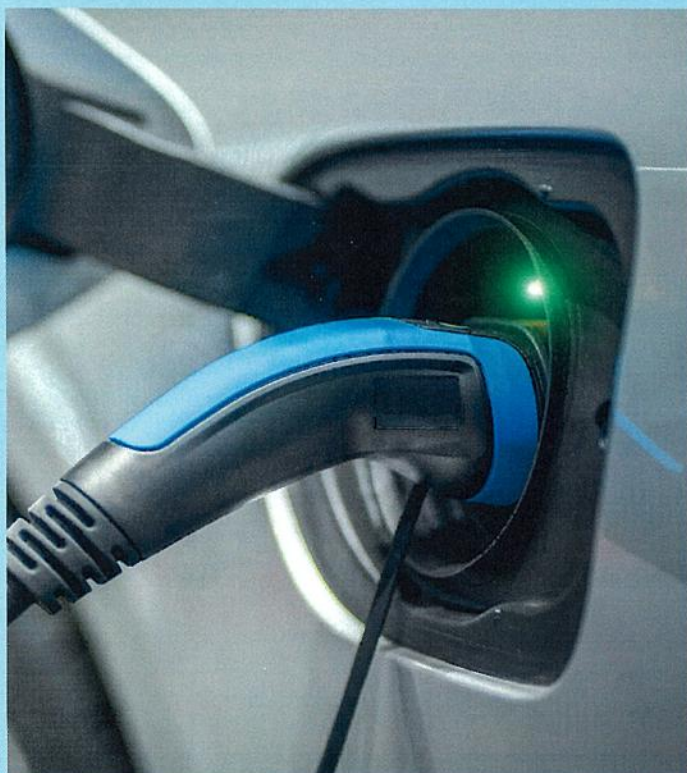


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# Guide

## Electric Vehicle User and First Responder

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# Section 1

## Introduction

This Guide is specifically for people who may work on or in an electric vehicle (EV) and is designed to ensure that they follow correct procedures and are aware of, and avoid, the potential hazards involved in dealing with high voltage direct current (DC) electricity that they may not be familiar with. Note that hybrid vehicles also have an electric power element so the guidelines here can be applied to hybrids as well.

## Purpose of this Guide

This Guide has been created to provide essential information to any person who may need to interact with such vehicles, and who is not wholly familiar with the concept, layout, components and functionality of electric and hybrid vehicles.

Its prime audience is people who will be among the first responders to any incident involving an EV, regardless of whether the request for assistance is from a driver, or as a result of a breakdown, sudden loss of power due to insufficient charge, or an emergency of some kind where vehicle damage or personal injury have occurred.

It is therefore recommended reading for all drivers to make them aware of the necessary safety steps that need to be taken to create a safe operating and working environment. It could also be beneficial to people from the emergency services including paramedics and ambulance operatives, fire and rescue staff and police. In addition, other potential first responders such as coastguard, helicopter crews, roadside assistance staff, car park operators and lease fleet owners etc., will also benefit from its advice and guidance.

**Note:** In this document the term high voltage (HV) is used to refer to any vehicle with an operating voltage greater than 60 V DC (Ref ISO 6469).

## Section 2

### Product and component identification

An EV typically features one or more electric motors which provide vehicle traction. An internal combustion engine (ICE) with attached high voltage generator will be fitted to a hybrid electric vehicle (HEV). The motor distributes its power through a single speed gearbox to the front wheels or through the main vehicle gearbox in terms of a hybrid. The motor is powered by electricity stored in a high voltage battery tray assembly in the vehicle. Typically, HEV batteries can use lithium-ion (Li-ion), nickel metal hydride (NiMH), nickel cadmium (Ni-CD), lead acid or sodium nickel chloride (Na-NiCl<sub>2</sub>). Other chemistries may well appear over time. Full details of key components, their functionality and location are described in this section of the Guide.

**Note:** All cables carrying high voltage current through the vehicle are orange in colour. These cables should never be disconnected except by competent and trained personnel. Do not touch them if there is any visual evidence of damage, which should be reported to an authorized repairer immediately.

Conventional electrical components on the vehicle such as lights, instruments, radio, wipers, windows etc, are all powered through the standard 12 V battery. This is charged through a DC/DC converter fitted to the vehicle which takes its power from the HV battery.

#### 2.1 How to recognize an EV

An EV is identified by a badge mounted on the bottom edge of the rear tailgate or the wing as shown in Figure 2.1.

**Figure 2.1** Examples of EV identification badges



## Section 2 – Product and component identification

HV warning labels are in the front motor compartment and in the boot. They may also be fitted to the external battery tray. An example is shown below in Figure 2.2.

