



Australian Government

**AURETHX03 Diagnose and repair high
voltage rechargeable energy storage systems
in battery electric vehicles**

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Modification History

Release	Comments
1	This unit of competency was first released in AUR Automotive Retail, Service and Repair Training Package Release 11.0.

Application

This unit describes the skills and knowledge required to diagnose and repair faults in the high voltage (HV) rechargeable energy storage systems (RESS) of battery electric vehicles (BEVs).

Repair in this unit includes the removal and replacement of faulty battery cells or modules. It does not include the repair of battery cells or modules themselves.

The unit involves preparing for the task, sourcing a diagnostic testing strategy, diagnosing the cause of the fault, carrying out the repair, performing post-repair testing, and completing workplace processes and documentation.

The unit applies to those who work in the automotive service and repair industry and applies to vehicles fitted with a RESS. Work is undertaken in line with manufacturer specifications and AS 5732. This unit applies the same voltage definitions as Australian Standards (AS) 5732 Electric Vehicle operations - Maintenance and repair.

Licensing/Regulatory Information

Licensing, legislative and certification requirements that apply to this unit can vary between States, Territories and industry sectors, and must be sourced from state jurisdictions prior to applying the unit.

Pre-requisite unit(s)

AURETHX01 Depower and reinitialise electric vehicles

Competency field(s)

N/A

Unit sector(s)

Electrical Technical - Hybrid Vehicle and Battery Vehicle

Elements and Performance Criteria

Element	Performance criteria
<i>Elements describe the essential outcomes.</i>	<i>Performance criteria describe the performance needed to demonstrate achievement of the element.</i>
1. Prepare to diagnose and repair high voltage rechargeable energy storage system	1.1 Determine job requirements from workplace instructions 1.2 Access and interpret manufacturer procedures, workplace procedures and applicable standards required for the diagnosis activity 1.3 Analyse diagnostic options and source testing strategy to identify cause of fault using workplace and manufacturer procedures 1.4 Identify hazards and environmental issues associated with diagnose and repair activity, assess risks and implement control measures according to safety requirements, workplace policies and procedures 1.5 Select and inspect tools, PPE and equipment required for testing strategy and establish serviceability according to workplace procedures 1.6 Apply warning tags and signage to vehicle to indicate potential hazards according to workplace procedures
2. Diagnose rechargeable energy storage system	2.1 Implement diagnostic tests set out in testing strategy according to manufacturer and workplace procedures, and workplace health and safety requirements 2.2 Retrieve and interpret battery management system data, including live data and diagnostic trouble codes, according to manufacturer procedures 2.3 Identify cause of fault through analysis of diagnostic test results 2.4 Confirm and report cause of fault according to workplace procedures 2.5 Identify any faults requiring work outside of job role or scope, and escalate according to workplace and manufacturer procedures 2.6 Develop and report recommendations for necessary repairs according to workplace procedures
3. Repair rechargeable energy storage systems	3.1 Access and interpret manufacturer procedures and applicable standards required for the repair activity

	3.2 Select and inspect tools, PPE, equipment and materials required for repair activity and establish serviceability according to workplace procedures 3.3 Isolate high voltage RESS using the isolation method specified in manufacturer procedures 3.4 Confirm high voltage system is depowered by testing and verifying components and equipment are at a zero-energy state according to manufacturer procedures 3.5 Secure isolation against accidental or unauthorised reactivation according to workplace and manufacturer procedures 3.6 Carry out repair, including balancing battery modules where required, according to workplace and manufacturer procedures, manufacturer specifications, work health and safety and environmental requirements 3.7 Reconnect high voltage RESS and reinitialise vehicle according to manufacturer procedures 3.8 Carry out post-repair testing according to workplace procedures, work health and safety and environmental requirements
4. Complete work processes	4.1 Conduct final inspection according to workplace procedures and confirm vehicle is ready for use 4.2 Clear work area and dispose of or recycle materials, including high voltage battery components, according to workplace and regulatory requirements 4.3 Complete documentation according to workplace procedures

Range of conditions

N/A

Assessment Requirements for AURETHX03 Diagnose and repair high voltage rechargeable energy storage systems in battery electric vehicles

Performance Evidence

The candidate must demonstrate the ability to complete the tasks outlined in the elements and performance criteria of this unit, including evidence of the ability to:

- diagnose and repair high voltage (HV) rechargeable energy storage systems (RESS) in at least two different battery electric vehicles to correct at least one of the following performance deficiencies in each:
 - high resistance in an input system
 - component failure
 - abnormal or irregular noises

In the course of the above, the candidate must:

- balance the battery modules within a RESS pack on at least one occasion
- identify and apply manufacturer-specific information and procedures, WHS and AS 5732 requirements
- apply electrical isolation procedures appropriate to the RESS configuration of each vehicle
- use test equipment to verify no residual high voltage before commencing service or repair work, in accordance with manufacturer specifications.

