IMIEV08
Diagnose and rectify faults in a hydrogen fuel cell electric vehicle system

Overview

This standard covers the competence and knowledge technicians need to safely diagnose and rectify faults 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 diagnosis and rectification 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.

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

P5 Support the identification of **faults**, by reviewing vehicle:

- P5.1 technical data
- P5.2 diagnostic test procedures

P6 Prepare the vehicle systems and work area for safe working procedures as appropriate to the vehicle and the nature of the **fault**

P7 Prepare, check and use all the required **equipment** following manufacturers' instructions

P8 Use **diagnostic methods** which are relevant to the symptoms presented

P9 Collect sufficient diagnostic information in a logical and systematic way to enable an accurate diagnosis of the hydrogen fuel cell electric vehicle system **faults**

P10 Identify and record any system deviation from manufacturer's specifications accurately

P11 Ensure your assessment of components and units identifies their condition and suitability for repair or replacement

P12 Inform the relevant person(s) promptly where repairs are uneconomic or unsatisfactory to perform

P13 Carry out all diagnostic and rectification activities following:

- P13.1 manufacturers' instructions
- P13.2 recognised repair methods
- P13.3 your workplace procedures
- P13.4 health, safety and environmental requirements

P14 Work in a way which minimises the risk of:

- P14.1 damage to other vehicle systems

P14.2 damage to other components and units

P14.3 injury to self and others

P15 Ensure all repaired and replacement components and units conform to the vehicle operating specification and any legal requirements

P16 Adjust components and units, when necessary, correctly to ensure that they operate to system requirements

P17 Record and report any relevant additional **faults** you notice during the course of work promptly

P18 Use testing methods which are suitable for assessing the performance of the rectified system

P19 Ensure the rectified system performs to the vehicle operating specification and any legal requirements prior to return to the customer

P20 Ensure your records are accurate, complete and passed to the relevant person(s) within the agreed timescale and in the format required

P21 Complete all activities within the agreed timescale

P22 Report any anticipated delays in completion to the relevant person(s) promptly

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 on hydrogen fuel cell electric vehicle system operating specifications, diagnostic test procedures, repair procedures and legal requirements

K3 Vehicle operating specifications relating to hydrogen fuel cell electric vehicle systems for the vehicle(s) on which you work

K4 The importance of using the correct sources of technical information for hydrogen fuel cell electric vehicle system diagnosis and rectification

Legislative and organisational requirements and procedures

K5 the legislation, industry codes of practice or guidelines and workplace procedures relevant to

- K5.1 health and safety
- K5.2 the environment (including waste disposal)
- K5.3 appropriate personal and vehicle protective **equipment**
- K5.4 legal requirements relating to the vehicle (including road safety requirements)

K6 How to immobilise, store and mobilise a hydrogen fuel cell electric vehicle and its components safely in accordance with manufacturer's recommendations

K7 Your workplace procedures for:

- K7.1 recording **fault l**ocation and correction activities
- K7.2 reporting the results of tests
- K7.3 the referral of problems
- K7.4 reporting delays to the completion of work

K8 How to confirm a hydrogen fuel cell electric vehicle is safe to work on

K9 The hazards associated with hydrogen and hydrogen under high-pressure, including the physiological, mechanical and chemical effects of hydrogen

K10 The hazards associated with hydrogen fuel cell electric vehicles when exposed to extreme temperatures, impact and other adverse conditions

K11 The implications of electrical conductivity through the human body and the potential medical conditions that can occur regardless of voltage or current type present in hydrogen fuel cell electric vehicles

You need to know

and understand:

K12 How to dispose of, recycle and return any removed hydrogen fuel cell electric vehicle components in line with legislative, environmental and organisational requirements

K13 How to work safely avoiding damage to other vehicle systems, components and units and contact with leakage and hazardous substances

K14 The importance of working to agreed timescales and keeping others informed of progress

K15 The relationship between time, costs and productivity

K16 The importance of reporting anticipated delays to the relevant person(s) promptly

Hydrogen fuel cell and the vehicle system principles

K17 The basic construction of a hydrogen polymer electrolyte/proton-exchange membrane (PEM) fuel cell