Figure 2.2 HV warning label



### 2.2 Where to find key data

All relevant safety and operating instructions are contained in the vehicle handbook. This should always be kept in the vehicle available for reference when required. Also included in this document is the vehicle service and maintenance record which should provide details of any significant component changes or upgrades that have been implemented.

## Section 2 – Product and component identification

### 2.3 Component descriptions

The components that you'll find in EVs are listed in Table 2.1, and Figure 2.3 shows their potential locations.

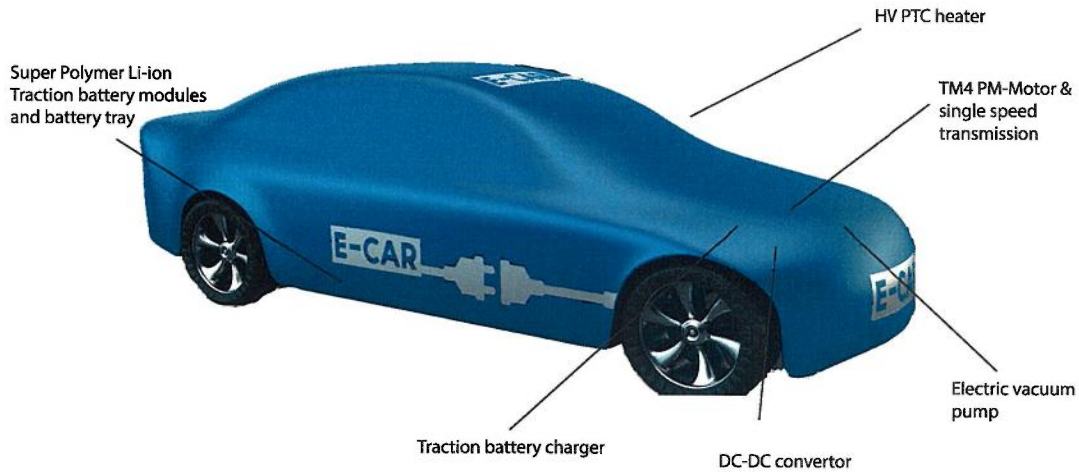
**Table 2.1** Component description

Component	Description	Potential location
1. Charger*	Manages the charging of the HV battery from external electricity supply.	Under bonnet, rear of vehicle.
2. Power distribution unit (PDU)*	Manages and distributes HV power flow to and from the battery.	Under bonnet, boot of vehicle.
3. Inverter*	Provides electronic control of motor functions.	Under bonnet and or over rear wheels.
4. Motor*	Provides vehicle traction and regenerative braking.	Under bonnet and or over rear wheels.
5. Gearbox	A single speed gearbox that reduces the revolution of the motor to a useable road speed.	
6. Coolant pump	Electrically driven coolant pump circulating coolant to the motor and PDU.	
7. 12 V battery	Conventional 12 V lead acid battery used for all vehicle electrical equipment except the e-drive.	
8. Vehicle management unit, electronic control unit or vehicle controller	Controls vehicle movement based on drive selector, accelerator pedal position and brake pedal position. Ensures that vehicle cannot be driven whilst on charge.	
9. Heater*	Provides cabin heating.	Behind instrument panel or under bonnet.
10. Air conditioning compressor*	Moves refrigerant around the cooling circuit to enable cabin cooling and, sometimes, to cool the traction battery.	Behind instrument panel or under bonnet.
11. HV cables*	Orange coloured armoured cables carry high voltage current (DC) between the traction battery, and other HV systems on the vehicle.	Under body, front to rear.
12. Charge socket*	Connects mains charge cable into vehicle HV electrical system.	In wing (front or rear) in vehicle front grill.
13. Traction battery*	Provides HV energy storage and energy to power the HV vehicle systems.	Under body, under boot space, front of vehicle.
14. Charge cable*	Connects the external electric supply to the vehicle on-board charger through the charge socket. The cable has an in-line residual current device (RCD) protector built in to provide electrical shock protection.	In boot, under driver/passenger seat.
15. Underbody tray	Tray is made from steel or composite and is not structural. Unable to accept any externally applied loading. Installed to provide spray protection to HV cabling and installation.  <b>Note:</b> Provides first line of protection to underbody HV cabling. If damaged care is required when removing.	

**Note:** All components marked with \* are high voltage and should be treated with extra care.

## Section 2 – Product and component identification

Figure 2.3 Location of key EV components



## 2.4 Key component specifications

### (a) Motor and e-drive

**Note:** High voltages operate inside the motor, inverter and PDU. Connectors MUST NOT be removed without first isolating the HV system from the vehicle. See guidance in Section 4.

