guide Template. This standard provides a template for emergency response guides, standardizing chapter headings, chapter sequences, color codes and pictograms. The ERG and rescue sheet headings are aligned with each other, i.e., the ERG information works as a direct extension of the related rescue sheet providing much more detail for the responders.

Part 4: Propulsion Energy Identification. This standard defines the labels and related colors for indication of the fuel and/or energy used for the propulsion of a road vehicle, including hybrid propulsion systems.

OEM manuals cover many of the necessary areas required for responders, but they vary in style and content from manufacturer to manufacturer. The text is often written from an engineering and technical mindset, rather than from a responder's point of view.

The NFPA Emergency Field Guide (EFG) (see Appendix K) provides a quick reference resource summarizing OEM information concerning suppression, submersion, damaged HV battery hazards, etc.

Rescue cards and emergency field guides attempt to summarize the essential information from OEM manuals. ISO 17840-1 provides a standardized method for providing the necessary information for first and second responders on rescue cards.

Mobile apps, while convenient and sometimes free, are too limited in scope (not enough vehicles, not updated frequently enough, lacking vehicle-specific disabling procedures) to be of much use at this time, but the concept of a free or very inexpensive mobile app needs to be considered.

Some commercially available apps and software currently cost hundreds or thousands of dollars (U.S.). The cost for such information should be minimal, as many departments, especially rural and volunteer fire departments, simply do not have the funds to purchase expensive systems.

4.2.1 Examples of Responder Guides and Rescue Information

- NFPA Emergency Field Guide that can be downloaded/ordered from NFPA website.
- OEM websites:
 - QR codes placed on a vehicle may provide a connection to the rescue sheets on the manufactures database when scanned.
- Commercial platforms (e.g. Moditech) are available to purchase.
- Smartphone applications.

4.3 ERG Recommendations

Emergency response information needs to be summarized efficiently and be specifically tailored to first and second responders in the field. Below are specific recommendations to facilitate this goal.

4.3.1 Quick Reference Sheets

OEMs should create quick reference sheets following the requirements of ISO 17840 part 1. This provides a standard method to quickly provide essential information to the responders on the scene. The normative standardized first page with normative standardized symbols contains a top and side views representative of the vehicle (see Appendix J). The additional pages shall provide condensed information and shall align with the headings of ISO 17840-Part 3. The additional pages of the rescue sheet shall minimize text with the use of normative standardized symbols and clear pictures or drawings.

4.3.2 Emergency Response Guides

OEMs creating Emergency Response Guides should follow the templated format described in ISO 17841-Part 3. This ISO standard has been created under the lead of CTIF (International Organization of Fire and Rescue Services who represent 40 countries amongst NFPA USA) together with manufactures, regulators, organizations, and other responders.

This ISO 17840 part 3 standard provides for:

- Normative Standardized chapter headings.
- Normative Standardized sequence of chapters.
- Normative Color codes to identify each chapter.
- Normative Standardized symbols.

The ERG should contain crucial and in-depth information linked to the quick reference sheet. The headings/contents of the ERG and the quick reference sheet information are aligned with each other, i.e., the ERG information works as a direct extension of the related quick reference sheet.

The ERG template follows in principle a flowchart for the main actions of the first and second responders arriving at an accident scene or performing towing and other activities afterwards. The ERG template provides a format for filling in the following (necessary and useful) emergency information:

- Relevant information for a vehicle involved in a traffic accident (including immobilization, disabling of hazards, access to occupants, shut off procedures, handling of stored propulsion energy).
- Information in case of fire or submersion.
- Information regarding towing, transportation, and storage.

4.3.3 Consultation with Responders

First and second responders should be consulted to ensure OEM recommendations are useable. (For example, terminology should be catered to first responders, not technicians.)

5. RECOMMENDATIONS FOR XEV IDENTIFICATION

xEVs involved in incidents such as mechanical breakdowns, collisions, and vehicle fire scenarios can present new hazards associated with the stored energy in the vehicle's high voltage system. These hazards include potential injuries from chemical, electrical, and thermal exposure to members of the emergency responder community. Other incidents such as garage structure fires and flooding/water submersion may also present risks to these responders when an xEV is involved.

