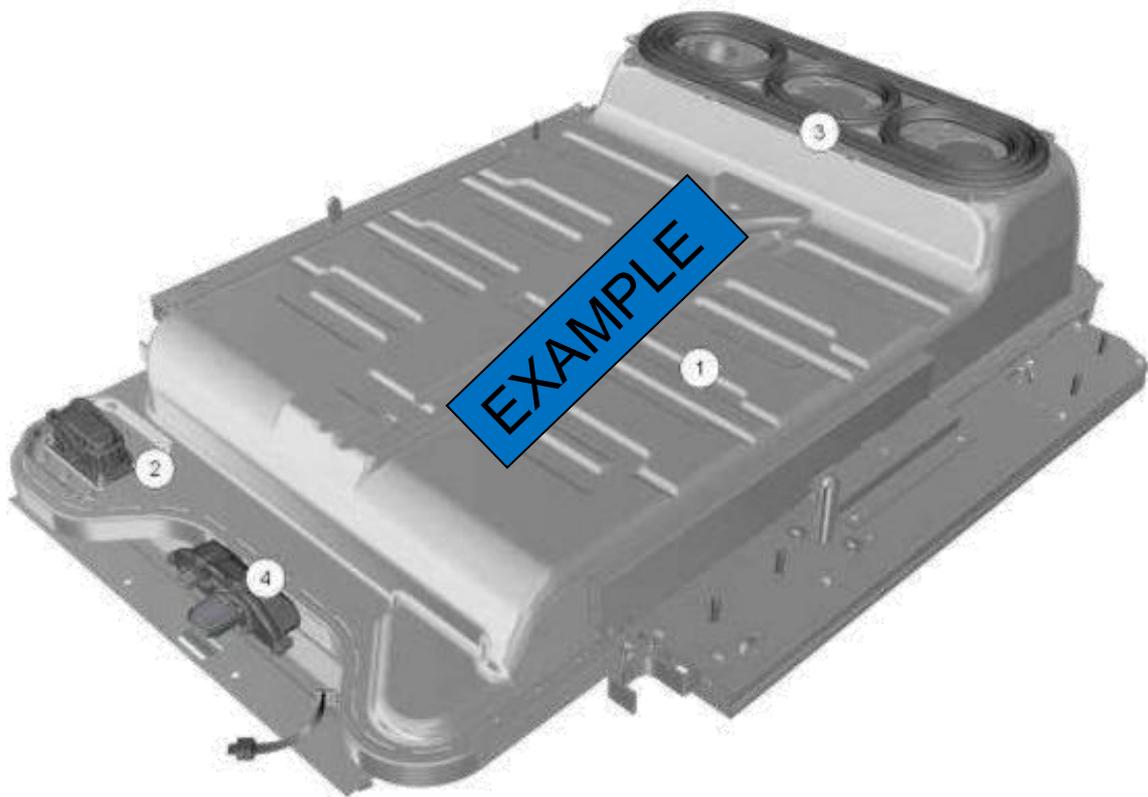


## INFORMATION FOR FIRST AND SECOND RESPONDERS RESCUE AND TRAINING MANUAL

### HIGH VOLTAGE (HV) LITHIUM-ION BATTERIES

TYPE VEHICLE

BRAND VEHICLE



Version ../../.. ENG

## INFORMATION FOR FIRST AND SECOND RESPONDERS RESCUE AND TRAINING MANUAL

### HIGH VOLTAGE (HV) LITHIUM-ION BATTERIES

IN AN HYBRID (HEV), PLUG-IN HYBRID (PHEV) , FULL ELECTRIC VEHICLE (EV)  
AND FUEL CELL ELECTRIC VEHICLE (FCEV)



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3. Hazards Associated with a Lithium-Ion Battery Fire

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damaged Lithium-Ion batteries and batteries at end of life.