EVs are powered by an electric motor. An EV will have a single or dual speed directly connected gearbox that transmits power to either the front or rear wheels, making the EV either front or rear wheel drive. If the EV has multiple motors (for example, Jaguar I-PACE, Tesla performance editions) one or more motors may be fitted at the rear and power the rear wheels through a similar reduction gearbox.

The motors are controlled by a motor control unit, also called an inverter. A PDU is often fitted which manages and controls the power flows from the HV battery tray assembly. This can either be smart or dumb with no on-board control.

### (b) Traction battery assembly

The energy source for the motor is a Li-ion (or sometimes NiMH) battery within the vehicle. Please refer to vehicle details for locations. The car often also has a conventional 12 V lead acid auxiliary battery which operates the normal electric components such as lights, windows, radio etc.

The battery can be located under the rear seat and behind the rear axle in the space traditionally occupied by the spare wheel. Alternatively, it can be fitted underneath the vehicle.

### (c) Materials contained in the battery cells

The battery tray assembly is rigidly mounted to the body structure. The tray has a sealed top cover and the entire tray is isolated from exposure to HV current. The battery tray assembly is monitored and controlled by a battery management system (BMS). This provides cell balancing and always prevents overcharging as well as monitoring of the HV system to ensure optimum safe performance. The battery



## Section 2 – Product and component identification

tray assembly is accessed from the underside of the EV. Full details of the material and chemical content of the battery cells is described in the Material Data Safety Sheet included with each vehicle.

### (d) Components powered by the HV battery:

Various components within the EV are powered by the HV battery including:

- i drive motor;
- ii cabin heater;
- iii DC/DC converter;
- iv air conditioning motor; and
- v control units including:
  - motor control unit;
  - PDU;
  - vehicle management unit;
  - battery management system; and
  - all HV cables.

The HV battery tray assembly is recyclable. For further information contact the nearest dealer or manufacturer.

### (e) Battery charger and cables

The HV battery is charged via an on-board charger. This is connected to the PDU and to the charger socket by a HV cable. The charger socket can be located in a number of possible locations on the vehicle (for example, front wing, rear wing, front grill) behind a flap. The flap can be operated by a lever/mechanism within the cabin, a button on the dashboard or centre console or by pushing once on the outside of the flap.

For higher charge rate systems, a specific wall box will need to be fitted and will typically have a devoted charger connector.

**Note:** All cables carrying HV current through the vehicle are orange in colour. These cables should only be disconnected by competent and trained personnel. Do not touch if there is any visual evidence of damage which should be immediately reported to an authorized repairer.

## Section 3

### Charging a vehicle

#### 3.1 Charger types

An electric vehicle is a plug-in pure EV, meaning that it gets all its power from the onboard battery. This is charged via an orange cable that connects to the vehicle through a power socket. These are typically located behind a flap like a traditional fuel filler flap. There are several power capability charging systems available.

##### 3.1.1 Low power (up to 3 kW)

- For this system the vehicle is connected to the electricity supply via a domestic type 3 pin 13 A plug.
- The other end of this cable has a domestic type 3 pin 13 A plug.
- The charge cable is protected by an RCD to prevent electrical shocks to the user. Charging is managed by an on-board charger located in the vehicle.
- This is sometimes referred to as Mode 1 charging.

**Note:** Not recommended for new EV charging installations: Mode 3 or Mode 4 electric vehicle supply equipment (EVSE) should be installed.

##### 3.1.2 Medium power (3 kW with standard socket-outlet, up to 7 kW with 32 A industrial socket-outlet)

- This system can be powered from the domestic electricity supply; however, a separate circuit must be installed.
- The complete system includes a safety device in the charging cable and communication over the charge cable between the in-cable safety system.
- This is referred to as Mode 2 charging.

**Note:** Not recommended for new EV charging installations: Mode 3 or Mode 4 EVSE should be installed.

##### 3.1.3 High power (up to 22 kW)

- This system would need to be powered from a three-phase electricity supply.
- This is sometimes referred to as fast charge.
- This is referred to as Mode 3 charging.

##### 3.1.4 DC charging (greater than 22 kW)

- This is sometimes termed rapid charge.
- This will require an offboard charge device that supplies DC power.
- This is referred to as Mode 4 charging.

