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**[www.enovasystems.com](http://www.enovasystems.com)**

**19850 South Magellan Drive, Torrance, California 90502 USA**

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## FOREWORD

- This guide has been prepared to help emergency responders in the safe handling of hybrid vehicles following an accident. Emergency response procedures are similar to other vehicles with the exception of the high voltage electrical system. It is important to recognize and understand the high voltage electrical system, features, specifications, and disabling procedures.
  
- High voltage electricity powers an electric motor and is controlled by the electronic unit (CEU). All other conventional automotive electrical devices such as the headlights, radio, and gauges are powered by the standard 12-Volt chassis battery. Numerous safeguards have been designed into the system to help ensure that the hybrid’s high voltage (approximately 330-Volt) Lithium-ion (Li-ion) battery packs are kept safe and secure at all times.
  
- The Lithium-ion battery packs contain sealed batteries that are similar to rechargeable batteries used in laptop computers, cell phones, and other consumer products. The electrolyte is absorbed in the cell plates and will not normally leak out even if the battery is cracked.
  
- High Voltage cables, identified by **orange insulation** (or loom) are isolated from the metal chassis of the vehicle. These cables are routed underneath the vehicle in areas which would not normally be accessed by emergency responders at the scene of an accident. *See figure 2.2 on page 9.*
  
- **EMERGENCY RESPONDERS SHOULD NOT TOUCH, CUT, OR DISCONNECT THE ORANGE COLORED HIGH VOLTAGE CABLES UNDER ANY CIRCUMSTANCES (UNLESS THE EMERGENCY RESPONDER IS TECHNICALLY TRAINED TO HANDLE HIGH VOLTAGE CABLES). THE HIGH VOLTAGE CABLES SHOULD ONLY BE HANDLED BY TRAINED TECHNICIANS.**
  
- **THE EMERGENCY RESPONDER SHOULD NOT TRY TO OPEN OR INVESTIGATE ANY OF THE HYBRID COMPONENTS. THE HYBRID COMPONENTS HAVE HIGH VOLTAGE CIRCUITS WHICH ARE VERY DANGEROUS AND CAN CAUSE SERIOUS INJURY OR DEATH DUE TO ELECTRIC SHOCK. HIGH VOLTAGE HYBRID COMPONENTS SHOULD ONLY BE HANDLED BY TRAINED TECHNICIANS.**

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## 1.0 OVERVIEW OF THE HYBRID VEHICLE

### 1.1 Operator's interface panel

No action is needed from the operator to protect the hybrid system. Hybrid system power is enabled by turning the vehicle ignition key and the hybrid enable switch ON. The operator's only accessible features are located on the operator's panel. If the vehicle is involved in an accident, turn the hybrid enable switch to the OFF position, and follow normal recovery and towing methods.

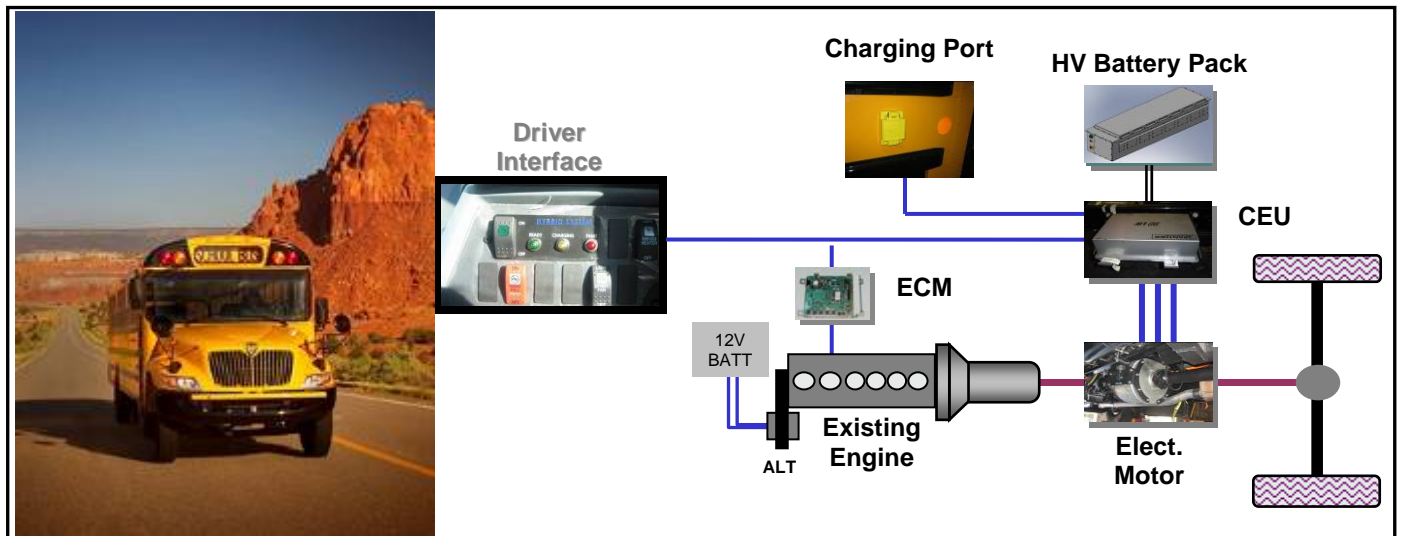
1) Hybrid enable switch (To turn ON/OFF the hybrid system)



