IMIEV11
Carry out electric vehicle conversion (re-powering)

Overview

This standard covers the competence and knowledge technicians need to safely carry out the conversion of an internal combustion engine vehicle into an electric vehicle. It also ensures that the technician is aware of the effect that high voltage component technology has on other vehicle systems. Please note, it does not include developing an electric vehicle or systems from scratch.

For the purposes of this standard, an electric vehicle is any vehicle that is in part or wholly electrically propelled. This would include

- Hybrid (HEV) - to include mild/micro hybrid vehicles where the voltage is considered dangerous
- Plug-in Hybrid (PHEV)
- Extended Range Electric Vehicle (ER-EV) or Range Extended Electric Vehicle (RE-EV)
- Battery Electric Vehicle (BEV) or Pure Electric Vehicle (PEV)
- Fuel Cell Electric Vehicle (FCEV).

Warning: It has been recommended by industry experts that only those with suitable training and experience on working on LIVE electric vehicle systems should carry out the functions below.

It should also be noted that the latest relevant transport legislation and regulation MUST be adhered to when carrying out EV conversions.

Performance criteria

You must be able to:

P1 Identify the base vehicle and electric vehicle conversion type and collect relevant technical information

P2 notify all relevant persons of your intention to work on a high voltage system

P3 Wear personal protective equipment (PPE) and use vehicle protection equipment (VPE) and workshop safety equipment appropriate to the work activities you are carrying out

P4 Ensure the work area is clearly identified using signs and barriers as appropriate, following environmental standards and regulations at all times

P5 Support your work activities by reviewing:

- P5.1 system manufacturer's vehicle technical data
- P5.2 removal and replacement procedures
- P5.3 legal requirements

P6 Prepare, check and use all the appropriate **equipment** required following manufacturers' instructions

P7 Work in a way which minimises the risk of:

- P7.1 damage to other vehicle systems, components and units
- P7.2 damage to your working environment
- P7.3 injury to yourself and others

P8 Select conversion **components** which meet the manufacturers' recommendations or conform to operating specifications

P9 Carry out component removal and replacement activities following:

- P9.1 manufacturers' instructions
- P9.2 industry recognised conversion methods
- P9.3 health, safety and environmental requirements

P10 Identify and prepare **components** suitable for re-use either as part of the conversion or elsewhere

P11 Dispose of unwanted **components** in line with local and national regulations

P12 Record and report any relevant/related faults you notice during the course of your work

P13 Use suitable **testing methods** to ensure the converted system performs to the vehicle operating specification and any legal requirements prior to sign off

P14 Ensure your records are accurate, complete and passed promptly to the relevant person(s) in the format required

Knowledge and understanding

You need to know and understand:

Use of technical information

K1 How to identify an electric vehicle and its type

K2 How to find, interpret and use sources of information applicable to **component** or system removal and replacement within an electric vehicle's high voltage systems

K3 The importance of using the correct sources of technical information for electric vehicle **component** or system construction and the implications of not

Legislative and organisational requirements and procedures

K4 The health and safety legislation, industry codes of practice or guidelines and workplace procedures relevant to working with electric vehicle conversions

K5 How to select, check and use appropriate personal protective equipment and vehicle protective equipment and workshop safety **equipment** when working on electric vehicles

K6 How to ensure the working environment is safe when working on an electric vehicle

K7 Your workplace procedures for the:

K7.1 referral/reporting of problems when working with electric vehicle conversions

K7.2 how to make others aware that work is being carried out on an electric vehicle conversion

K8 The precautions necessary when using plug-in charging equipment.

K9 How to carry out a risk assessment on damaged and non-functioning electric vehicles, systems, and **components**

K10 How to confirm an electric vehicle is safe to work on and the precautions you should take to ensure the high voltage system cannot be re-energised without your knowledge and agreement

K11 The hazards associated with electric vehicle high voltage **components**, including batteries

K12 How to reduce the risk of high voltage hazards when working on and around electric vehicles

K13 The implications and effects of electricity through the human body

K14 The implications of strong magnetic fields and the effects on medical devices

You need to know and understand:

K15 The signs and symptoms of electrocution

K16 Workplace procedures that must be followed in the event of electric shock

K17 The hazards associated with electric vehicles when exposed to extreme temperatures, impact and other adverse conditions

K18 How to store, dispose of, recycle and return any removed high voltage **components** in line with legislative, environmental, manufacturer's instructions and organisational requirements

K19 How to work safely avoiding damage to other vehicle systems, **component**s and units and contact with leakage and hazardous substances

K20 The hazards associated with all fuel sources and systems, including alternative fuels

Electrical and electronic principles

K21 The principles of chassis and insulated return systems as appropriate to electric vehicles

K22 Basic electrical and electronic principles, including ohms law, voltage, power, current (ac/dc), resistance, magnetism, electromagnetism and electromagnetic induction

K23 Specific high voltage circuit protection

K24 Electrical and electronic principles associated with ancillary systems, including types of sensors and actuators, their application, and operation

K25 The interaction between electrical, electronic, magnetic, chemical, and mechanical **components** within electric vehicle systems