## Section 3 – Charging a vehicle

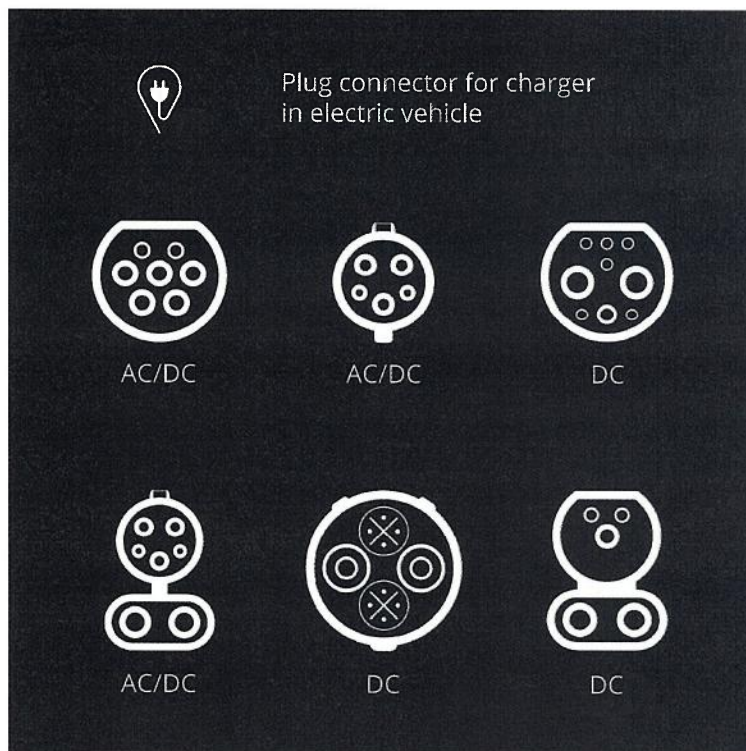
### 3.2 Charger connectors

Charging is typically controlled by the vehicle and the unit that charges it. Once a charger is connected to the vehicle and charging is started (either by switching the charge socket on or activating by payment) the vehicle will either display a charging icon in the cluster or illuminate a charging LED around the vehicle charge socket.

If neither of these happen than it may be necessary to contact the vehicle supplier or OEM as it may indicate a problem with the vehicle or battery.

The normal charging connectors in Europe are shown below in Figure 3.1.

**Figure 3.1** Normal European charging connectors



The number of charge points is constantly growing and there are several sources to find out where chargers are located and what type they are. Some examples include:

- (a) [www.zap-map.com](http://www.zap-map.com)
- (b) [www.chargepoint.com](http://www.chargepoint.com)
- (c) [www.ecotricity.co.uk](http://www.ecotricity.co.uk)
- (d) Council websites
- (e) University websites
- (f) Company websites

## Section 4

### High voltage safety

#### 4.1 Description of the HV system

The HV traction battery assembly powers the HV system with 240 V to 800 V DC electricity. Positive and negative HV cables are routed from the battery tray down the centre or along the inner sill of the EV. These are mounted as high as possible, to provide protection, and the entire underbody is covered by a removable tray.

Power flows down these cables to the PDU located in the front motor compartment or within the battery. The PDU distributes this electrical power to the motor via three HV cables through the inverter and to other vehicle systems such as the cabin heater and DC/DC converter.

The EV, its occupants and emergency responders are separated from this HV current by a series of protection devices contained in the HV system. There are several levels of protection provided which are explored in this Section.

#### 4.2 Levels of protection

##### 4.2.1 HV protection level one

**(a) Crash sensor**

The EV is fitted with a crash or inertia sensor which is triggered in the event of a vehicle impact. This opens the HV contactors within the battery tray assembly, rendering it immobile and preventing drive or charge.

**(b) High voltage interlock (HVIL)**

A low voltage circuit is fitted to the vehicle which loops through all of the high voltage connector housings. If any HV connector is removed it breaks the circuit and hence removes power from the HV system.

**(c) Battery fuses**

Two battery fuses and two battery disconnect devices are fitted to each battery box. The fuses will fail in the event of a vehicle HV wiring short circuit. Both fuses and battery disconnect devices can be easily removed by suitably qualified and competent personnel. This will provide an additional level of isolation and protection.

**(d) Isolation**

The EV constantly checks its HV isolation status through the BMS. If a failure is detected during the drive phase, the isolation warning light on the instrument panel is illuminated. The vehicle should be driven to the nearest safe area and the motor start key turned off and removed.

If an isolation failure is detected at vehicle start-up, or during charging, the vehicle is immobilized and HV contactors are opened.

**(e) HV earthing**

The HV system is totally isolated from the vehicle chassis ground and uses a negative return protection strategy, rather than a conventional ground earth. In order to improve vehicle performance and functionality certain HV components have LV earth connections fitted. No HV system negative return or earth connections should be disturbed as this could affect isolation integrity.