*Hybrid System Interface panel*

## 1.2 The hybrid Vehicle

Enova’s post-transmission electric motor hybrid system:



S.N.	Component	Location	Description
1	Electric Motor	In Driveline	A 3-phase induction electric motor contained in the trans-axle is used to help power the vehicle during acceleration.
2	Control Electronics Unit (CEU)	Driver’s Side, Under-carriage	Converts DC to AC when accelerating. Converts AC to DC during regeneration. Also contains the circuitry to recharge the battery pack (when the vehicle is connected to an AC power outlet.)
3	Cooling System	Pump: Driver’s Side, Under-carriage Radiator: Driver’s Side, Under-carriage	The pump circulates coolant in the hybrid system. Coolant is circulated through the radiator to remove heat.
4	High Voltage (HV) Battery Packs	Pack 1: Driver’s Side, Under-carriage Pack 2: Passenger’s Side, Under-carriage	Each battery pack consists of fourteen 12V Li-Ion battery modules connected in series to provide a total of 330V. Provides power to the motor during acceleration and stores power during deceleration.

Table 1.1: Location & description of hybrid system components on the vehicle



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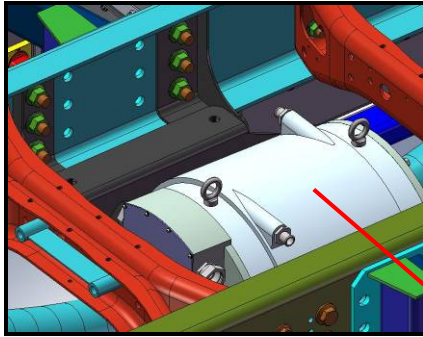
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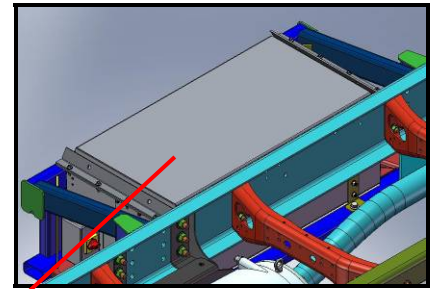
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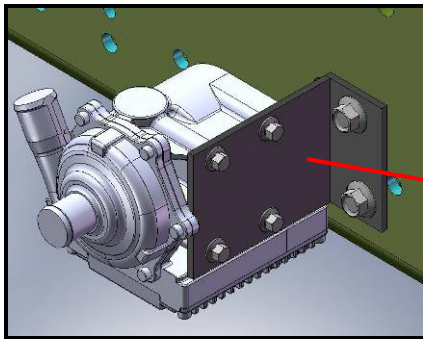
## 1.3 Location of hybrid system components