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Note:

**First responders:** Fire Fighters, Police, Medical personal, Emergency Medical Transporters.

**Second responders:** Towing and maintenance personnel,...

**INFORMATION FOR FIRST AND SECOND RESPONDERS  
RESCUE AND TRAINING MANUAL  
HIGH VOLTAGE (HV) LITHIUM-ION BATTERIES**

**IN AN HYBRID (HEV), PLUG-IN HYBRID (PHEV), FULL ELECTRIC VEHICLE (EV)  
AND FUEL CELL ELECTRIC VEHICLE (FCEV)**

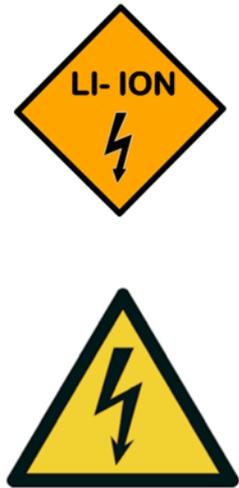
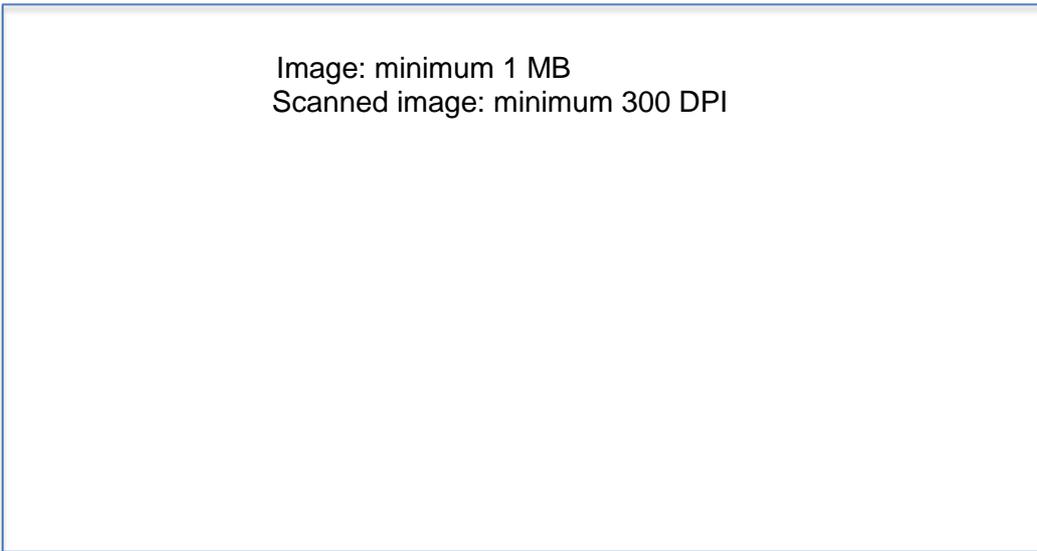
**BRAND/TYPE OF VEHICLE**

Manufacturer vehicle : **XXX**  
Info in case of emergency: **XXX**

Version: **17/08/2014**

**1. GENERAL INFORMATION**

**1.1 Picture and information:**



High voltage battery	Type of Li-ion battery	Info
1. High Voltage Battery Type: <b>(e.g. Li ION)</b>	<b>XXX</b>	xxx Volt (nominal) battery pack consisting of xxx Volt cells connected in a series-parallel circuit. <b>XXX</b> kg.

**1.2 General considerations in the event of damage to or fire involving an electric vehicle (EV) or hybrid-electric vehicle (HEV):**

- Always follow the “safety considerations” about the specific vehicle as supply by the car manufacturer.
- Warn all responders and dispatch/inform that an Hybrid, Electric or Fuel-Cell Vehicle is involved.
- Always assume that the high voltage (HV) battery and associated components are energized and fully charged.
- Exposed electrical components, (orange) wires, and HV batteries present potential HV shock hazards even when the battery is partially or fully discharged.
- Physical damage to the vehicle or HV battery may result in immediate or delayed release of toxic and/or flammable liquids and gases with a risk of fire.
- Venting/off-gassing HV battery vapours are potentially hazardous and flammable, and could contain hydrogen fluoride, carbon monoxide and carbon dioxide (Leaking electrolyte from a Li-ion battery gives a typical sweet/ether-like odour).
- In case of fire, parts of the battery (e.g. cells) may be ejected as projectile. When the inside cells of the battery are damaged flammable liquid may be expelled from the battery.
- When Li-ion batteries have been mechanically damaged there is a risk of fire as a result of a rapid temperature elevation in the battery due to e.g. an internal or external short circuit. For battery fires involving packs of several cells, the individual cell fires occur over a period of several seconds rather than simultaneously.
- As with any vehicle fire, the by-products of combustion can be hazardous and all individuals should be directed to move to a safe distance upwind and uphill from the vehicle fire and out of the way of oncoming traffic.
- When individual(s) are trapped in a vehicle with fire or leaking electrolyte, it is necessary to give them, immediately fresh air coming from a SCBA gear.

