

Overview

This standard covers the competence and knowledge technicians need to safely carry out the removal and replacement of components in hydrogen fuel cell electric vehicle (FCEV) systems. The unit also ensures that the technician is aware of the hazards posed by hydrogen fuel cell electric vehicle systems and the safe working practices to follow when carrying out removal and replacement activities.

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

N.B. This NOS must be used in conjunction with IMIEV03

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**Performance
criteria**

- You must be able to:
- P1 Identify that the vehicle has a hydrogen fuel cell electric vehicle system and collect relevant technical information
 - P2 Wear **personal protective equipment** (PPE) and use vehicle protection equipment (VPE) appropriate to the work activities you are carrying out
 - P3 Ensure the vehicle is safe to work on
 - P4 Ensure the working environment is suitable and safe, including zone classification
 - P5 Ensure the work area is clearly identified using signs and barriers as appropriate, following environmental standards and regulations all times
 - P6 Support your work activities by reviewing:
 - P6.1 system manufacturer's vehicle technical data
 - P6.2 removal and replacement procedures
 - P6.3 legal requirements
 - P7 Prepare, check and use all the appropriate **equipment** required following manufacturer's instructions
 - P8 Carry out tests and monitor for hydrogen leaks
 - P9 Work in a way which minimises the risk of:
 - P9.1 damage to other vehicle systems, components and units
 - P9.2 damage to your working environment
 - P9.3 injury to yourself and others
 - P10 Select replacement **components** which meet the manufacturer's recommendations or conform to operating specification
 - P11 Carry out **component** removal and replacement activities following:
 - P11.1 manufacturers' instructions
 - P11.2 industry recognised repair methods
 - P11.3 health, safety and environmental requirements
 - P12 Record and report any relevant/related faults you notice during the course of your work
 - P13 Follow manufacturer's instructions to test and evaluate the performance of the reassembled hydrogen fuel cell electric vehicle system accurately and ensure other associated systems operate correctly

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

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Knowledge and understanding

You need to know and understand:

Use of technical information

- K1 The different types of hydrogen fuel cell electric vehicle systems and associated hydrogen storage systems
- K2 How to find, interpret and use sources of information applicable to component removal and replacement within a hydrogen fuel cell electric vehicle system
- K3 The importance of using the correct sources of technical information for hydrogen fuel cell electric vehicle **component** construction

Legislative and organisational requirements and procedures

- K4 The health and safety legislation, hazardous and explosive atmosphere zone classifications, industry codes of practice or guidelines and workplace procedures relevant to working with hydrogen fuel cell electric vehicles
- K5 How to select, check and use appropriate **personal protective equipment** and vehicle protective equipment when working on hydrogen fuel cell electric vehicles
- K6 How to ensure the working environment is suitable and safe, including zone classification, when working on a hydrogen fuel cell electric vehicle
- K7 How to immobilise, store and mobilise a hydrogen fuel cell electric vehicle and its **components** safely in accordance with manufacturer's recommendations
- K8 Your workplace procedures for the:
 - K8.1 evacuation in case of emergency
 - K8.2 documenting removal and replacement activities
 - K8.3 referral/reporting of problems when working with hydrogen fuel cell electric vehicles
 - K8.4 how to make others aware that work is being carried out on a hydrogen fuel cell electric vehicle
- K9 The precautions necessary when handling hydrogen and using hydrogen related equipment
- K10 How to carry out a risk assessment on damaged and broken-down hydrogen fuel cell electric vehicles
- K11 How to confirm a hydrogen fuel cell electric vehicle is safe to work on, including testing for and monitoring hydrogen leaks and absence of high voltage
- K12 Hazards associated with hydrogen and hydrogen under high-pressure,

- including the physiological, mechanical and chemical effects of hydrogen
- K13 The hazards associated with hydrogen fuel cell electric vehicles when exposed to extreme temperatures, impact and other adverse conditions
 - K14 The effects of electricity through the human body and the potential medical conditions that can occur regardless of voltage or current type present in a hydrogen fuel cell electric vehicle
 - K15 How to dispose of, recycle and return any removed hydrogen fuel cell electric vehicle system **components** in line with legislative, environmental and organisational requirements
 - K16 How to work safely avoiding damage to other vehicle systems, components and units and contact with leakage and hazardous substances

Hydrogen fuel cell and the vehicle system principles

- K17 The basic construction of a hydrogen fuel cell
- K18 The electrochemical reactions in a fuel cell
- K19 How a fuel cell operates and the advantages for automotive applications
- K20 The by-products of the fuel cell chemical reaction
- K21 The differences between different fuel cell technologies which may come into automotive use, for example solid oxide (SOFC) and alkaline fuel cells (AFC)
- K22 The reasons for connecting fuel cells into a stack
- K23 Hydrogen fuel storage, supply and re-fuelling systems on-board the vehicle
- K24 The methods of hydrogen production
- K25 The components and operation of the air intake system associated with hydrogen fuel cell vehicles
- K26 The components and operation of the exhaust system associated with hydrogen fuel cell vehicles