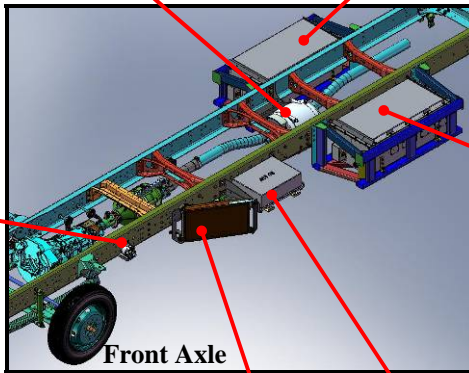
**Electric Motor**



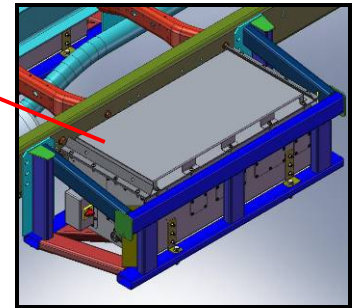
**Passenger's side Battery Pack**



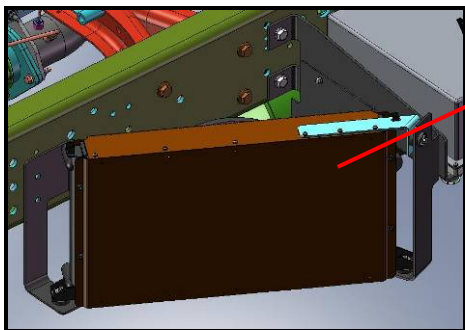
**Coolant Circulation Pump**



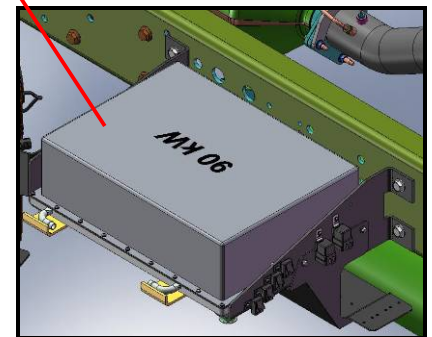
**Front Axle**



**Driver's side Battery Pack**



**Radiator**




**Control Electronics Unit (CEU)**

*Location of hybrid system components on the vehicle*

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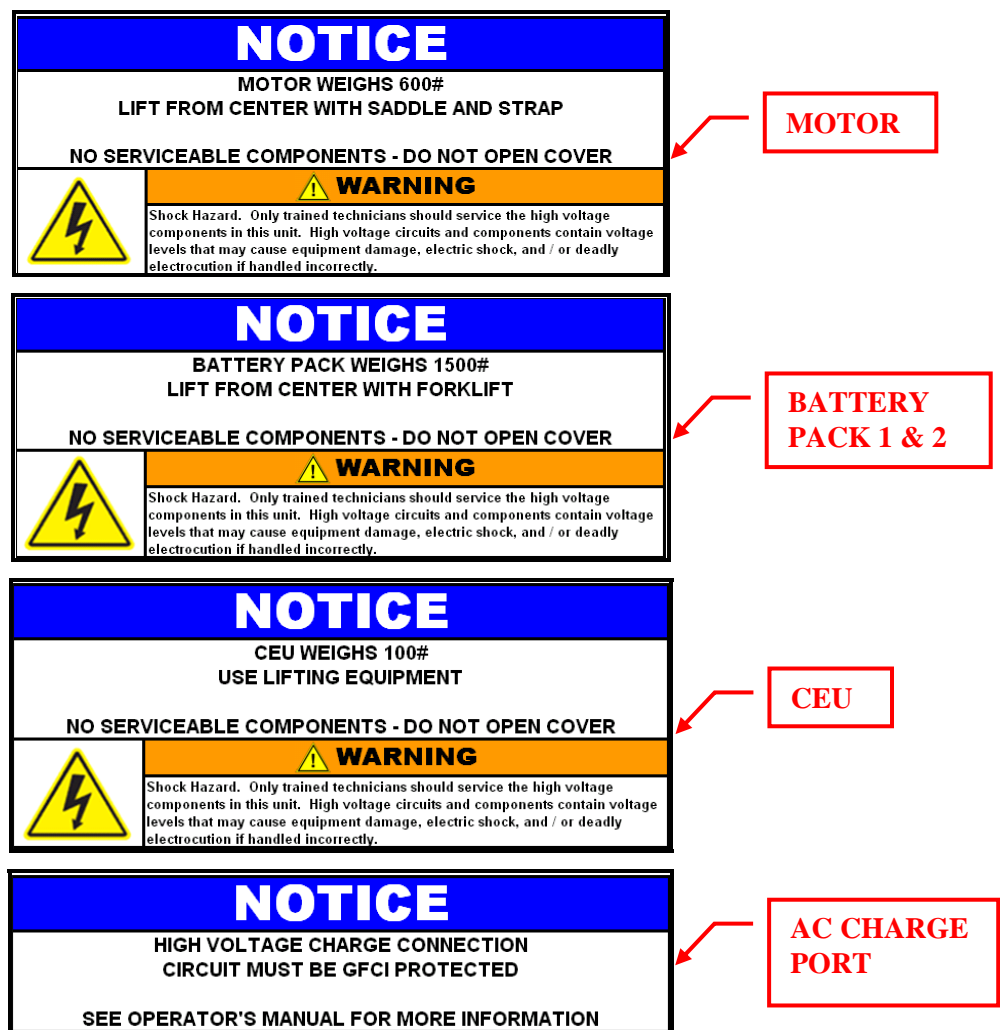
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## 2.0 HIGH VOLTAGE SAFETY SYSTEM