**1.3 Classification**

Lithium-Ion Batteries are classified as Dangerous Goods for Transportation under UN 3480  
Class of Hazard: Class 9 (Miscellaneous).

NFPA Code: **XXX**



**1.4 General first aid measures:**

**Exposure to High voltage (case of batteries with voltage higher than 60V).**

Use insulating gloves or protections.

Turn off the source of electricity, if possible. If not, move the source away from you and the person (victim), using a dry, nonconductive object made of cardboard, plastic or wood.

Check for signs of life (breathing, coughing or movement). If absent, begin cardiopulmonary recovery (CPR) immediately.

Prevent shock. Lay the person down and, if possible, position the head slightly lower than the body with the legs elevated.

After coming into contact with electricity, the person should see a doctor to check for internal injuries, even if he or she has no obvious signs or symptoms.

**Exposure to Material/Electrolyte Mixture:**

The following actions are recommended if direct contact occurs with Electrolyte or Material mixture due to damage of battery pack or cells:

- Inhalation** : Leave area immediately, move to fresh air and seek medical attention if irritation occurs.
- Eye contact** : Rinse eyes with water for 15-20 minutes and seek medical attention immediately.
- Skin contact** : Wash area thoroughly with soap and water and seek medical attention if irritation occurs.
- Ingestion** : Do not give anything by mouth to a victim who is either unconscious or is losing consciousness. If swallowed, rinse mouth with water and have victim spit the wash water out. Repeat. Do NOT induce vomiting. If vomiting occurs naturally, have victim lean forward to avoid aspiration. Call poison control centre immediately

**Always contact medical assistance**

**1.5 Content of chemical products:**

- The battery contains the following substances (in % by weight of the battery: **XXX** % ).
- Total weight battery : **XXX**

<b>NAME:XXX</b>	<b>UN Nr: XXX</b>	<b>CAS #:XXX</b>
<b>NAME:XXX</b>	<b>UN Nr: XXX</b>	<b>CAS #:XXX</b>
<b>NAME:XXX</b>	<b>UN Nr: XXX</b>	<b>CAS #:XXX</b>
<b>NAME:XXX</b>	<b>UN Nr: XXX</b>	<b>CAS #:XXX</b>
<b>NAME:XXX</b>	<b>UN Nr: XXX</b>	<b>CAS #:XXX</b>

## 2. Danger by spills/leaks (absence of fire)

Under normal conditions of use, the battery does not present any risk of exposure to its content.

### SPILLS

#### Specific Attention



#### 2.1 Inhalation in non-fire situations

The electrolyte used in the Li-ion battery cells contains a volatile flammable organic solvent and a corrosive substance.

- **Inhalation:** High vapour concentrations may cause respiratory tract irritation.
- **Eye contact:** Eye contact may cause severe irritation and possibly a burning sensation or corneal tissue injury.
- **Skin contact:** skin contact may cause irritation. Prolonged contact with electrolyte mixture may result in more severe irritation.
- **Ingestion:** swallowing electrolyte mixture may cause gastrointestinal tract burns. May cause nausea and vomiting.

#### Safety Measures



#### 2.2 Recommended Personal Protective Equipment:

Use personal protective equipment. Avoid contact with skin and eyes. Ventilate the area. Position yourself in the wind direction. The information below refers to exposure to the substances contained in the battery.

- Respiratory track protection  
Protective mask for acidic vapours or Self Contained Breathing Apparatus (SCBA) or Air-purifying respirator equipped with acid gas cartridge
- Hand protection  
Neoprene or nitrile gloves (EN 374) or equivalent.
- Eye protection  
Safety glasses with side-shields conforming to EN166, or face shield equivalent.
- Skin and body protection  
Boots, apron, long sleeved clothing.

