



Australian Government

AURETHX05 Diagnose and repair traction motors 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 traction motors of battery electric vehicles (BEVs). The unit involves preparing for the task, sourcing a diagnostic testing strategy, diagnosing the cause of the fault, depowering the high voltage (HV) rechargeable energy storage system (RESS), carrying out the repair, reinitialising the vehicle, performing post-repair testing, and completing workplace processes and documentation.

The unit emphasises the safe application of electrical safety procedures when working on the high voltage RESS. This unit applies the same voltage definitions as Australian Standards (AS) 5732 Electric vehicle operations - Maintenance and repair.

The unit applies to those who work in the automotive service and repair industry and applies to vehicles fitted with a RESS. It does not apply to mobile plant or agricultural machinery. Work is undertaken in line with manufacturer specifications and AS 5732.

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)

Electrical

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 traction motors	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, and AS 5732 1.5 Select and inspect tools, PPE and equipment required for testing strategy and establish serviceability according to workplace procedures
2. Diagnose high voltage traction motors	2.1 Implement diagnostic tests set out in testing strategy according to manufacturer and workplace procedures, and work health and safety requirements 2.2 Retrieve and interpret traction motor fault codes and control data, including data on the interaction between the traction motor, the inverter and vehicle control systems, 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 high voltage traction motors	3.1 Access and interpret manufacturer procedures, workplace procedures and applicable standards required for the repair activity 3.2 Select and inspect tools, equipment, PPE 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 repairs according to workplace and manufacturer procedures, manufacturer specifications, work health and safety and environmental requirements 3.7 Reinitialise vehicle according to manufacturer procedures 3.8 Carry out manufacturer required calibration, coding or initialisation procedures following traction motor or sensor replacement 3.9 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 according to workplace procedures 4.3 Complete documentation according to workplace procedures

Range of conditions

N/A

Assessment Requirements for AURETHX05 Diagnose and repair traction motors 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) traction motor systems and associated components on at least two battery electric vehicles (BEVs) to correct at least one of the following performance deficiencies in each:
 - damaged or faulty cabling
 - component failure
 - damaged traction motor windings

In the course of the above, the candidate must:

- identify and apply manufacturer-specific information and procedures, WHS and AS 5732 requirements
- measure the insulation resistance of the traction motor windings on each vehicle and interpret the result against manufacturer specifications.
- 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 and performance criteria of this unit, including knowledge of:

- methods to locate and interpret information required to diagnose and repair high voltage traction motors 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 repair high voltage traction motors 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
 - recycling procedures
- 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 repairing high voltage traction motors in battery electric vehicles, including procedures for:
 - identifying hazards and controlling risks associated with:
 - working with high voltages in vehicle 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 jewellery 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 electrical safety gloves and 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 control
 - escalating a high voltage or thermal event to emergency services according to workplace emergency response procedures
 - following live system warning tags and signs
 - establishing and controlling a high voltage isolation zone, including exclusion zones and arc flash boundaries
- environmental requirements relating to diagnosing and repairing high voltage traction motors in battery electric vehicles, including:
 - procedures for trapping, storing and disposing of waste produced during repair
 - safety data sheets (SDS)
- safe operating procedures for tools and equipment, including:
 - digital multimeter and other test equipment suitably rated in accordance with manufacturer specifications and the applicable standard
 - insulation tester
 - residual voltage tester

- scan tool
 - oscilloscope
- operating principles of high voltage traction motors in battery electric vehicles, including:
 - motor generators
 - types of batteries
 - battery charging
- purpose and operation of high voltage traction motors in battery electric vehicles and components, including:
 - direct current (DC) motor generators
 - alternating current (AC) motor generators
 - control logic and torque control strategies, including the interaction between the traction motor, the inverter and vehicle control systems
- diagnostic testing procedures for high voltage traction motors in battery electric vehicles, including procedures for:
 - accessing and interpreting scan tool system data, including:
 - diagnostic trouble codes (DTCs)
 - live data
 - freeze frame data
 - using diagnostic flow charts
 - interpreting traction motor fault codes and control data
 - electrical system testing, including procedures for:
 - accessing electrical terminals and using test probes without damaging connectors, fuse holders or wiring
 - determining damage to traction motor windings
 - checking insulation resistance of traction motor windings
 - checking routing and damage to HV cabling
 - conducting vehicle dynamic and static tests
 - analysing abnormal noise
 - analysing component failure
- repair procedures for high voltage traction motors in battery electric vehicles, including procedures for:
 - tightening connections
 - replacing faulty or damaged cable connections
 - removing and replacing faulty or damaged components

- removing and replacing the traction motor
- post-repair testing procedures for high voltage traction motors in battery electric vehicles, including procedures for:
 - DTC clearing procedures
 - checking for electrical connector mating
 - manufacturer-required calibration, coding or initialisation procedures following traction motor or sensor replacement
 - static and dynamic performance tests of traction motors.

Assessment Conditions

Competency is to be assessed in the workplace or a simulated environment that accurately reflects performance in a real workplace setting.

Assessment must include direct observation by the assessor of the individual, confirming the BEV is safe to work on, in accordance with manufacturer specifications, before inspecting high voltage components, and diagnosing and repairing the BEV. Third party evidence must not replace this observation.

Where assessment of competency includes third-party evidence, it must identify the individual and each BEV by VIN, include reference to the manufacturer procedure followed, include record confirming the BEV was safe to work on before high voltage components were inspected and be verified and signed by a workplace supervisor who is competent in diagnosing and repairing BEVs.

The following resources must be made available:

- workplace or simulated workplace appropriate to the vehicles being diagnosed and repaired
- 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 repair procedures for BEV HV traction motor systems of the vehicles being diagnosed and repaired
- AS 5732 Electric vehicle operations - Maintenance and repair
- two different BEVs with HV traction motor systems accessible for diagnosis and repair or replacement activities as specified in the performance evidence
- electrical diagnostic equipment appropriate to the BEV being diagnosed and repaired, including:
 - digital multimeter and other test equipment rated in accordance with manufacturer specifications and the applicable standard
 - insulation tester
 - scan tool, or equivalent electronic isolation and diagnostic equipment
 - oscilloscope

- residual voltage tester, if specified in original equipment manufacturer (OEM) test requirements
- tools, equipment and materials appropriate for repairing HV traction motors in BEVs.

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
AURETH105 Diagnose and repair high voltage traction motors in battery electric vehicles	Equivalent	

Links

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