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## Overview

This standard is about diagnosing faults occurring in the light electric vehicle e-system, including the motor, controller, sensors and wiring. It is also about removing and replacing units and components, including after-market upgrades/enhancements, and evaluating the performance of the rectified system.

For the purposes of this standard, a light electric vehicle is any small vehicle powered by an electric motor (e-system) with 1, 2, 3 or more wheels, for example electric bikes, electric scooters, quadrimobiles, etc.

## Performance criteria

### You must be able to:

P1 use suitable personal protective equipment and vehicle coverings (where applicable) when using **diagnostic methods** and carrying out removal and replacement activities

P2 ensure vehicle and the work area is safe prior to commencing with any diagnostic, remove or replace activity

P3 support the identification of faults by reviewing light electric vehicle:

P3.1 technical data

P3.2 appropriate diagnostic test procedures

P3.3 legal requirements

P4 prepare and check all the required **tools and equipment** following manufacturer's instructions prior to use

P5 use **diagnostic methods** which are relevant to the symptoms presented

P6 collect sufficient diagnostic information in a systematic way to enable an accurate diagnosis of e-system faults

P7 correctly interpret test results from e-systems

P8 accurately identify and record any vehicle system deviation from acceptable limits

P9 ensure your assessment of removed **units and components** accurately identifies their condition and suitability for repair or replacement

P10 promptly inform the relevant person(s) where repairs are uneconomic or unsatisfactory to perform

P11 use the equipment required, correctly and safely throughout all **diagnostic methods** and remove or replace activities

P12 carry out all diagnose, remove and replace activities following:

P12.1 manufacturer's instructions

P12.2 industry recognised methods

P12.3 your workplace procedures

P12.4 health, safety and environmental requirements

P13 work in a way which minimises the risk of:

P13.1 damage to other vehicle systems, units and components

P13.2 contact with leakage and hazardous substances

P13.3 damage to your working environment

P13.4 injury to self and others

P14 ensure components returned to manufacturer or supplier are packaged and transported in line with legislation and manufacturer's guidance

P15 ensure all replaced **units and components** conform to the light electric vehicle operating specification and any legal requirements

P16 record and report any **light electric vehicle systems** that do not conform to legal requirements

P17 correctly adjust **units and components** to ensure that they operate to meet light electric vehicle system requirements, when necessary

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P18 promptly record and report any additional faults you notice during the course of work

P19 use **testing methods** which are appropriate for assessing the performance of the rectified system

P20 ensure the rectified e-system and any other **light electric vehicle system** that might have been affected by the work carried out, perform to the light electric vehicle operating specification and any legal requirements prior to return to the customer

P21 ensure your records are accurate, complete and promptly passed to the relevant person(s) in the format required

P22 complete all system diagnostic and removal and replacement activities within the agreed timescale

P23 promptly report any anticipated delays in completion to the relevant person(s)

## Knowledge and understanding

You need to know and understand:

### Legislative and organisational requirements and procedures

K1 the health and safety legislation environmental requirements and workplace procedures relevant to workshop practices and personal and vehicle protection when diagnosing e-system faults

K2 legal requirements relating to the light electric vehicle and e-system (including road safety and environmental requirements)

K3 your workplace procedures for:

K3.1 recording diagnostic and removal and replacement information

K3.2 the referral of problems

K3.3 reporting delays to the completion of work

K4 the importance of documenting diagnostic and rectification information

K5 the importance of working to agreed timescales and keeping others informed of progress

K6 the relationship between time, costs and productivity

K7 the importance of promptly reporting anticipated delays to the relevant person(s)

K8 the implications on warranty where adjustments or replacements fall outside of acceptable parameters

K9 how to package and transport **e-system units and components** in line with legislation and manufacturer's guidance

### Use of technical information

K10 how to find, interpret and use sources of information applicable to **e-system unit and component** removal and replacement

K11 the importance of using the appropriate sources of technical information

K12 how to find, interpret and use sources of information on e-system electrical and electronic operating specifications, diagnostic test procedures, repair procedures and legal requirements