## Section 4 – High voltage safety

### 4.2.2 HV protection level two

- (a) The principal driver-operated safety system is the motor start key, located on the steering column. By turning the key off, 12 V power to the HV battery contactors is disconnected. The HV contactors require constant 12 V power to hold them in the closed position, allowing HV current to flow to the PDU. As a second level of protection, removing the key prevents inadvertent reconnection of 12 V power.
- (b) Alternatively, the vehicle is actuated by a start-stop button within the passenger compartment. This replaces the traditional ignition key and operates in conjunction with a wireless transponder fob. If the fob is within the vehicle, then pressing this will start the vehicle power-up sequence.
- (c) Any failure of the isolation protection on the EV will cause the isolation warning light in the instrument cluster to illuminate.

### 4.2.3 HV protection level three

- (a) To provide a further level of protection, disconnecting the earth lead on the 12 V battery physically prevents any power flowing to the HV contactors removing any possibility that they can be accidentally powered.

**Note:** Residual HV power can remain in the HV system for two minutes after the battery tray assembly has been disconnected. It is recommended that a period of five minutes should be allowed for this residual current to dissipate.

NEVER cut, disconnect or tamper with any orange HV cable or interfere with any of the HV components.

## Section 5

### Emergency response

On arrival at an incident involving an EV all emergency services should follow their standard operating procedures for vehicle incidents. Quick identification that the vehicle is an EV will enable additional response strategies to be activated (see Section 2 for more information on identification).

First responders should take note of the safety steps described and be aware of the visual checks necessary to confirm that the vehicle has not incurred any damage that has the potential to create a unique safety hazard.

#### 5.1 How to verify the EV is safe to approach

##### (a) Step one

Visually check the vehicle for signs of external damage. Pay attention to the front and rear of the car, and the underside.

##### (b) Step two

If there is extensive body damage, visually check that no HV cabling is exposed or badly damaged, to the point where the orange insulation has been removed, revealing bare wire.

If damage is seen on HV components such as the motor, charger, inverter or battery tray, or if HV wire is exposed, then access to the steering column should be gained by breaking the driver's window. The motor start key should be switched off and removed. If the vehicle has a push button start, then this should be pressed to power down the vehicle.

##### (c) Step three

If the above checks have not raised any concerns, then proceed to isolate the vehicle using the procedure detailed below.

Locate and remove the vehicle manual service disconnect (MSD) fitted to the battery.

When these specific checks have been completed it is safe to continue with the incident response.

#### 5.2 Essential required tools and equipment

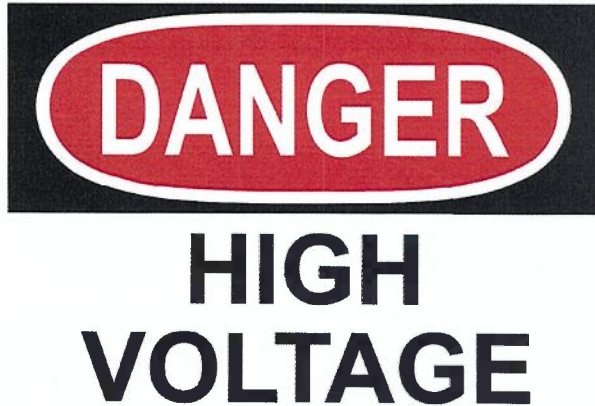
Appropriately rated insulated automotive hand tools should be used on the vehicle. Care should be taken to ensure that isolation procedures have been followed prior to commencing any work.

#### 5.3 Hazard identification

Under normal operating or storage conditions no adverse health effects are anticipated. Following an incident that has caused catastrophic damage to the battery tray assembly, either as a result of fire or crushing, leakage of specific chemicals or combustion products could cause concern. The severity of any incident must be significant to achieve penetration of the outer battery tray and the inner box before the individual cells can be damaged. Hazard warnings (as shown in Figure 5.1) are included on the battery assembly. Potential for exposure should not exist unless the battery leaks, is exposed to high temperatures or is mechanically, physically, or electrically abused.

## Section 5 – Emergency response

Figure 5.1 Hazard warning



If such a catastrophic incident were to occur, the following potentially dangerous chemicals or combustion products could be released:

- (a) **Ethylene carbonate and other organic carbonates:** such carbonates are volatile and can leave a residue of lithium hexafluorophosphate, which is an irritant to skin and eyes and is a caustic chemical.
- (b) **Lithium intercalated in carbon:** this can react with water or moisture in the air to potentially cause thermal burns or fire.

The following product can only be released following exposure of the battery assembly to fire. This information is provided for use by professional fire fighters who may be exposed following their extinguishing or rescue activities.