Hydrogen fuel cell electric vehicle systems and components

- K27 How hydrogen supply system **components** function and are constructed
- K28 How to identify the location of hydrogen and high-pressure hydrogen pipes and other system **components**, for example, by labelling or colour
- K29 The different pressures and voltages associated with **components** in hydrogen fuel cell electric vehicles
- K30 How hydrogen fuel cell electric vehicle systems interact with other vehicle

systems

- K31 The manufacturer's specification for the type and quality of **components** to be used for replacement
- K32 The different types of energy storage systems and voltages associated with hydrogen fuel cell electric vehicles
- K33 The ancillary **components** of alternative fuel sources and systems on hydrogen fuel cells

Vehicle system operation

- K34 The main differences between a hydrogen fuel cell electric vehicle (FCEV) and a battery electric vehicle (BEV) and its operation
- K35 How to safely operate a hydrogen fuel cell electric vehicle
- K36 The specific manufacturer's guidelines and the precautions necessary when charging, connecting an auxiliary power source to or towing/lifting an electric vehicle
- K37 The evacuation and re-fuelling systems associated with hydrogen fuel cell electric vehicles and how to operate them safely

Use of tools and testing equipment and testing techniques

- K38 How to select and use the **tools and testing equipment** required
- K39 How to select, prepare, check and use all the repair and replacement **tools and testing equipment** required
- K40 How to conduct tests on hydrogen fuel cell electric vehicle systems following safety and workplace procedures
- K41 How to conduct a test on energy sources and systems
- K42 How to determine the serviceability of a **component** in a hydrogen fuel cell electric vehicle system
- K43 How to interpret the results of your tests and make recommendations based on these results
- K44 The importance of basing your recommendations on test results

Vehicle component faults/condition and their correction

- K45 How to identify faults, damage and condition of hydrogen fuel cell electric vehicle systems and **components**

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- K46 How to remove, replace, test and evaluate the performance of **components** and the reassembled system against operating specifications and legal requirements
 - K47 The importance of ensuring **components** are functioning correctly before release to the customer

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Scope/range

- 1. Fuel cell technology includes:**
 - 1.1. polymer electrolyte/proton-exchange membrane (PEM)
 - 1.2. solid oxide (SOFC)
 - 1.3. alkaline fuel cells (AFC)

- 2. PPE includes:**
 - 2.1. Anti-static shoes
 - 2.2. Anti-static overalls
 - 2.3. Anti-static bonding straps
 - 2.4. Personal hydrogen leak detector
 - 2.5. Absence of oxygen monitor
 - 2.6. Appropriate high voltage PPE

- 3. Working environment safety equipment includes:**
 - 3.1. hydrogen leak detector
 - 3.2. flame detection
 - 3.3. anti-static flooring
 - 3.4. ventilation and extraction equipment
 - 3.5. alarms, visual and audible

- 4. Tools and testing equipment include:**
 - 4.1. hand tools
 - 4.2. code readers
 - 4.3. special tools, for example manufacturer specific equipment and software
 - 4.4. safe and appropriate electrical testing equipment
 - 4.5. hydrogen evacuation (purge) equipment

- 5. Testing methods include:**
 - 5.1. sensory
 - 5.2. functional
 - 5.3. measurement

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6. **Components** include:
- 6.1. On board re-fuelling components
 - 6.2. supply pipes
 - 6.3. safety venting systems
 - 6.4. thermal pressure release device (TPRD)
 - 6.5. valves and other safety devices
 - 6.6. pressure reduction devices
 - 6.7. storage tanks
 - 6.8. insulation and protection methods and components
 - 6.9. fuel cell stack
 - 6.10. fuel cell components
 - 6.11. intake air supply system components
 - 6.12. exhaust components
 - 6.13. electronic control units, sensors and actuators
 - 6.14. driver inputs and instrumentation
 - 6.15. service items

**Additional
Information****Glossary**

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

Fuel cell system

Includes fuel cell and fuel cell stack, hydrogen storage and supply, on-board fuelling systems and safety and control systems

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.

Hazards associated with hydrogen and hydrogen fuel cell electric vehicle systems

Physiological (e.g. frostbite, respiratory ailments, injury from unexpected release of pressure and asphyxiation), mechanical (for example, embrittlement) and chemical (flammable - burns without visible flame, causes explosive atmospheres).

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 $> 60 \text{ V}$ and $\leq 1\,500 \text{ V DC}$ or $> 30 \text{ V}$ and $\leq 1\,000 \text{ V AC}$ 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.

Sensory testing methods

Include looking, listening, smelling, touching for temperature or vibration.

Sources of information applicable to fuel cell electric vehicles

Examples include hard copy manuals, data on computer and data obtained from on- board diagnostic displays.

Vehicle

Fuel Cell Electric Vehicle (FCEV)

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Originating organisation	IMI Ltd
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Relevant occupations	Light Vehicle Service Technician (Automotive); Light Vehicle Diagnostic Technician (Automotive); Light Vehicle Master technician (Automotive); Bus and Coach Mechanic; Bus and Coach Electrician; Bus and Coach Mechelec; Bus and Coach Master Technician
Suite	Electric and Hybrid Vehicles;
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