A standardized xEV identification methodology is necessary to help protect first and second responders including fire, rescue, emergency medical, law enforcement, tow and/or recovery, storage, repair, and salvage personnel during and after an incident of an xEV.

5.1 xEV Identification Background

During the development of the identification of xEV recommendations, there was significant amount of information studied. This supporting information is included under the appendix sections of this document. These appendices include:

APPENDIX A - BASELINE SCENARIO VALIDATION

This document analyzes crash statistics for vehicles and the baseline crash scenario which identified gaps for responders when an xEV was involved. This analysis was part of the original version of SAE J2990, published in 2012.

APPENDIX C - FIRST RESPONDER ACTIVITIES AT HYBRID AND ELECTRIC VEHICLE COLLISION EVENTS

This document serves to list typical first responder activities at hybrid and electric vehicle collision events. The information is based on a realistic timeline from initial summoning of these responders through their arrival and subsequent activities at a collision incident involving a hybrid or electric plug-in vehicle.

APPENDIX D - FIRST RESPONDER ACTIVITIES AT HYBRID AND ELECTRIC VEHICLE FIRE EVENTS

This document serves to list typical first responder activities at hybrid and electric vehicle fire-related events. The information is based on a realistic timeline from initial summoning of responders through their arrival and subsequent activities at the vehicle fire incident.

APPENDIX E - FIRST RESPONDER ACTIVITIES AT HYBRID AND ELECTRIC VEHICLE SUBMERSION EVENTS

This document lists typical first responder activities at hybrid and electric vehicle events when the vehicle is partially or fully submersed in water. This may involve still or moving body of water such as a pond, lake, or river as well as a vehicle caught in a flash flooding situation.

APPENDIX F - CURRENT STATUS OF EXTERIOR BADGING (2012)

This document lists some of the 2012 model year exterior badging names used by electric and hybrid passenger vehicles.

APPENDIX G - EXISTING EXTERIOR BADGING SIZE SUMMARY

This document summarizes sizes of existing rear badging of 82 vehicles and was used to justify the recommended height for the exterior badging of xEVs.

APPENDIX H - EXAMPLES OF EXISTING HYBRID AND ELECTRIC VEHICLE IDENTIFICATION SYSTEMS

This document provides some examples of hybrid and electric vehicle identification systems reviewed by the task force.

APPENDIX I - EXAMPLES OF 2012 BADGING COMPLIANT WITH EXTERIOR BADGING RECOMMENDATIONS

This document presents several visual examples of existing 2012 badging that would be considered compliant with the recommendations for exterior badging specifications.

APPENDIX M - CONSIDERATION OF COLORED AIR BAGS FOR IDENTIFYING xEV

The task force had several meetings reviewing the concept of colored airbags as an aide to responders to identify xEVs in a crash event. A summary of this discussion is included in Appendix M.

5.2 xEV Identification Summary

xEV identification is necessary to provide first and second responders with information to clearly, accurately, and reliably determine that a given vehicle encountered at an incident (collision, fire, water submersion, etc.) contains a high voltage system. Furthermore, the identification should be standardized, consistent, and reliable on exterior and/or interior locations on a passenger vehicle under 10000 pounds (4536 kg) GVWR where manufacturers will visually identify that a given vehicle is an xEV.