- (c) **Hydrofluoric acid:** this is not present in the battery unless it has been subject to extreme abuse or incident and is only produced following exposure to moisture. This substance is highly corrosive and contact with hydrogen fluoride fumes should be avoided.

Permissible exposure limit is 3 PPM. In case of contact with hydrogen fluoride fumes, immediately leave the area and seek first aid and emergency medical attention.

Symptoms may have delayed onset. Fluoride ions penetrate skin readily causing destruction of deep tissue layers and even bone. Fluoride interferes with nerve impulse conduction causing severe pain or absence of sensation. Immediately flush eyes or skin with water for at least 20 minutes to neutralize the acidity and remove some fluoride.

Remove and destroy all contaminated clothing and permeable personal possessions.

Before reuse, impermeable possessions should be soaked in benzalkonium chloride after water washing. Following flushing of the affected areas, an iced aqueous solution of benzalkonium chloride or 2.5 % calcium gluconate gel should be applied to react with the fluoride ion. Compresses and wraps may be used for areas where immersion is not practical. Medicated dressing should be changed every two minutes. Exposure to hydrofluoric acid fumes enough to cause pain requires immediate hospitalization to monitor for pulmonary oedema.

## Section 5 – Emergency response

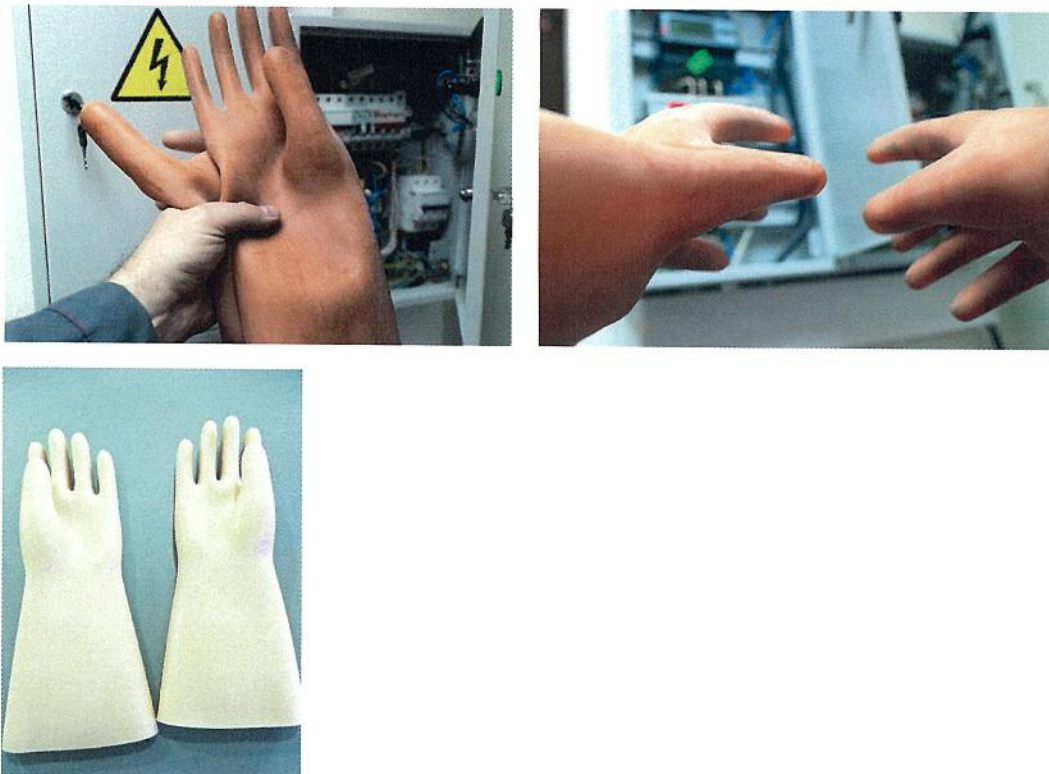
### 5.4 Providing first aid

Emergency first responders may not be familiar with the specific EV hazards described above. The risk is very small, due to the protective measures previously outlined, and could only appear due to a catastrophic crash or through gross mishandling.

If there is any visual evidence of damage to, or near HV cables and components, then great care should be taken during the approach. If persons are trapped, specifically if they are in contact with any damaged HV cables or components then they **MUST** be initially removed from such contact using an approved, insulated rescue hook.

In the event of such potential exposure it is always important to wear relevant and appropriate personal protection equipment (PPE). This would include safety goggles, electrical safety gloves made from latex or similar material, preferably with leather electrical over-gloves to avoid damage, protective clothing with electrical resistance and isolating properties (see Figure 5.2). Avoid synthetic materials unless specifically authorized for electrical hazards.