### 2.1 Identifying (HV) hybrid system components

Emergency responders who are not familiar with the hybrid system may find it difficult to recognize the hybrid system components. There are two ways in which an emergency responder can identify hybrid system components and thus avoid any potential high voltage electrical hazard:

- 1) All hybrid system components have warning labels which are visible from the sides and underneath. The labels provide a high voltage hazard warning.



*Warning labels for high voltage hybrid system components*



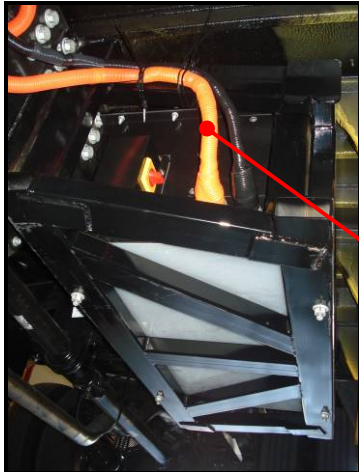
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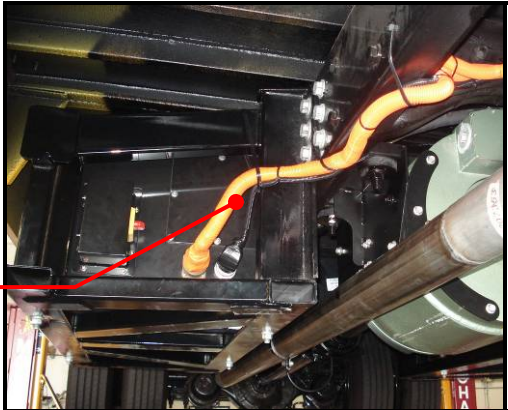
Prepared by: DJ / ND

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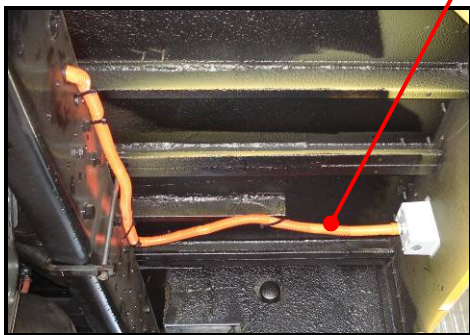
2) Any component that has cable covered in orange colored loom can be assumed to be a hybrid system component. These orange colored cables carry high voltage and should not be touched, cut, or disconnected by emergency responders.



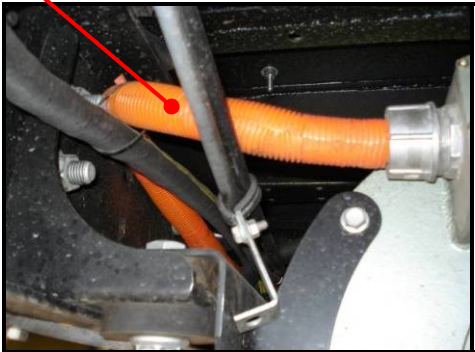
**From Battery Pack 1 to CEU**



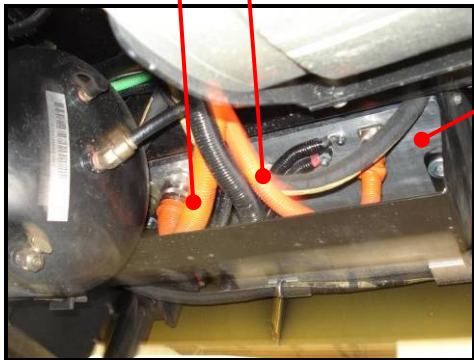
**From Battery Pack 2 to CEU**



**From AC Charge Port to CEU**



**From Electric Motor to CEU**



**HV cables connecting to CEU**


**CEU**

*High voltage cables (covered with orange colored loom)*

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## 2.2 High voltage system safeguards


The hybrid system is designed with the following safeguards:

- a) All HV cables are covered in orange colored loom.
- b) All HV components have warning labels.
- c) All hybrid system connectors are interlocked. This safeguard circuitry will power down and remove high voltage from the hybrid system automatically with no operator intervention needed.
- d) A fast acting fuse located inside each battery pack provides protection from short circuits.
- e) Contactors located inside the battery packs remove power during system faults or when the hybrid system is turned off.
- f) Service disconnect switch located on each battery pack removes high battery voltage during service.
- g) High voltage battery cables are isolated from the metal chassis.
- h) The CEU actively monitors battery voltage with respect to the vehicle's chassis ground. If the isolated voltage exceeds a preset limit, contactors located inside the battery packs will open to remove power from the system. A fault (amber indicator lamp) will also display on the operator's indicator panel.
- i) The Battery Management System (BMS) continuously monitors the battery packs for abnormal conditions that are referenced to preset limits within the CEU.

Examples of monitored BMS items:

- 1) Battery temperature
  - 2) Battery voltage
  - 3) Battery current
- j) When used properly, the charge cable and water resistant charge port are isolated from the vehicle's ground. A GFCI protected charge cable should be the only type of cable used to recharge the vehicle.
  - k) **Fuse 8** of the Hybrid Drive system is located underneath the dash board. It protects the harness and ignition switch from an electrical short. If this fuse blows, the hybrid system's capabilities will cease. **Warning: As with all fuses, replace with the same type and rating.**
  - l) The brake pedal sensor (located on the brake pedal assembly), sends braking information to the CEU. In turn, the CEU controls the motor's regenerative braking torque. **During an ABS event, regenerative braking is automatically disabled.** If the brake pressure sensor malfunctions or stops working, a fault is generated and displayed (amber lamp) on the operator's panel. See picture on next page for brake sensor location.

**CAUTION:** All Hybrid System components are to be serviced by trained and authorized personnel only. Equipment enclosures are not to be opened under any circumstances except by Enova Systems personnel. The vehicle uses high AC and DC voltage. The high voltage circuits are dangerous and can cause serious injury or death. To avoid electric shock, do not touch the orange colored cables or anything related to these cables.

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### 3.0 EMERGENCY RESPONSE PROCEDURE

Emergency response personnel should follow standard procedures developed by their own organization for assessing situations and dealing with potential hazards. The procedures outlined in this section are also recommended.

#### 3.1 *Disabling the hybrid's high voltage electrical system*

- Immobilize Vehicle

Pull the vehicle off the road, park the vehicle, chock the wheels, and set the parking brake (if the bus is not equipped with PB, place the transmission in neutral and set the parking brakes).

- Disable Hybrid System

Switch the hybrid enable switch located on the operator's panel to the OFF position, turn the ignition switch to the OFF position.

#### 3.2 *Hybrid system or battery pack fire*


The ABC Fire Extinguisher supplied with the vehicle is recommended.

#### 3.3 *Submersion or partial submersion*

Turn the key switch to the off position. Turn the hybrid enable switch to the off position. Pull the vehicle out of the water. Tow vehicle to authorized service center.

#### 3.4 *Spills*

The hybrid vehicle contains the same common automotive fluids used in non-hybrid vehicles with the addition of the electrolyte that is used in the high voltage battery pack. The electrolyte is absorbed in the cell plates and will not normally spill or leak out even if the battery case is cracked. The emergency and first aid procedure to handle exposure to battery pack electrolyte is described in the next section.

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### ***3.5 Emergency and first aid procedures (Exposure to battery electrolyte)***

Exposure to electrolyte is highly unlikely except in the event of a catastrophic crash or through improper handling. Emergency responders should utilize the following guidelines during an electrolytic exposure. Additional information about the Li-ion batteries is available from the MSDS (pages 12 – 15) provided by the battery manufacturer – **Valence Technology, Inc.**