Finally, the identification should be clearly recognizable as an xEV badge by an approaching responder from a distance of 50 feet. When first responders arrive at a highway incident, they size up the vehicle as they approach the scene. This scan of the scene for clues is done from a moving vehicle, and having the lettering of a size to be read from 50 feet (15 m) allows for this to be visible without having to be in a close proximity to the vehicle. Specifically, for firefighters responding to a vehicle fire, a standard length of hose is 50 feet (15 m), and that is a common distance firefighters and fire apparatus stage from a burning vehicle while preparing to advance and suppress the fire. From "Fundamentals of Firefighter Skills" (Jones and Bartlett, page 638) it states, "Using the reach of the 1-3/4 inch hose, start approximately 50 feet from the car..." Utilizing this standard will allow for this information to be readily available to any responder approaching the scene, and not rely on it having to be restated by those who arrived earlier. NFPA 704, chapter 9, "Identification of Materials by Hazard Rating System," specifies a 1 inch text height to legibly identify a hazard from a distance of 50 feet (15.2 m). This text height also appears to be a common height utilized today by OEMs in rear badging (see Appendix G). For these reasons, a 1 inch (25 mm) exterior badge height is expected, in most cases, to provide adequate information to a first or second responder approaching the vehicle. (Note: While NFPA 704 standard supported the derivation of the 1 inch character height, no other requirements from that document are implied to be required to comply with SAE J2990.)

5.3 xEV Identification Recommendations

The initial and most important means of identifying that a vehicle contains high voltage systems for first or second responders arriving at an incident should be through the use of compliant hybrid or electric vehicle badges placed at standardized and consistent locations on the exterior of the xEV.

Manufacturers should identify the presence of an xEV in one of two methods:

1. A minimum of three badges identifying the vehicle as an xEV shall be placed at standardized and consistent exterior locations on the vehicle, or
2. A minimum of one exterior vehicle badge shall be placed in a prescribed exterior, rear location on the xEV and a minimum of one additional interior hybrid or electric vehicle marker shall be located in prescribed locations within the passenger compartment of the xEV.

5.3.1 Exterior Badging Locations

When the manufacturer desires to utilize three exterior xEV badges, these three locations shall include:

1. One compliant xEV badge at an exterior location on the rear surface, preferably right side, of the vehicle, such as the trunk, hatchback, or liftgate, but not on the bumper, so as to be clearly visible upon approach to the rear of the xEV. Note that the right rear location was chosen to provide first responders one consistent location for training, unlike other locations, where placement is more flexible to suit OEM marketing needs and desires.

AND

2. Two compliant xEV exterior badges, one on each side of the vehicle. One on the left side and one on the right side of the vehicle such as the front fender, front door panel, or roof pillar trim, that allows the xEV badging to be clearly seen upon approaching either the left or right side of the xEV.

Additional xEV exterior badging is acceptable on the front surface of the vehicle as well as at additional exterior locations as desired by the OEM.

5.3.2 Exterior Badging Design

Parameters for the visual content of the exterior badging are defined, taking into account the needs of OEMs to effectively and creatively market their vehicles to the consumer as well as conformity and consistency in communicating the presence of an xEV to both first and second responders.

For exterior badging to consistently and reliably deliver its safety-oriented message to first and second responders, all required xEV exterior badging should clearly contain in its design one of the following:

1. The word “HYBRID,”
2. The word “ELECTRIC,” or
3. The letters “EV.”

Combinations of words and letters with items listed above are allowed. For example: “PLUG-IN HYBRID,” “PHEV,” “BEV” as exterior badging design elements would comply with the above recommendation.

The exterior badging system height should be a minimum 1 inch (25 mm) tall (per NFPA 704, chapter 9), and may incorporate colors, designs, fonts, or shapes as desired by the OEM. For vehicles where xEV badging height is less than 1 inch, the badging should be no smaller than the largest letters used in other exterior vehicle identification.

- 5.3.2.1 In lieu of the above designs, an OEM desiring to identify the exterior of their xEV for first and second responders may use a unique symbol, word, or name plate as their exterior badging. Unique name plates are permitted as long as vehicle name is not used on any other vehicle with a propulsion system that is not an xEV. Examples of unique vehicle names currently used include Chevrolet “Volt” and Nissan “Leaf.” Prior to use of a unique xEV exterior badging, the OEM should validate the first and second responder community’s human factors comprehension of said unique xEV name plate or badging as indicating a hybrid or electric vehicle as per SAE J2830 or ISO 9186-1. Unique xEV nameplates shall be on the rear of the vehicle as specified in 5.3.1; however, the unique nameplate should not be restricted to the right rear location.