**Figure 5.2** Electrical safety gloves



**Note:** Remember that electrical safety gloves require regular testing to demonstrate integrity.

All persons contaminated should be referred to a medical facility for treatment. People suffering from electrical burns or shock injuries should be treated according to standard operating practices.

Exposure to the above chemicals and combustion products could be by inhalation, ingestion, eye, mouth or skin contact. In all cases wash the affected area with copious quantities of clean water and seek urgent medical advice.



## Section 5 – Emergency response

### 5.5 In the event of an EV fire

A fire in an EV should be approached and extinguished using standard emergency services operating practices.

**Note:** Li-ion battery cells are difficult to extinguish as they create oxygen when burning and are therefore self-sustaining. The most efficient extinguishing process is therefore to lower their temperature below the critical point by the application of significant quantities of cold water.

Under NO circumstances should the battery tray assembly be removed from the vehicle or opened in the event of an incident, as live HV connections could be exposed.

### 5.6 In the event of leakage from an EV

An EV contains similar fluids to those in common use in the automotive industry, including glycol coolant and gear oil. Standard operating practices should be followed in the event of such a leakage.

The battery assembly is contained in a steel tray designed to limit and minimize any possible leakage. Under normal circumstances penetration of the tray assembly is highly unlikely. The Li-ion battery cells are further protected by being contained in stainless steel battery boxes inside this outer tray.

In the very unlikely event of such a battery leak occurring, please consult the material safety data sheet (MSDS) at the back of the Guide for further information on the potential hazards. The MSDS also provides full details of the material and chemical content of the battery cells and describes all associated hazards and risks.

### 5.7 Disable/isolate the vehicle

Open the driver's door or reach into the cabin then switch off and remove the steering lock key. This enables the first level of EV safety as it isolates the 12 V power and ensures that the HV battery contactors are open.

Then disconnect the 12 V auxiliary battery by removing the negative terminal first. This removes all possibility of 12 V electrical power being available to operate the HV battery contactors.

Locate the battery manual service disconnect (MSD) and remove it. This will be located on the battery tray assembly. Often it can be accessed through the floor of the vehicle or boot area.

### 5.8 Handling an inverted EV

Provided that there is no visible damage to the HV systems or battery tray assembly on the EV, standard recovery practice should be followed. The points to be aware of are:

- (a) The EV has a protective undershield fitted. Note that this is NOT a structural member and must not be subjected to any external load. This extends from the front bumper to the leading edge of the battery tray assembly.
- (b) The battery tray assembly is clearly visible when the vehicle is inverted, and the protective undertray is removed. Again, this is NOT a structural member and all external loads MUST be avoided.
- (c) Check whether there is any significant damage to either the undershield or battery tray assembly before attempting to move the vehicle. Any penetration damage to the battery tray assembly has the potential to create an electrical hazard. Take all appropriate measures for handling such voltages. If you are unaware of the correct process await the arrival of Fire and Rescue Service personnel.

## Section 5 – Emergency response

- (d) Additionally, check that all the HV cables are undamaged. If there is any visible evidence of the orange insulation being damaged, then follow the isolation process described earlier before proceeding further.

### 5.9 Handling a submerged hybrid or EV

Provided that there is no visible damage to the HV systems or battery tray assembly on the EV, standard recovery practice should be followed. The points to be aware of are:

- (a) In the event of an incident the HV system crash sensor should have been initiated and will have isolated the HV system by disconnecting the 12 V supply causing the battery contactors to have opened.
- (b) Visually check the vehicle for signs of damage that could have interfered with any of the HV systems, notably the HV cabling and battery tray assembly.
- (c) A removable towing eye is supplied with the EV. This is stowed in the rear luggage compartment with the other vehicle tools. The towing eye can be fitted to the vehicle through a detachable cover in the front and rear bumpers.
- (d) If access to the towing eye is not possible then a tow rope should be securely fastened to the vehicle underside using the rear axle or front lower suspension as fixing points. This process **MUST ONLY** be used for immediate recovery from the water: The EV should not be towed for any significant distance without use of the towing eye.
- (e) Once the EV has been removed from the water it should be drained before towing.

### 5.10 Stabilize the vehicle

With the vehicle electrically isolated, it should then be stabilized. If it is seen to be in an unstable position, such as on uneven, heavily sloping ground or otherwise at risk, this should be rectified.

The EV will have jacking points designed to be used when raising the vehicle.

If required these four jacking points can be used to support the weight of the vehicle on stands or supports if wheels have been damaged or removed.