### Equipment

K13 how to prepare, check and use all the removal and replacement **tools and equipment** required

K14 how to prepare and confirm the accuracy of diagnostic testing equipment

### Electrical and electronic principles

K15 electrical and electronic principles, including Ohms Law, voltage, power, current (AC/DC) resistance, magnetism, electromagnetism, electromagnetic induction, EMC, digital and fibre optics principles

K16 types of circuit protection and why they are necessary

K17 how electrical and electronic systems operate, including electrical component function, electrical inputs, outputs, voltages, oscilloscope patterns and digital principles

K18 the interaction between electrical, electronic and mechanical components within e-systems

K19 electrical symbols, units and terms

K20 electrical safety procedures

K21 the hazards associated with working on or near high voltage electrical systems and components

### **E-system operation and construction**

K22 how e-systems and their related **units and components** are constructed and their operation

K23 how e-systems and their related **units and components** are dismantled and reassembled for the types of light electric vehicle on which you work

K24 how to remove and replace e-system mechanical and electrical **units and components** for the types of light electric vehicle on which you work

K25 how **light electric vehicle systems** and components interlink, including multiplexing

K26 how adjustments made to the e-system might affect how other systems or units operate

### **E-system faults, their diagnosis and correction**

K27 the types and causes of **e-system unit and component** faults and failures

K28 **e-system unit and component** replacement procedures, the circumstances which will necessitate replacement and other possible courses of action

K29 vehicle operating specifications for limits, fits and tolerances relating to e-systems for the types of light electric vehicle on which you work

K30 how to select and carry out the correct diagnostic testing method

K31 how to assess and interpret results of the condition of components

K32 how to make cost effective recommendations for rectification

K33 how to carry out system rectification activities in order to correct faults in the light electric vehicle e-system

K34 the relationship between test methodology and the faults rectified – the use of appropriate **testing methods**

K35 how to ensure all **light electric vehicle systems** operate correctly following rectification activities

## Scope/range

### 1. **Light electric vehicle systems** are:

- 1.1. mechanical systems
- 1.2. electrical systems
- 1.3. electronic systems

### 2. **E-system units and components** are:

- 2.1. batteries
- 2.2. motors
- 2.3. controllers
- 2.4. sensors
- 2.5. actuators
- 2.6. electronic control unit (ECU)
- 2.7. wiring

### 3. **Diagnostic and testing methods** are:

- 3.1. sensory
- 3.2. functional
- 3.3. measurement

### 4. **Tools and equipment** include:

- 4.1. hand tools
- 4.2. special workshop tools
- 4.3. general workshop equipment
- 4.4. electrical and electronic testing equipment
- 4.5. diagnostic and rectification equipment for e-systems

### 5. **Rectification activities** are:

- 5.1. dismantling
- 5.2. replacement of units and components
- 5.3. adjustment of units and components
- 5.4. repairs to wiring and connectors
- 5.5. re-programming e-systems
- 5.6. updating operating software
- 5.7. reassembly
- 5.8. functional testing

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## Glossary

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

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### **Agreed timescales**

Examples include job times set by your company or agreed with a specific customer.

### **Dismantled**

For this standard, components will not be dismantled for overhaul purposes. However systems will be dismantled for components to be inspected and potentially returned to the manufacturer/supplier.

### **Functional diagnostic methods**

Examples include: to include performance testing and road testing where relevant

### **Light electric vehicle**

For the purposes of this standard, a light electric vehicle is any small vehicle powered by an electric motor (e-system) with 1, 2, 3 or more wheels, for example electric bikes, electric scooters, quadrimobiles, etc.

### **Recommendations**

Examples include servicing, dismantling for further inspection and test, repair and replacement

### **Sensory diagnostic methods**

These may include looking, listening, smelling and touching for heat.

IMICY14

Diagnose faults and remove and replace light electric vehicle e-system units and components



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