The unique xEV nameplate or exterior badging design height should be a minimum 1 inch (25 mm) tall and may incorporate colors, designs, fonts, or shapes as desired by the OEM. For vehicles where xEV badging height is less than 1 inch, the badging should be no smaller than the largest letters used in other exterior vehicle identification.

- 5.3.2.2 The letter “E” preceding or proceeding a vehicle’s name may be acceptable to designate that vehicle as electric version of that model. The letter may be upper or lower case. The letter shall not be combined with any other letters except the model name.
- 5.3.2.3 The letter “H” preceding or proceeding a vehicle’s name may be acceptable to designate that vehicle as a hybrid version of that model. The letter may be upper or lower case. The letter shall not be combined with any other letters except the model name.

5.3.3 Interior Passenger Compartment Marker Locations

It is recommended that in the case when only one exterior xEV badging is provided, an interior xEV marker is also required. First responders are trained to recognize the importance of turning OFF the ignition system of any vehicle involved in a collision or other unplanned event. Therefore, the interior marker on the xEV should be a durable emblem or insignia securely affixed at a location visible from the driver or passenger window near the key ignition switch or the Start or power button on the instrument panel, console, or steering column. This interior marker should be as readily identifiable both when the vehicle is powered ON and when the vehicle is powered OFF.

An alternate location for the required interior xEV marker is on one side/surface of the driver’s sun visor if said location allows conformance with applicable FMVSS 208 standard or similar regulations.

5.3.4 Interior Marker Design

In order for the interior xEV marker system to consistently and reliably deliver its safety-oriented message to first and second responders, it is recommended that all required xEV interior markers clearly contain in its design one of the following examples:

1. The word “HYBRID,”
2. The word “ELECTRIC,” or
3. The letters “EV.”

Combinations of words and letters with items listed above are allowed. For example: “PLUG-IN HYBRID,” “PHEV,” “BEV” as components of an xEV interior marker would comply with the above recommendation.

Words or letters utilized in the design of the interior marker should be a minimum height of the largest letter on the instrument panel, console, or steering column where marker is located and may incorporate colors, designs, fonts, or shapes as desired by the OEM.

In lieu of use of the above designs, an OEM desiring to identify the interior of their xEV for first and second responders may utilize a unique symbol, word, or name plate as their interior marker. Unique name plates are permitted so long as said vehicle name is not utilized on any other vehicle with a propulsion system that is not an xEV type of system. Examples of unique vehicle names currently used include Chevrolet “Volt” and Nissan “Leaf.” Prior to use of a unique xEV name plate as the interior marker, the OEM should validate the first and second responder community’s human factors comprehension of said unique xEV name plate and marker as indicating a hybrid or electric vehicle as per SAE J2830 or ISO 9186-1.

An example of an interior marker design that could be considered would be an ISO icon triangle with lightning bolt on a yellow background as shown in Figure 1.



Figure 1 - High voltage symbol

5.4 Alternative Background Color Identification

A recent trend has been noted in vehicle badging for alternative vehicles that deserves highlighting as a good practice in the industry. Several OEMs are adding a color background to their alternative fueled vehicles to differentiate the vehicle from the standard ICE versions, but there are also other incidents where OEMs are adding background colors to their badging for other reasons not related to electrification. Most notably, Toyota has colored their badging with a blue background for their hybrid, electric, and fuel cell vehicles (Figure 2). GM has applied a blue background to its badging for “eco” vehicles (Figures 2 and 3). For GM, the “eco” badging highlights vehicles with high fuel economy, including alternative fueled vehicles, but also non-electrified vehicles, such as turbo diesel. Other OEMs have used background colors such as red to indicate high performance vehicles. Due to the varying use of the color backgrounds, we do not recommend this as a standard practice, but would encourage future development of standard badging background color codes for identifying or differentiating propulsion systems.