- *Wear Personal Protective Equipment (PPE):* Use proper Personal Protective Equipment (PPE) such as a splash shield or safety goggles. Fold down helmet shields are not acceptable for electrolytic fumes or mist. Rubber, latex or nitrile gloves, apron and rubber boots are acceptable PPE for handling electrolytic spills.
- *Contact with eyes:* In case of contact with eyes, immediately flush eyes with large amounts of water for at least 15 minutes. Assure adequate flushing of the eyes by separating the eyelids with fingers. Transport to the nearest emergency medical care facility.
- *Contact with skin:* In case of contact with skin, flush skin with ample amounts of water. Remove and wash contaminated clothing promptly. Transport to the nearest emergency medical care facility.
- *Inhalation of electrolytic vapor:* Under normal conditions, no toxic gases are emitted from the batteries. If the electrolyte leaks and is exposed to air, electrolytic vapors might arise. In a non-fire situation the electrolytic vapors are non-toxic, and if vapors are inhaled, immediately move to a location with fresh air. Artificial respiration or oxygen might be required if the person is exposed to electrolytic vapors for a prolonged duration. In case of a fire situation, some irritating and/or toxic fumes may be emitted as a by-product of combustion. All responders should wear NIOSH/MSHA approved self contained breathing apparatus (SCBA) and protective clothing when fighting chemical fires. Remove patient from the hazardous environment to a safe area and administer oxygen. Transport to the nearest emergency medical care facility.
- *If swallowed:* Rinse mouth with ample amounts of water. Call a physician or transport person to the nearest emergency medical care facility.



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## Material Safety Data Sheet Valence Battery

Revised Date: 12-16-03  
Preparation Date: 8-9-01

Section 1 (Product Identification)	
Manufacture's Name Valence Technology, Inc.	Emergency Telephone No. CHEMTREC 1-800-424-9300
Address (Number, Street, City, State and ZIP Code) 301 Conestoga Way, Henderson, NV. 89015	
Chemical Name and Synonyms Valence P1a Battery Liquid Cell and Polymer	Chemical Abstract No (CAS). Mixture
Chemical Family N/A	Chemical Formula N/A

Section 2 (Hazardous Ingredients)				
Hazardous Ingredients	CAS	Percent	ACGIH TLV	OSHA PEL
Polyethylene/Polypropylene Film	TS	.5-10	Not Established	Not Established
Graphite	TS	10-20	N/A	15 mg/m <sup>3</sup> (TWA Dust)
Silica	TS	.5-10	10 mg/m <sup>3</sup> (TWA)	10 mg/m <sup>3</sup> (TWA)
Carbon black	TS	10-20	3.5 mg/m <sup>3</sup> (TWA)	3.5 mg/m <sup>3</sup> (TWA)
Lithium Metal Phosphate	TS	30-40	Not Established	Not Established
Fluorinated Polymer	TS	5-15	Not Established	Not Established
Electrolyte Solvent A	TS	1-10	200 ppm (TWA)	200 ppm (TWA)
Electrolyte Solvents B and C	TS	5-15	Not Established	Not Established
Electrolyte Solvent D	TS	1-5	Not Established	Not Established
Electrolytic Fluorinated Lithium Salt	TS	1-10	Not Established	Not Established
Copper	TS	1-10	1 mg/m <sup>3</sup> (TWA dust)	1 mg/m <sup>3</sup> (TWA dust)
Aluminum	TS	1-10	10 mg/m <sup>3</sup> (TWA)	15 mg/m <sup>3</sup> (TWA)
Packaging	Mixture	1-10	Not Established	Not Established

Note: TLV - Threshold Limit Value; TWA - Time weighted average; TS -Trade Secret



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Section 3 (Physical Data)	
Boiling Point	90 °C (Solvent A); 243 °C @ 740mm (Solvent B); 125.8° C (Solvent C); 242.1° C (Solvent D)
Melting Point	3500 °C (Carbon); 3500° C (Graphite); 140°C (Fluorinated Polymer); >1000°C (Lithium Metal Phosphate); 2-4 °C (Solvent A); 37-39 °C (Solvent B)
Density (gm/cc) @ 25°C	1.7-1.9 (Carbon);
Vapor Pressure	97.68mm @ 20 °C (Solvent A)
Vapor Density (Air=1)	Not Established
Specific Gravity	1.9-2.1 (Carbon); 1.78 (Fluorinated polymer); 3.6 (Lithium Metal Phosphate); 2.2 (Silica); 1.069 (Solvent A); 1.321 (Solvent B)
Solubility in Water	Insoluble: Carbons, Silica, Lithium Metal Phosphate; Negligible: Fluorinated polymer; Not Established: All other materials
Appearance and Odor	Appearances vary. Odor negligible

Section 4 (Fire & Explosion Hazard Data)				
Flash Point	Autoignition Temperature	Flammability	LEL	UEL
Not Established	Not Established	Not Established	Not Applicable	Not Applicable
Extinguishing Media Water, Carbon Dioxide, Dry Chemical or appropriate Foam				
Special Fire Fighting Procedures Wear NIOSH/MSHA approved SCBA and protective clothing when fighting chemical fires.				
Unusual Fire and Explosive Hazards Emits irritating and/or toxic fumes under fire conditions.				