Absorption/neutralisation see chapter 4: **Environmental aspects**

### 3. Hazards Associated with a Lithium-Ion Battery Fire

Under normal conditions of use the battery does not present any risk of exposure to its content.

#### FIRE

##### Specific Attention



- If you detect leaking fluids, sparks, smoke, flames, increased temperature, gurgling or bubbling sounds from the HV battery compartment, assume there is a battery fire and ventilate the passenger area (roll down windows or open doors).

##### 3.1 Fire in the HV Battery Assembly

- Be alert. There is a potential for delayed fire with damaged lithium-ion batteries.
- When the inside cells of the battery are damaged flammable liquid may be expelled from the battery,
- The battery contains a combustible organic solvent.
- When one cell ignites there is a risk a propagation of the fire to neighbour cells (Thermal runaway).  
Parts of the battery(e.g. cells) may be ejected as projectile.

##### 3.2 Inhalation in Fire Situations

- Hazardous gases are given off as by-products of combustion.
- Vapour emitted in case of a fire contains CO, CO2 and hazardous fluorinated substances!
- May rupture or explode in a fire, which could release hydrogen, hydrogen fluoride, carbon monoxide, carbon dioxide, aldehydes, and short chain hydrocarbons.
- 

##### Safety Measures



- Keep distance from the vehicle and evacuate people upwind from the immediate area.
- Keep any person not involved in the rescue, 15 meters away from the fire zone,

##### 3.3 Recommended Personal Protective Equipment:

- Wear always full Personal Protective Equipment suitable for organic solvents and Self-Contained Breathing Apparatus (SCBA).



- **To avoid serious injury or death from severe burns or electric shock, never breach or remove the high voltage battery assembly cover under any circumstance.**

##### Extinguish Measures



##### 3.3 Extinguish Fire

###### 1<sup>st</sup> Objective

- In case of a large fire cool down the battery with an overflow of water with in order to reduce the temperature of the battery.

###### 2<sup>nd</sup> Objective:

- Shutting off the oxygen supply to the fire: using if possible (dry) sand or other suitable mineral agent.

### **Offensive attack**

- Recommended where exposures are present or the high voltage battery is not involved.
- Copious quantities of water with 3% AFFF can be used to cool down burning Li-ion cells and batteries.
- During application, caution should be exercised as flammable particles may be ejected from the fire.

### **Defensive attack**

- Recommended if the high voltage battery is involved and no exposures are present. Due to the difficulty in reaching the burning cells inside the battery with the extinguishing agent, the Incident Commander may choose to allow it to burn itself out. Any individuals without SCBA should remain upwind of the fire and avoid inhalation, due to toxic compounds in the smoke.
- crews may utilize a water stream or fog pattern to protect exposures or to control the path of smoke.
- Allow battery to cool to ambient temperature before approaching. Measure temperature remotely with an infrared temperature (IR) gun or similar device, if available.

### **3.4 Risk of fire self re-ignition**

- When the car with a damaged Li Ion battery needs to be transported/ stored be aware of the possibility of a reactivation of the fire within a damaged battery.
- During overhaul, immobilize and disable the vehicle if not already done.
- Keep the damaged car with a battery or the damaged battery under supervision and control.

WARNING: There is a possibility for delayed ignition or re-ignition of a lithium-ion battery fire even after it is believed to be extinguished. This may remain an issue until the lithium-ion battery is properly handled/ managed/ conditioned by a qualified person.

Re-ignition may appear even after a few days.



**The HV battery assembly cover should never be breached or removed under any circumstances including fire. Doing so may result in severe electrical burns, shock, or electrocution.**

## 4. Environmental Aspects

### IN ALL CASES

#### Specific Attention



#### Safety Measures



#### **4.1 Absorbent materials.**

- To confine the spillage of liquids and the fire: use dry materials such as sand or mineral absorbing agents.
- Cleanup all spills/leaks immediately using an absorbent material such as vermiculite or dry sand. Neutralization is not necessary.
- Collect all contaminated absorbent material in a designated approved plastic waste container (non-conductive).
- In case of abundant use of water, care should be taken to confine and neutralise the water outflow.
- After intervention, rinse the affected areas with water adequately.

