

Automotive and Bodyshop Competence Awards Service and Repair of Electric and Hybrid Vehicles

Accreditation Overview

The accreditation will enable the candidate to demonstrate their:

- knowledge in working safely on electric and hybrid vehicles
- competence in removing and replacing high voltage components
- competence in diagnosing and rectifying high voltage electrical faults

Practical Assessment Requirements

The candidate must be able to demonstrate, whilst being observed:

- selecting and wearing the appropriate 'high voltage' personal protective clothing
- observing safety information prior to starting work on the vehicle
- identifying high voltage components and cables
- carrying out an initial risk assessment on the vehicle for the work being carried out
- carrying out checks, looking for damage to visible parts of the high and low voltage systems and recording where applicable
- notifying colleagues of their intention to work on a high voltage vehicle and complete the appropriate documentation
- locating and consulting appropriate repair methods and data
- checking for any existing diagnostic trouble codes (DTCs) in the system
- diagnosing the electrical fault following the vehicle manufacturer's guidelines
- following '*power down*' procedures, including isolating the high voltage system and the ancillary battery
- selecting and collating tools and equipment which are required to carry out the work
- carrying out an appropriate test to ensure the remaining voltage is below the manufacturer's specification and state the vehicle is safe to work on
(Assessor to comment on processes such as waiting times, observing MIL lights, and state the actual identified voltage)
- removing a high voltage component in accordance with the manufacturer's guidelines
- checking to ensure that the replaced high voltage electrical component meets the manufacturer's specification
- replacing the high voltage component in accordance with the manufacturer's guidelines
- following the vehicle manufacturer's procedures to reinstate the high voltage system

- using testing methods to assess the performance of the reassembled vehicle systems
- carrying out diagnostic checks and analyse results to ensure that the vehicle meets the manufacturer’s specification and legal requirements, including checking warning lamps and diagnostic trouble codes
- working in a way which minimises the risk of damage to other vehicle systems, components, units and bodywork
- working safely and legally throughout the task and considered the safety of others
- completing the task within the timescale allowed

Knowledge Assessment Overview

The knowledge assessment is set by Skills and Education Group Awards. For this accreditation this will be in the form of a centre invigilated multiple choice online test. The assessment has 25 multiple choice questions in total, which are selected at random.

Please note: candidates must achieve a minimum of 60% in each section, with an overall minimum of 80% to achieve a pass. Failure to do so will require the candidate to take a resit of the complete online assessment, not just the failed section(s). Any candidate that is referred must be prevented from continuing with the skills (practical) assessment.

The maximum time allowed to complete the assessment is **50 minutes** and the questions will assess the knowledge from across the breadth of the criteria in the following way:

Subject	Number of questions
1. Safety Practices for Hybrid and Electric Vehicles	5
2. Electrically propelled vehicles and the terminology associated with them	5
3. Hybrid and Electric Vehicle Components and their Function(s)	5
4. Hybrid and Electric Vehicle Electrical Circuits	5
5. Rectify Hybrid and Electric Vehicle Faults Using Technical Information	5

Knowledge Assessment Requirements

Electrically propelled vehicles and the terminology associated with them

The candidate needs to:

- explain why electrically propelled vehicles have evolved
- define terminology and acronyms associated with hybrid and electric vehicles and their systems
- explain the differences between an electric, hybrid and non-electric vehicle

Safety practices for hybrid and electric vehicles

The candidate needs to:

- explain the types of personal protective equipment which is required to work on hybrid and electric vehicle systems
- explain how to assess the hazards and risks associated with high energy electrical vehicle components
- explain the health and safety procedures for working on hybrid and electric vehicles
- explain the implications of electrical and magnetic conductivity through the human body and its effects on life-saver devices

Hybrid and electric vehicle components and their function(s)

The candidate needs to:

- explain how to operate an electric and hybrid vehicle
- explain how to locate and interpret technical data and researched repair methods
- explain the consequences of failing to use the correct technical information
- explain the different types of energy storage systems and voltages associated with them
- explain how components work in conjunction with associated components
- explain how to interpret technical information to remove and replace components and trim

Hybrid and electric vehicle electrical circuits

The candidate needs to:

- analyse a range of vehicle manufacturers' methods used to protect the vehicle and its components from damage
- explain the procedures to isolate hybrid and electric vehicles
- explain how to identify the location of high energy electrical cables and components
- explain electrical / electronic principles and circuit protection methods
- explain the construction, operation and specification of high voltage electrical components
- explain how to use electrical testing equipment and electrical testing techniques

- explain how to identify damage to high voltage connections and cables
- critically compare electrical test results to identify serviceability of components in a high voltage electrical system
- explain the procedures to reinstate the high voltage system
- explain the precautions which are necessary when charging, jump starting or towing an electric or hybrid vehicle

Rectify hybrid and electric vehicle faults using technical information

The candidate needs to:

- explain how to diagnose and rectify vehicle electrical faults and draw conclusions from the results
- explain how to test and evaluate the performance of replacement components and ensure they meet operating specifications and legal requirements
- describe the process to charge electric and hybrid vehicle batteries

Knowledge Criteria

To successfully complete the online assessment the candidate must have current knowledge in the following subject areas:

Personal health and safety to include:

- legislation appropriate to electric and hybrid vehicles
- PPE
- the removal of jewellery and watches prior to commencing work
- how to work safely, taking others into consideration
- the use of and importance of warning signs and communication when working on hybrid and electric vehicles
- safety considerations regarding magnetic components
- the effects of interference from magnetic radiation on lifesaving devices and equipment such as pacemakers and defibrillators