#### **WARNING**

Under no circumstances should the EV be raised using different underbody points as these have not been designed to absorb the potential loads.

If inflatable airbags are used to raise the vehicle, care must be taken to avoid exerting crush loads on the vehicle underbody tray and rear mounted HV battery tray installation, as this could cause HV cable or battery damage, or short circuit.

The EV **MUST NOT** be lifted, raised or supported by use of the battery tray assembly.

Ensure any stability equipment, such as stands, is kept clear of the central and rear areas of the vehicle to avoid any possibility of contact with the orange HV cabling, or the battery tray assembly.

Once vehicle stability has been restored the wheels should be chocked to avoid any further unplanned movement.

## Section 5 – Emergency response

### 5.11 Occupant extrication

Once the EV has been electrically isolated and, if necessary, stability been restored, then occupant extrication can be completed following standard operating practice:

- (a) **Glass removal** - this can be undertaken following standard operating practice.
- (b) **Supplementary restraint system (SRS) awareness** - the EV will have air bags like traditional vehicles. Standard procedures for SRS systems should be used.
- (c) **Roof removal** - use standard emergency recovery tools to remove the roof.

## Section 6

### Recovery

Provided that there is no visible damage to the HV systems or battery tray assembly on the EV, standard roadside recovery practice should be followed. The points to be aware of are:

- (a) It is recommended that the EV is always recovered using a flatbed recovery truck or trailer to avoid any possibility of causing further damage to the electric drivetrain and related systems.
- (b) A semi-suspended tow may be possible for front wheel drive vehicles with the front wheels raised from the ground (for rear wheel drive vehicles the opposite wheels will need to be raised). Ideally this should be limited to short distances to avoid overloading rear wheel bearings and suspension components.
- (c) For all wheel drive vehicles (for example, Tesla high performance models) towing should be avoided. Instead the vehicle should be loaded onto a flat-bed trailer. If towing is unavoidable then the speed should be kept below 20 mph.
- (d) A removable towing eye is supplied with the vehicle. This is usually stowed in the rear luggage compartment with the other vehicle tools (make sure you check). The towing eye can be fitted to the vehicle through a detachable cover in the front and rear bumpers.
- (e) If access to the towing eye is not possible then a tow rope should be securely fastened to the vehicle underside using the rear axle or front lower suspension as fixing points. This process **MUST** only be used for immediate recovery from the scene of the incident. The EV should not be towed for any significant distance without use of the towing eye.
- (f) If the towing eye, or fixing point, is not available due to damage then the EV should be recovered on a trailer or recovery truck.

## Annex A

### Glossary

AC	alternating current
A post	roof support pillar either side of windscreen
BIM	battery interface module
BMS	battery management system
DC	direct current
EV	electric vehicle
EVSE	electric vehicle supply equipment
HEV	hybrid electric vehicle
HV	high voltage
HVAC	heater, ventilation, air conditioning
inverter	motor control unit
kg	kilogram
kW	kilowatt
kWh	kilowatt hours
Li-ion	lithium ion
LV	low voltage
MSD	manual service disconnect
MSDS	material safety data sheet
Na-NiCl <sub>2</sub>	sodium nickel chloride
Ni-CD	nickel cadmium
NIMH	nickel metal hydride
PDU	power distribution unit
PPE	personal protection equipment
PPM	parts per million
RCD	residual current device
SRS	supplementary restraint system
VMU	vehicle management unit

# Guide

## Electric Vehicle User and First Responder

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By 2030 it is expected that electric vehicles will outnumber conventional petrol fuelled vehicles and the Dept for Transport have already banned the sales of new petrol and diesel cars and vans after 2030. All major car manufacturers are developing a range of electric and hybrid models to satisfy the demand for battery powered vehicles. By the end of 2020, at least 50 different battery-powered cars were available to buy from British showrooms, and that number is set to grow considerably in the coming years.

Engineers, mechanics and the front-line rescue services are all well trained to deal with incidents involving EVs. There are significantly different issues to be aware of when dealing with such incidents, and a large number of individuals need to be up to speed as regards these differences.

This Guide is specifically aimed towards people who are expected to work on or in an electric vehicle (or hybrid). It is designed to ensure that they follow correct procedures and are aware of, and avoid, the potential hazards involved in dealing with high voltage direct current [DC] electricity.

Its prime audience is people who will be among the first responders to any incident involving an electric vehicle. All people from the emergency services including paramedics and ambulance operatives, fire and rescue staff, as well as police. In addition, other potential first responders such as coastguard, helicopter crews, roadside assistance staffs, car park operators and lease fleet owners etc.) will also benefit from its advice and guidance.

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