#### **4.2 Recommended Personal Protective Equipment:**

- Handle Li- ion spills using the following personal protective equipment (PPE)
  - Safety glasses or face shield
  - Chemical resistant neoprene or nitrile gloves
  - Protective apron or coveralls
  - Protective mask for acidic vapours or SCBA.

Perform gross decontamination by removing affected clothing. Wash skin with water and soap.

#### **4.2 Treatment of Waste Water.**

- Confine the effluent or the contaminated material and collect it as hazardous waste (water) for appropriate treatment.
- Pick up and transfer to properly labelled containers.
- Dispose of in accordance with local waste management legislation and emissions regulations.

## 5. Specific requirements for packaging, storage and transportation of damaged Lithium-Ion batteries.

### Safety Measures During Storage and Transport



### 6.1 When the battery is left in the car.

Damage to the high voltage battery or high voltage system can create a risk of electric shock, overheating, or fire.

If the vehicle is damaged from a moderate to severe crash, flood, fire, or other event, the vehicle should be inspected as soon as possible. Until the vehicle has been inspected, store it outside at least (15m) 50 feet from any structure or anything that can burn. Ventilate the vehicle by opening a window or a door.

Contact **XXX** as soon as possible to determine whether an inspection is needed.

### 6.2 When the battery has been removed from the car

#### 6.2.1 Recommended Personal Protective Equipment:

- Safety glasses or face shield
- Chemical resistant neoprene or nitrile gloves
- Protective apron or coveralls
- Protective mask for acidic vapours or SCBA.

#### 6.1.2 Other requirements

- Place and store the battery in a remote area, 15 meters (50 feet) away from a building where there are human activities. If possible, store on a floor made of concrete.
- Before being offered for transport, the cells or batteries shall be inspected by a qualified person to determine if the batteries are damaged. Damaged batteries may include, but are not limited to:
  - Cells or batteries identified as being defective for safety reasons;
  - Cells or batteries that have leaked or vented;
  - Cells or batteries that cannot be diagnosed prior to transport; or
  - Cells or batteries that have sustained physical or mechanical damage.
- Damaged or defective batteries can only be transported according to the UN Regulation for the transport of dangerous goods (UN 3480).
- Only trained persons are allowed to offer a damaged or defective battery for transport.
- Alternatively place the battery in a metal container,
  - Fill the container to the top with a non-combustible and non-conductive thermal insulation material (sand, vermiculite, glass, mineral agent...)
  - Store the container with the battery in a safe place for several days.

**Remark:** Trained personnel (for fire) should always accompany the transport of the damaged vehicle/battery to the safe place.

**Author:** XXX  
**Sources:** XXX

***Following text may never be deleted!***

This template is developed as an “example of good practice” in cooperation with RECHARGE and CTIF  
This document is not legally binding. It is prepared with the best information available to the authors at the time of its preparation.  
The information contained in this template rescue and training manual may be updated without notice.

The information on this template must be further filled in (XXX) and specific adapted to the type of battery by the car manufacturer!  
The information in the template has to be approved by the car manufacturer before distribution of this specific document.  
The manufacturer is always the final author of the “filled in training and rescue manual” and it relays always under his responsibility.

This template is built for fire fighters/rescue workers/towing and maintenance, **as free information source** at the scene and after.  
Also usable for training purposes.  
Misuse of this document, containing specialized and lifesaving information, in any form or shape is punishable by law.