Health and safety practices when working on high voltage electrical systems to include:

- initial and dynamic risk assessments
- types of hazards
- levels of risks
- methods which can be used to eliminate hazards and reduce the levels of risk

Terminology and acronyms associated with hybrid and electric vehicles to include:

- **PHEV** – Plug In Hybrid Electric Vehicle
- **EV** – Electric Vehicle ('pure electric')
- **RE** – Range Extender
- **HEV** – Hybrid Electric Vehicle
- **Series Hybrid** – A system in which a vehicle is propelled solely by the electric motor. The internal combustion engine provides energy and recharges the battery, but in series mode, the engine does not mechanically drive the wheels
- **Parallel Hybrid** – When a vehicle is propelled by both the engine and/or electric motor(s)
- **Regenerative braking** – An energy recovery system used in electric and hybrid vehicles that can help charge the battery while the car is slowing down. Typically the electric motor acts as the generator
- **Trickle Charging** - The slowest type of charging, this is best reserved for long overnight charges at home and is typically provided by a standard 3 pin plug.
- **Fast Charging** - Ideal for top up charging, this can provide up to 30 miles of range per hour of charging, or a full charge in a few hours. Fast chargers are ideal for keeping you going while out and about, and are typically found in public car parks.
- **Rapid Charging** - Rapid chargers typically allow for around 80% charge in as little as 20 minutes. This is useful for longer road trips and journeys beyond your local area
- **kWh** - A unit of energy equivalent to the energy transferred in one hour by one kilowatt of power.
- **Battery cell, module and pack**

The differences between an electric, hybrid and non-electric vehicle to include:

- hybrid vehicles – how they produce power and the combinations
- electric vehicles power comes from electrical sources
- quick identification – electric vehicles do not have an exhaust system

Hybrid and electric vehicles to include:

- reasons for manufacturing hybrid and electric vehicles
- methods of identifying different types of hybrid and electric vehicles
- methods used to locate vehicle identification numbers and identify the vehicle accurately
- technical information
- construction and layout
- vehicle operation

- drivetrain configurations
- methods of identifying vehicle cables and the systems that they are connected to

Vehicle operation and dashboard displays to include:

- identifying symbols and their meaning
- warning lights and their meanings
- audible warnings and their meanings
- different vehicle modes, for example 'ready' / power modes
- vehicle owner manuals and operation of electric and hybrid vehicles

Electric and hybrid component identification, construction, location and function to include:

- systems charge ports, cables and plug types
- automatic shut off devices and high voltage service disconnects
- battery types and their construction: high voltage batteries and low voltage auxiliary batteries
- the hazards associated with high voltage batteries when exposed to extreme temperatures, and impacts from other adverse conditions
- wiring
- inverter / converter
- DC/DC converters
- power control units
- electric motors, their construction and outputs
- engines / range extenders, electrical generators
- air conditioning compressors and climate control systems
- battery cooling systems

Additional vehicle systems and their relationship with electric and hybrid vehicle components to include:

- transmissions systems, transmissions control and drive modes
- engines and motors
- engine cooling
- braking and regenerative braking systems
- steering
- suspension

Trim and component removal to include:

- interpretation of technical information to remove and replace components and trim
- consequences of failing to use technical information to support the remove and replace components and trim

High voltage circuits to include:

- how to identify them
- identifying damage to cables and connectors
- protecting electrical systems and components from damage
- warning symbols: decals / stickers
- fuses
- interlock circuits
- service disconnect
- thermal sensors

Workshop equipment to include:

- specialist tools
- electrical testing equipment
- diagnostic equipment

Wiring diagrams to include:

- interpretation of information
- location of connections and components
- how to use wiring diagrams to support the identification and rectification of faults

Electrical measurements to include:

- current
- voltage
- resistance

Electrical testing methods to include diagnosing:

- a short circuit
- an open circuit
- high resistance
- analysing and critically comparing electrical test results to identify serviceability of components

Vehicle isolation to include:

- 'powering down' and shutdown procedures
- capacitors and procedures to discharge stored electrical energy

Reinstate high voltage systems to include:

- procedures
- precautions when charging, jump starting or towing

Component removal and refitting procedures to include:

- service procedures
- repair procedures
- manufacturers' guidelines
- researched repair methods
- timescales

System testing, troubleshooting and diagnostics to include:

- locating troubleshooting guides
- how to identify component faults and failure
- circuit and component testing
- how to ensure diagnosis of faults are accurate
- how to calibrate and interpret test equipment results
- retrieving and referencing vehicle fault codes
- how to interpret test equipment readings
- the purpose and procedures of a function check after repair
- how to make comparisons between actual testing results with vehicle manufacturers' specifications
- how to ensure the vehicle meets legal requirements and is roadworthy

Recording information to include:

- recording results and readings
- job related information / job cards
- faults and rectification work
- vehicle information
- parts information

Waste disposal and recycling of:

- batteries
- fluids
- electrical and electronic components
- mechanical components
- hazardous materials

Vehicle charging to include:

- state of charge
- workshop charging procedures and methods (plug in and workshop chargers)

Additional Prerequisites (not stated in the Centre Guidance)

To be eligible to undertake this Accreditation the candidate must meet all prerequisites as stated in the Centre Guidance document and:

- have at least two years' experience to ensure they have the sufficient skills and knowledge to remove, replace, diagnose and rectify high voltage/high energy components in a non-live state