Knowledge Evidence

The candidate must be able to demonstrate knowledge to complete the tasks outlined in the elements, performance criteria and foundation skills of this unit, including knowledge of:

- the requirements to diagnose and replace high voltage rechargeable energy storage systems in battery electric vehicles, including:
 - information provided by customers and supervisors
 - Australian Standards (AS) 5732 Electric vehicle operations - Maintenance and repair
 - manufacturer specifications and procedures
- workplace procedures required to diagnose and replace high voltage rechargeable energy storage systems in battery electric vehicles, including:
 - establishing serviceability of tools and equipment
 - documentation procedures
 - housekeeping procedures, including:

- examination of tools and equipment
 - storage of equipment
 - identification, tagging and isolation of faulty equipment
 - disposal of excess materials, including high voltage battery components
 - recycling procedures, including those for high voltage battery components
- limits of own job role and scope of work, and workplace procedures for escalating work outside that scope, including who to notify and the information to provide
- workplace health and safety (WHS) requirements relating to diagnosing and replacing high voltage rechargeable energy storage systems in battery electric vehicles, including procedures for:
 - identifying hazards and controlling risks associated with:
 - working with high voltages in BEV electrical systems, including electric shock, arc flash and arc blast
 - energy stored in the RESS, including energy retained after the RESS is isolated
 - wearing jewellery, watches and other conductive items while working on or near high voltage systems
 - determining appropriate procedures for minimising risk associated with hazards, including applying electrical safety precautions when:
 - using personal protective equipment (PPE), including arc-rated (CAL-rated) protective clothing of an appropriate rating
 - responding to the indicators of a battery thermal management event or thermal runaway according to workplace emergency procedures, including evacuation and exclusion zone control
 - escalating a high voltage or thermal event to emergency services according to workplace emergency response procedures
 - following live system warning tags and signs
 - stabilising vehicle electrical system
- environmental requirements relating to diagnosing and replacing high voltage rechargeable energy storage systems in battery electric vehicles, including procedures for:
 - trapping, storing and disposing of waste produced during repair
 - handling, storing, transporting and disposing of high voltage battery components, including disposal through an authorised waste or recycling facility where manufacturer procedures do not specify a disposal pathway
 - safety data sheets (SDS)
- safe operating procedures for tools and equipment, including:

- digital multimeter and other test equipment rated in accordance with manufacturer specifications and the applicable standard
 - insulation tester
 - residual voltage tester
 - scan tool
 - oscilloscope
- operating principles of high voltage rechargeable energy storage systems in battery electric vehicles, including:
 - battery pack construction, including:
 - battery types
 - battery internal resistance
 - battery pack system, including:
 - charging characteristics
 - open circuit cells
 - series cell configuration
 - methods of interconnecting cells and modules within a RESS pack, including busbars and bolted straps
 - physical arrangement of cells and modules within a RESS pack and its effect on thermal management and structural integrity
- purpose and operation of high voltage rechargeable energy storage systems in battery electric vehicles and components, including:
 - HV battery charger and direct current (DC) to DC converter
 - battery management system (BMS), including cell and module monitoring, balancing, thermal control and fault detection
 - power distribution unit (PDU)
- diagnostic testing procedures for high voltage rechargeable energy storage systems in battery electric vehicles, including procedures for:
 - accessing and interpreting scan tool system data, including:
 - diagnostic trouble codes (DTCs)
 - live data
 - freeze frame data
 - waveforms
 - using diagnostic flow charts
 - interpreting battery management system live data, including cell and module voltages, temperatures and state of charge

- identifying software-related faults, including control module software versions and update procedures
- electrical system testing, including procedures for:
 - accessing electrical terminals and using test probes without damaging connectors, fuse holders or wiring
 - testing controller input and output signals and waveforms
 - vehicle dynamic and static testing procedures
 - analysing abnormal noise
 - analysing component failure
- RESS cooling system testing
- repair procedures for high voltage rechargeable energy storage systems in battery electric vehicles, including procedures for:
 - tightening connections
 - replacing faulty or damaged cable connections
 - removing and replacing faulty or damaged components
- post-repair testing procedures for high voltage rechargeable energy storage systems in battery electric vehicles, including procedures for:
 - DTC clearing procedures
 - checking for electrical connector mating
 - performance testing RESS

Assessment Conditions

Assessment must include direct observation of tasks.

Where assessment of competency includes third-party evidence, it must identify the individual and each electric vehicle by VIN, including isolation and voltage verification results, and be signed by a workplace supervisor competent in diagnosing and replacing high voltage RESS in electric vehicles. Assessors must confirm its authenticity with the third party.

Assessors must verify performance evidence through questioning on skills and knowledge to ensure correct interpretation and application.

The following resources must be made available:

- automotive repair workplace or simulated workplace
- AS 5732 Electric vehicle operations - Maintenance and repair
- PPE and safety equipment, including electrical safety gloves of an appropriate voltage rating in accordance with AS 5732, arc-rated clothing and face protection, and an insulating mat
- manufacturer specifications and procedures for the BEV and RESS undertaking diagnosis and repair

- two different BEVs with RESS and associated components accessible for diagnosis and replacement activities as specified in the performance evidence
- electrical test equipment including:
 - digital multimeter in accordance with manufacturer specifications and the applicable standards
 - insulation tester
 - residual voltage tester, if specified in original equipment manufacturer (OEM) specifications
 - scan tool
 - oscilloscope
- tools, equipment and materials appropriate for repairing BEV and RESS and their components.

Assessors of this unit must satisfy the requirements for assessors in applicable vocational education and training legislation, frameworks and/or standards.

Mandatory Workplace Requirements

Assessment of performance evidence may be in a workplace setting or an environment that accurately represents a real workplace.

Unit Mapping Information

Previous Code and Title	Equivalence	Comments
AURETH103 Diagnose and repair high voltage rechargeable energy storage systems in battery electric vehicles	Not equivalent	Updated Title, Application, Elements, Performance Criteria, Foundation Skills, Performance Evidence, Knowledge Evidence, and Assessment Conditions. Application now specifies that the unit applies to the replacement of cells and modules, and not repairs.

Links

Companion volumes, including implementation guides, are found on the national training register - <https://training.gov.au/training/details/AUR>.