K26 The operating principles of electric vehicle **components**

K27 How electric vehicle systems interact and communicate

K28 Isolation monitoring systems

Vehicle equipment faults and their correction

K29 How to identify faults and damage in electric vehicle high voltage electrical systems and **components**

K30 How to remove, replace, test, and evaluate the performance of conversion **components** and the converted system against operating specifications and legal requirements

K31 The importance of ensuring **components** are functioning prior to sign off

High voltage systems and components removal and replacement

K32 How high voltage **components** function and are constructed, including battery modules, electric motors, and associated components

K33 How to calculate battery size and requirements

K34 How to identify the **components** which make up the high voltage electrical system

K35 How to identify suitable locations of high voltage cables and **components,** including the effects this may have on the inspection process

K36 The different voltages associated with **components** in electric vehicles

K37 The manufacturers' specification for the type and quality of **components** to be used for conversion

K38 The different types of energy storage systems and voltages associated with electric vehicles

K39 The **components** of alternative fuel sources and systems on electric vehicles, including hydrogen fuel cells

Use of tools and testing equipment and testing techniques

K40 How to select and use the testing **equipment** required

K41 How to select, prepare, check, and use all the repair and replacement **equipment** required

K42 How to conduct tests on isolated high voltage systems following safety and workplace procedures

K43 How to conduct a test on energy sources and systems

K44 How to determine the compatibility of **components**

K45 How to determine the serviceability of a **component** in a high voltage system

K46 How to interpret the results of your tests and make recommendations based on these results

K47 The importance of basing your recommendations on test results

Vehicle system operation

K48 The main differences between an electric vehicle and a non-electric vehicle and its basic operation, including regeneration

K49 How to safely operate an electric vehicle

K50 The specific manufacturer's guidelines and the precautions necessary when charging, connecting an auxiliary power source to or towing/lifting an electric vehicle

K51 How to mobilise an electric vehicle safely

K52 The charging systems (types and modes) associated with electric vehicles and how to charge electric vehicles safely

Scope/range

1. Equipment includes:

1.1. hand tools
1.2. code readers
1.3. special tools, for example manufacturer specific equipment and software
1.4. safe and appropriate electrical testing equipment
1.5. relevant safety equipment

2. Testing methods include**:**

2.1. sensory
2.2. functional
2.3. measurement

3. Components include**:**

3.1. high voltage batteries
3.2. motors/generators
3.3. cabling and wiring
3.4. relays and contactors
3.5. electronic control units, sensors and actuators
3.6. on-board charger and charging port
3.7. isolators
3.8. inverters/rectifiers
3.9. battery management units
3.10. vehicle start/stop control
3.11. driver instrumentation
3.12. multi-battery systems
3.13. drive trains
3.14. power sources
3.15. charging systems and control
3.16. ancillary systems and components

Additional Information

Glossary

This section contains examples and explanations of some of the terms used but does not form part of the standard.

Hazards associated with high voltage electrical vehicle components - exist not only during work on high voltage systems, as specified above, but also on all other high-power electrical drive systems and high-pressure storage systems. Vehicle and equipment manufacturers' guidance should be followed at all times.

High voltage – Regulation No 100 of the Economic Commission for Europe of the United Nations (UNECE) — Uniform provisions concerning the approval of vehicles with regard to specific requirements for the electric power train, states that: 'High Voltage' means the classification of an electric component or circuit, if its working voltage is > 60 V and ≤ 1 500 V DC or > 30 V and ≤ 1 000 V AC root mean square (rms). Electricity at Work Regulations (1989), and associated HSE guidance should be followed at all times.
N.B. Some electric vehicles may operate at voltages below or above industry recognised standards.

Records - 'build book' to include wiring diagrams of the conversion and itemising serial numbers of components for traceability

Sensory testing methods - include looking, listening, smelling, touching for temperature or vibration.

Sign off - to include (as appropriate) Department for Transport requirements

Sources of information applicable to electric vehicles - examples include hard copy manuals, data on computer, and data obtained from on-board diagnostic displays.

Vehicle - any vehicle that is in part or wholly electrically propelled. This would include

- Hybrid (HEV) - to include mild/micro hybrid vehicles where the voltage is

considered dangerous

- Plug-in Hybrid (PHEV)
- Extended Range Electric Vehicle (ER-EV) or Range Extended Electric Vehicle (RE-EV)
- Battery Electric Vehicle (BEV) or Pure Electric Vehicle (PEV)
- Fuel Cell Electric Vehicle (FCEV)

IMIEV11
Carry out electric vehicle conversion (re-powering)

Developed by	IMI
Version number	1
Date approved	March 2024
Indicative review date	March 2027
Validity	Current
Status	Original
Originating organisation	IMI Ltd
Original URN	IMIEV11
Relevant occupations	Coach builders, vehicle restorers, vehicle convertors,
Suite	Electric and Hybrid Vehicles;
Key words	Electric Vehicle; conversion; re-powering; high voltage; restoration; adaptation; competition vehicle preparation; competition vehicle building; retro fit