K18 The electrochemical reactions in a PEM fuel cell

K19 The purpose of the membrane in a PEM fuel cell

K20 How a PEM fuel cell operates

K21 The by-products of the PEM fuel cell chemical reaction

K22 The differences between PEM fuel cell and other alternative fuel cell technologies which may come into general use

K23 The reasons for connecting PEM fuel cells into a stack

K24 On-board hydrogen fuel storage and supply systems

K25 The sources of hydrogen

Hydrogen fuel cell electric vehicle system component faults, their diagnosis and rectification

K26 The components of alternative fuel sources and systems on electrically powered vehicles, including hydrogen fuel cells

K27 How hydrogen supply system components function and are constructed

K28 How the hydrogen fuel cell electric vehicle system and other vehicle systems interlink and interact

K29 How hydrogen fuel cell electric vehicle systems are dismantled, reassembled and adjusted to manufacturer's specifications

K30 The types and causes of hydrogen fuel cell electric vehicle system, component and unit **faults** and failures

K31 Hydrogen fuel cell electric vehicle system component unit and replacement procedures, the circumstances which will necessitate replacement and other possible courses of action

K32 The importance of working to recognised diagnostic and rectification procedures and processes and obtaining the correct information for diagnostic and rectification activities to proceed

K33 The importance of recording diagnostic and rectification information

K34 How to select the most appropriate **diagnostic testing** method for the symptoms presented

K35 How to carry out systematic **diagnostic testing** of hydrogen fuel cell electric vehicle systems using prescribed processes or formats

K36 How to assess the condition of hydrogen fuel cell electric vehicle system components and units

K37 How to interpret test results and vehicle data in order to identify the location and cause of hydrogen fuel cell electric vehicle system **faults**

K38 How to carry out the rectification activities in order to correct **faults** in the hydrogen fuel cell electric vehicle system

K39 The relationship between test methodology and the **faults** repaired – the use of appropriate testing methods

K40 How to make cost effective recommendations for rectification

Use of diagnostic and rectification equipment

K41 How to prepare and check the accuracy of **diagnostic testing equipment**

K42 How to use diagnostic and rectification **equipment** for hydrogen fuel cell electric vehicle systems, specialist repair tools and general workshop **equipment**

Vehicle system operation

K43 The main differences between a hydrogen fuel cell electric vehicle (FCEV) and a battery electric vehicle (BEV) and its operation

K44 How to safely operate a hydrogen fuel cell electric vehicle

K45 The specific manufacturer's guidelines and the precautions necessary when charging, connecting an auxiliary power source to or towing/lifting an electric vehicle

K46 The evacuation and re-fuelling systems associated with hydrogen fuel cell

electric vehicles and how to operate them safely

Scope/range

1. **Faults** occur within
   - 1.1. Fuel cells and fuel cell stack
   - 1.2. Hydrogen storage and supply
   - 1.3. On-board fuelling systems
   - 1.4. Safety and control systems
   - 1.5. Mechanical and electrical components
   - 1.6. Fluid systems

2. **Diagnostic methods** are
   - 2.1. sensory
   - 2.2. measurement
   - 2.3. functional testing

3. **Diagnostic Testing** is defined as**:**
   - 3.1. Identify the fault
   - 3.2. Verify the fault
   - 3.3. Collect further information
   - 3.4. Evaluate the evidence
   - 3.5. Carry out further tests in a logical sequence
   - 3.6. Rectify the problem
   - 3.7. Check all systems

4. **Equipment** is
   - 4.1. diagnostic and rectification equipment for hydrogen fuel cell electric vehicle systems
   - 4.2. hand tools
   - 4.3. code readers
   - 4.4. special tools, for example manufacturer specific equipment and software
   - 4.5. safe and appropriate electrical testing equipment
   - 4.6. relevant safety equipment
   - 4.7. hydrogen leak detector
   - 4.8. hydrogen evacuation equipment

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 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.

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)

Developed by	IMI
Version number	1
Date approved	Not yet approved
Indicative review date	31 March 2025
Validity	Draft
Status	Original
Originating organisation	IMI Ltd
Original URN	IMIEV08
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; Light Vehicle;
Key words	Hydrogen Electric Vehicle; diagnosis; rectification; electrical components; high voltage.