Section 5 (Health Hazard Data)	
Toxicity Data	HMIS Hazard Rating
Not Established	Not Established
Routes of Entry Not Applicable	
Effects of Overexposure (acute and chronic) None under normal conditions. In the event of exposure to battery contents the following could occur. Acute Effects: Vapor or mist is irritating to the eyes, mucous membranes and respiratory tract. Causes eye and skin irritation. Exposure can cause: Nausea, Dizziness and headache. Chronic Effects: Overexposure may cause reproductive disorder(s) based on tests with laboratory animals. Target Organs: Kidneys, Central nervous system, eyes, male reproductive system.	
Medical Conditions Generally Aggravated by Exposure Unknown	



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Carcinogenicity	NTP	IARC Monographs	OSHA Regulated
Not tested	N/A	N/A	N/A
Emergency and First Aid Procedures			
<p>In case of contact, immediately flush eyes with copious amounts of water for at least 15 minutes. Assure adequate flushing of the eyes by separating the eyelids with fingers. Flush skin with water. Remove and wash contaminated clothing promptly. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. If swallowed, wash out mouth with water provided person is conscious. Call a physician.</p>			

Section 6 (Reactivity Data)	
Stability [ <input checked="" type="checkbox"/> ] Stable      [ <input type="checkbox"/> ] Unstable	Conditions Contributing to Instability N/A
Incompatibility Organic Solvents	
Hazardous Decomposition Products - Thermal and Other Hydrogen Fluoride, Carbon Monoxide and Carbon Dioxide	
Hazardous Polymerization [ <input type="checkbox"/> ] May Occur      [ <input checked="" type="checkbox"/> ] Will Not Occur	Conditions to Avoid Do not open, puncture, or incinerate.

Section 7 (Spill & Disposal Procedures)
Steps to be taken in Case Material is Released or Spilled Not Established
Waste Disposal Method (Consult federal, state or local authorities for proper disposal procedures). Consult federal, state, or local authorities for disposal procedures.

Section 8 (Special Protection Information)		
Respiratory Protection Where concentration may exceed OSHA/ACGIH permissible limits, use appropriate approved respiratory protection.		
Ventilation (Always maintain exposure below permissible limits)	Local Exhaust N/A	Special N/A
	Mechanical (general) N/A	Other N/A
Protective Gloves Not required during normal handling.	Eye Protection Not required during normal handling.	
Other Protective Equipment/Work Practices Handle with care. Do not short positive and negative terminals.		



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### Section 9 (Storage and Handling Precautions)

#### Precautions to be Taken in Handling and Storing

When not being used store in cool dry area. Avoid storing in excessive heat.

#### Precautionary Labeling


All batteries should be appropriately labeled.

### Disclaimer

This information in this Material Safety Data Sheet meets the requirements of the United States Occupational Safety and Health Act and the regulations promulgated thereunder (29 CFR 1910.1200 *et. seq.*). This document is intended only as a guide to the appropriate precautionary handling of this product by a person trained in, or supervised by a person trained in, chemical handling. The user is responsible for determining the precautions and dangers of this product for his or her particular application.

Most of the hazards associated with this product concern the substances used within the seal packaging. To avoid these hazards, the user must insure the integrity of the packaging. Exposure to chemicals present in this product may have serious adverse health effects. Valence Technology cannot warn of all the potential dangers of use or interaction with other chemicals or materials. Valence Technology warrants that the battery laminate components meet the indicated specifications. Valence Technology disclaims any other warranties, expressed or implied with regard to the product supplied hereunder, its merchantability or its fitness for a particular purpose.

Read all precautionary information. As newly documented general safety information becomes available, Valence Technology will periodically revise this Material Safety Data Sheet. If you have any questions, please call Valence Technology (1-702-558-1000) for assistance.

