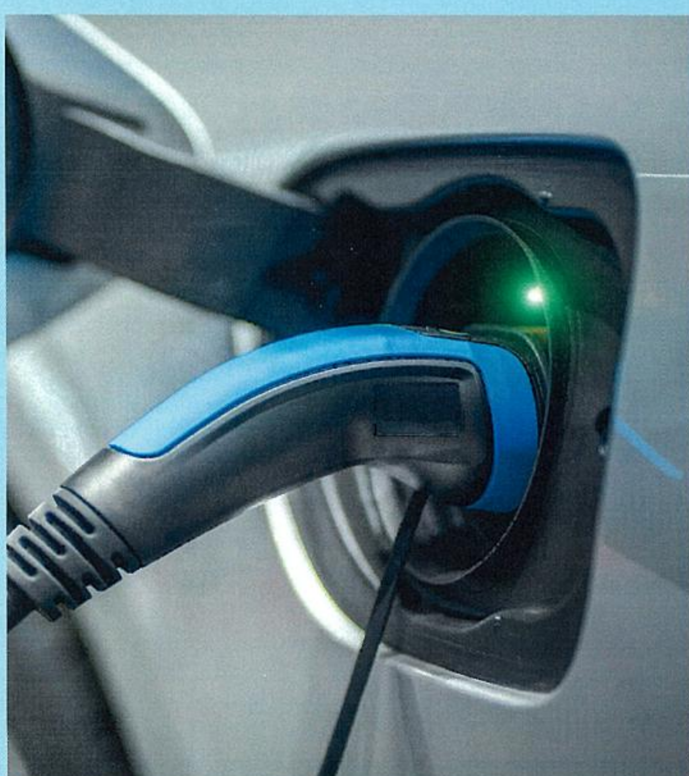
The Institution of Engineering and Technology

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 ($Na\text{-}NiCl_2$). 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.

2.3 Component descriptions

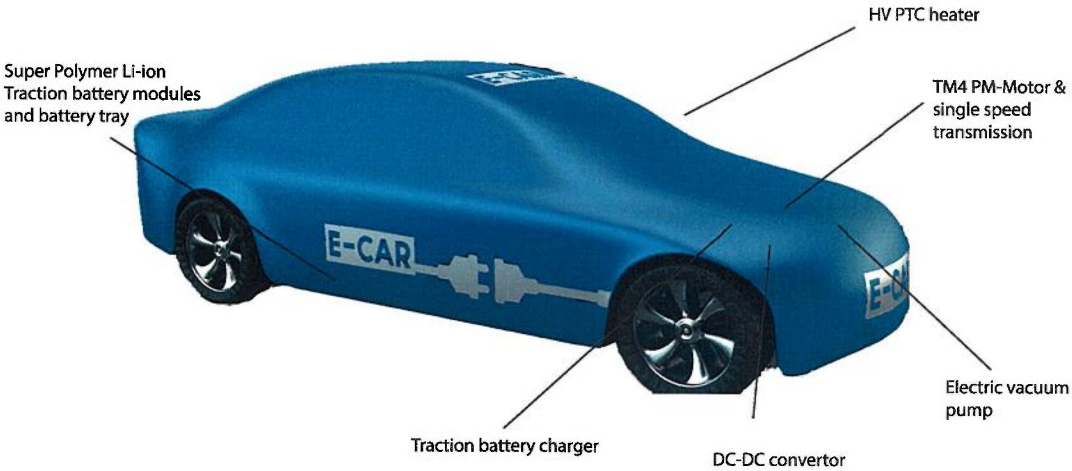
The components that you'll find in EVs are listed in Table 2.1, and Figure 2.3 shows their potential locations.

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. **Note:** 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.

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 real 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