Figure 2 - Blue background indicating xEV



Figure 3 - Blue background indicating "eco" vehicle

5.5 Special Considerations for Camouflaged/Prototype Vehicles

In the development process for vehicle manufacturers, it is often necessary to test vehicles on public roads prior to the vehicles being announced or released to the public. Typically, these vehicles are camouflaged to hide their identities and design features from the public. This may raise issues for responders if one of these vehicles is an xEV and involved in an incident without exterior badging. Responders indicated that when they encounter a camouflaged vehicle, they already are aware that this vehicle is still under development and extra precaution is needed. That said, there are a few recommendations that would assist responders in identifying camouflaged xEVs.

1. The use of the ISO high voltage symbol (Figure 1) on the vehicle is an acceptable method to communicate to the responders that the vehicle is an xEV without letting the public know too many details of the electrification architecture of the vehicle. Multiple locations are recommended for this symbol (back and sides of the vehicle).
2. Use of a QR code linking to emergency responder guides and rescue sheets on the dash or windows with a red fire helmet symbol (refer to SAE J3108) would alert responders and allow them to scan information relevant to the vehicle. Training of the responder community about locations and use of these QR systems would be recommended when applied to these advanced vehicles.
3. Having a copy of the particular vehicle's rescue sheet readily available and visible in the driver compartment is another acceptable method. Responders would be able to locate this as they approach the vehicle and assess the occupancy of the vehicle. Drivers of these vehicles should be trained on the locations of these sheets and instruct responders of their availability. For this case, it is recommended a decal be placed on the rear of the vehicle and sides of the vehicle indicating the presence of the rescue sheets in the vehicle. See Figure 4 for an example of such image.



Figure 4 - Example window decal for responders

6. RECOMMENDATIONS FOR XEV HIGH VOLTAGE (HV) SYSTEM DISABLING

6.1 HV System Disabling Background

In order to achieve energy efficiency goals, xEVs frequently have multiple components that need high voltage power during normal operation. These components are generally distributed around the vehicle based on various design constraints, such as their required interactions with other systems or devices.

For xEVs involved in an impact or some other form of incident, it is desirable to have methods of limiting the number of components containing high voltage. This would serve to reduce the probability that a first responder or other person is inadvertently exposed to high voltage while simultaneously reducing the probability that high voltage might induce secondary events after the initial incident.

6.2 HV System Disabling Summary

This section describes multiple methods that vehicle designers can incorporate into xEVs to allow automatic or manual disabling of the high voltage systems after a vehicle impact or other vehicle incident. Because of the possibility of the impact causing damage to some of the disabling circuits, it is recommended that designers incorporate two or more of these methods into the design of an xEV.

It should be noted that these methods generally do not completely remove high voltage from the vehicle. The intent of performing these HV shutdown procedures is not to eliminate HV but rather to limit its distribution around a vehicle.

6.3 HV System Disabling Recommendations

6.3.1 HV System Design Considerations for First Responder

Vehicle OEMs should provide a minimum of two methods of initiating the disconnection of the propulsion system from high voltage sources on xEVs. Responders should realize that these methods are only intended to cover the disconnection of high voltage; they may or may not simultaneously remove the vehicle's 12 V, 12 V components, or other non-high voltages from the vehicle. Also consider that as these other vehicle systems are simultaneously disconnected or de-energized, these other systems may not be disconnected or de-energized in the timeframe given below for the high voltage components.

To comply with this recommendation for high voltage disconnection, the following methods of initiating the disconnection are allowed (listed in order of preferred sequence):

1. Automatic shutdown of the high voltage system based on the detection of a prescribed level of vehicle impact that might damage the high voltage system or that activates the vehicle's SRS. Assuming no damage to the shutdown circuits, this method should disconnect the high voltage system and discharge the propulsion side of the automatic disconnect to less than or equal to 60 V for DC buses or 30 V for AC buses within the time period recommended by SAE J1766, 4.4.3.1.
2. Switching the xEVs ignition switch or power button to the OFF position and assuming no damage to the shutdown circuits or high voltage discharge circuits. This method should disconnect the high voltage system from the high voltage sources and discharge the high voltage system to less than or equal to 60 V for DC buses or 30 V for AC buses within 10 minutes of being initiated.