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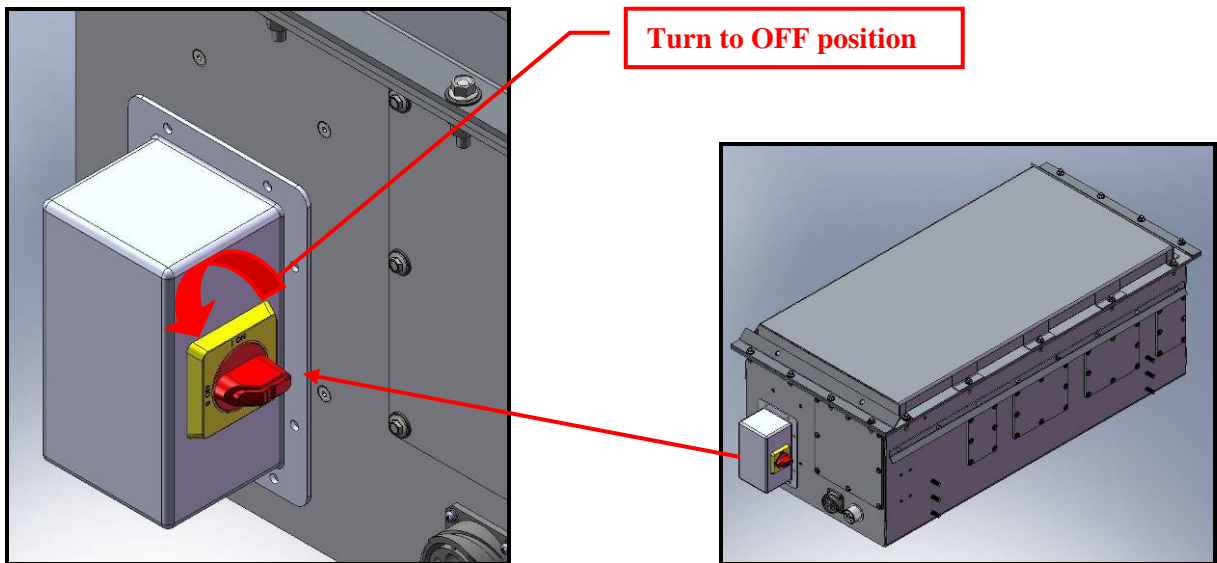
## 4.0 SHUTTING DOWN THE HYBRID SYSTEM

At the scene of an emergency, the hybrid vehicle may or may not be operational. If the vehicle is operational and the emergency responder needs to shut-down the hybrid system, the following procedures below should be followed. If towing is needed, please see the procedure on page 19.

### 4.1 Hybrid shut-down procedure


The hybrid system can be shut down in either of the following ways:

- 1) Turn OFF the vehicle's ignition switch.
- 2) Turn OFF the hybrid enable switch located on the operator's panel.
- 3) **For service related issues**, the service disconnect switch located on the battery pack can be switched to the off position (*see figure below*).



*Service Disconnect Switch – HV Battery Pack*

**UNDER NO CIRCUMSTANCES SHOULD THIS SWITCH BE TREATED AS AN EMERGENCY CUT-OFF SWITCH.** This switch is not meant to be used as an over-current interrupter during situations when the HV cables sustain extensive damage which causes a short in the HV circuit. The only purpose of this switch is to cut-off battery voltage during service, transport, or installation of the battery pack and HV cables.

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## 5.0 TOWING & RECOVERY

The electric motor will neither sustain nor cause any damage if it spins with the hybrid system off. Emergency responders can tow the hybrid vehicle by following standard towing instructions as recommended by the manufacturer in the “Operator’s Manual.” In cases where an accident or vehicle break-downs occur, emergency responders should make sure that the hybrid system is shut down before the vehicle is towed. To transport the hybrid vehicle, a flatbed truck should be used. Do not use sling-type towing equipment unless the hybrid vehicle has been damaged beyond repair. Emergency responders should follow these steps:

### 1) *In case of an accident:*

- Switch the hybrid enable switch located on the operator’s panel to the OFF position.
- Switch the vehicle ignition key to OFF position and remove the key.
- **Do not touch** the high voltage cables (orange loom) or anything relating to the orange cables.
- Coolant can be cleaned up with a dry cloth or towel.
- Follow the standard towing procedures as described by the Manufacture in the “Operator’s Manual.”
- Do not turn the hybrid system back ON until the vehicle has been thoroughly checked, serviced, or repaired by authorized service personnel.

### 2) *In case the vehicle breaks down:*

- Switch the hybrid enable switch located on the operator’s panel to the OFF position.
- Switch the vehicle ignition key to OFF position and remove the key.
- Follow the standard towing procedures as described by the Manufacture in the “Operator’s Manual.”
- Do not turn the hybrid system back ON until the vehicle has been thoroughly checked, serviced, or repaired by authorized service personnel.

## 6.0 CONTACT INFORMATION

- **TEL: 310-527-2800, Enova’s Customer Service**
- **WEBSITE: [www.enovasystems.com](http://www.enovasystems.com)**