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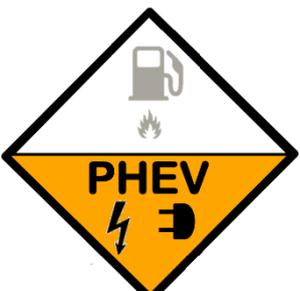
## Used Symbols

	<p><b>Use water to extinguish</b></p>
	<p><b>Do not break open</b></p>
	<p><b>Use heat Camera</b></p>
	<p><b>Danger electricity/electric shock</b></p>
	<p><b>Wear safety boots</b></p>
	<p><b>Wear safety gloves</b></p>
	<p><b>Wear protective clothing</b></p>
	<p><b>Wear face shield</b></p>
	<p><b>Wear protective mask</b></p>

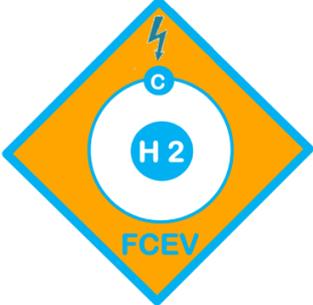
	<p><b>Wear breathing apparatus</b></p>
	<p><b>Disassembly only allowed by qualified persons</b></p>
	<p><b>NFPA 704 Hazard Identification System (To be filled in)</b></p>
	<p><b>Explosive</b></p>
	<p><b>Flammable</b></p>
	<p><b>Corrosives</b></p>
	<p><b>Caution harmful</b></p>
	<p><b>Acute toxicity</b></p>
	<p><b>Environmental hazard</b></p>

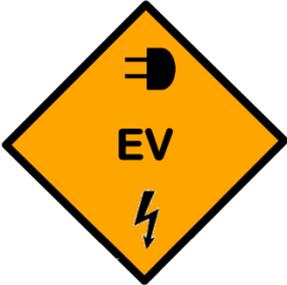
	<p><b>General warning</b></p>
	<p><b>Indication of life threatening situation!</b>  <b>Not acting on provided information can lead to life threatening consequences...</b></p>
	<p><b>ADR Class 9 (Miscellaneous)</b></p>
	<p><b>Lithium ion battery, high voltage</b></p>

**DRIVE LINE SIGNS**

	<p><b>Hybrid <u>E</u>lectric <u>V</u>ehicle: hybrid vehicle with 2 driving mechanisms: liquid fuel ( e.g. Diesel) and electric.</b></p> <p><u>Symbol description:</u>          Fuel pump with          1 flame = flammable liquid.          High voltage symbol.</p> <p><u>Colors:</u>          Orange R/G/B: 255/165/0          Grey R/G/B: 127/127/127          Black</p> <p><u>Text:</u> Arial rounded MT Bold</p>
	<p><b>Plug In <u>H</u>ybrid <u>E</u>lectric <u>V</u>ehicle: hybrid vehicle with 2 driving mechanisms: liquid fuel ( e.g. Diesel) and electric. Also power grid-connector to recharge battery.</b></p> <p><u>Symbol description:</u>          Fuel pump with          1 flame = flammable liquid.          High voltage/plug in symbol</p> <p><u>Colors:</u>          Orange R/G/B: 255/165/0          Grey R/G/B: 127/127/127          Black</p> <p><u>Text:</u> Arial rounded MT Bold</p>

	<p><b>Plug In Hybrid Electric Vehicle: hybrid vehicle with 2 driving mechanisms: liquid fuel ( e.g. Gasoline ) and electric. Also power grid-connector to recharge battery.</b></p> <p><u>Symbol description:</u>          Fuel pump with          2 flames = highly flammable liquid.          High voltage/plug in symbol</p> <p><u>Colors:</u>          Orange R/G/B: 255/165/0          Red R/G/B: 161/37/3          Black</p> <p><u>Text:</u> Arial rounded MT Bold</p>
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	<p><b>Fuel Cell Electric Vehicle: electric vehicle powered by a hydrogen fuel cell.</b></p> <p><u>Symbol description:</u>          H2 hydrogen atom/high voltage symbol          The stored hydrogen is compressed. (C= compressed)</p> <p><u>Colors:</u>          Orange: R/G/B: 255/165/0          Blue: R/G/B: 0/176/240          White</p> <p><u>Text:</u> Arial rounded MT Bold</p>
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	<p><b>Electric Vehicle: electric vehicle with power grid-connector to recharge battery.</b></p> <p><u>Symbol description:</u>          High voltage/plug in symbol.</p> <p><u>Colors:</u>          Orange R/G/B: 255/165/0          Black</p> <p><u>Text:</u> Arial rounded MT Bold</p>
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