AS 5732:2022

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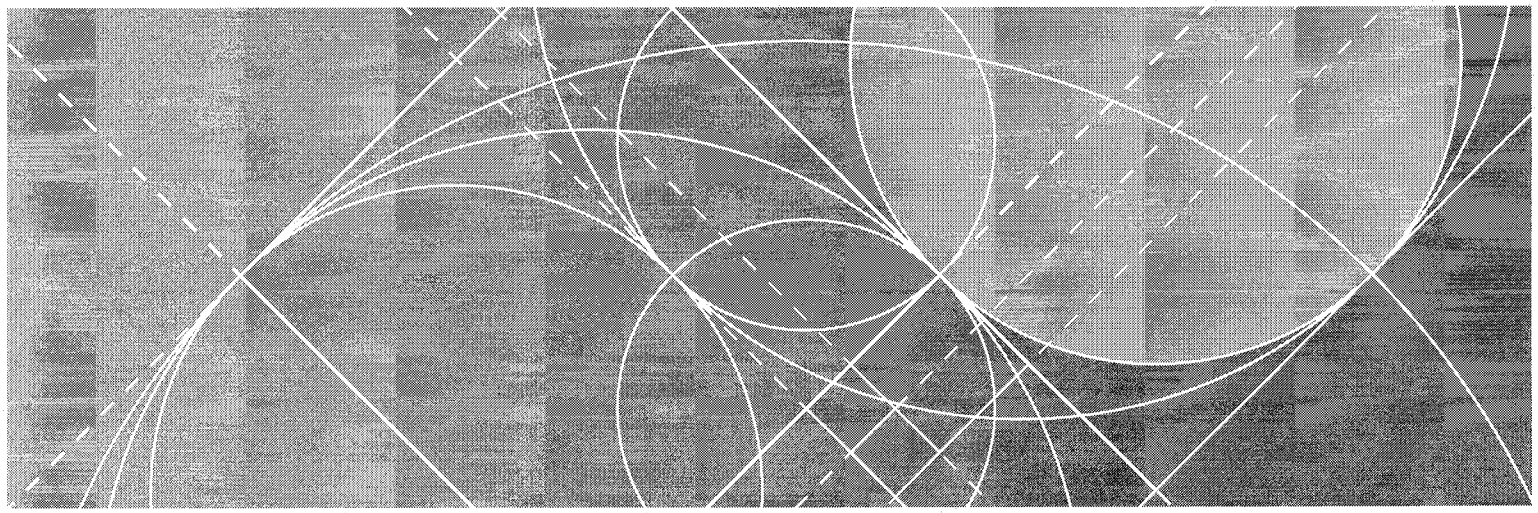
Electric vehicle operations — Maintenance and repair



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ARRB (Australian Road Research Board)
Australian Automobile Association
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Australian Electric Vehicle Association
Australian Industry Group
Consumers Federation of Australia
CSIRO
Department of Industry, Science and Resources
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Electric vehicle operations — Maintenance and repair

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Preface

This Standard was prepared by the Standards Australia Committee EM-001, Electric Vehicle Operation, to supersede AS 5732:2015.

The objective of this document is to provide requirements and guidance on the safe and appropriate handling procedures for those within the mechanical repair, body repair and refinishing industries when working on plug-in electric vehicles (PEVs), hybrid electric vehicles (HEVs), battery electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs), and fuel cell electric vehicles (FCEVs).

The major changes in this edition are as follows:

(a) Alignment with AS 60903's latest changes regarding insulating gloves.

(b) Additional guidance on safety and Personal Protective Equipment (PPE), particularly in relation to electrical hazards and the availability of an automated external defibrillator (AED).

(c) Inclusion of fuel cell electric vehicles.

Contents

NOTES

Australian Standard®

Electric vehicle operations — Maintenance and repair

Section 1 Scope and general

1.1 Scope

This document sets out requirements for the premises and procedures for the following types of work or activity associated with plug-in electric vehicles (PEVs), hybrid electric vehicles (HEVs), battery electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs), and fuel cell electric vehicles (FCEVs):

(a) Routine motor vehicle maintenance and repairs not involving the high voltage (HV) rechargeable electric energy storage system (REESS), including lubrication, brake repair, wheel alignment, body or windscreen repairs, cleaning or detailing, and tyre fitting.

(b) Maintenance, servicing and repairs to vehicles which involve working on or with a HV REESS including the need to disconnect hazardous voltage systems of the PEV, HEV, BEV, PHEV or FCEV.

(c) Handling procedures and storage precautions required in the event where the vehicle's structural integrity has been compromised, and the REESS is to be removed from the PEV, HEV, BEV, PHEV or FCEV.

NOTE Refer to ENA NENS 09 for potential FCEV hazards related to hydrogen systems. Hydrogen system risks in FCEVs are notaddressed in this document, and require additional risk mitigation measures from sources other than this document.

1.2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document.

NOTE Documents referenced for informative purposes are listed in the Bibliography.

AS 1851, *Routine service of fire protection systems and equipment*

AS 2441, *Installation of fire hose reels*

AS/NZS 1221, *Fire hose reels*

AS/NZS 1841.1, *Portable fire extinguishers, Part 1: General requirements*

AS/NZS 1841.5, *Portable fire extinguishers, Part 5: Specific requirements for powder type extinguishers*

AS/NZS 1841.6, *Portable fire extinguishers, Part 6: Specific requirements for carbon dioxide type extinguishers*

AS/NZS 1850, *Portable fire extinguishers — Classification, rating and performance testing*

AS/NZS 2210.1, *Safety, protective and occupational footwear, Part 1: Guide to selection, care and use*

AS/IEC 60903, *Live working — Electrical insulating gloves*

1.3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

1.3.1
acid spill containment mat
flexible, powder-filled cloth mat used to absorb and contain electrolytes

1.3.2
automated external defibrillator
AED
medical device designed to restore a person's normal heartbeat by sending electrical pulses to the heart

1.3.3
battery electric vehicle
BEV
vehicle that sources its energy from an internal rechargeable storage system, and can be recharged from an external electrical energy source

1.3.4
competent person
person who has acquired, through education, training, qualification or experience or a combination of these, the knowledge and skill enabling that person to perform the task required

1.3.5
covered tool
electrical insulated tool that has not been routinely electrically tested to ensure its integrity for the rated voltage

1.3.6
depower
isolate the *rechargeable electric energy storage system* (1.3.20) from a vehicle's *high voltage* (1.3.9) system and discharge its HV system excluding the rechargeable electric energy storage system

1.3.7
electrical arc hazard
Note 1 to entry: Refer to ENA NENS 09.

1.3.8
fuel cell electric vehicle
FCEV
vehicle that combines a fuel cell generating electricity and a battery for electric propulsion

1.3.9
high voltage
HV
electric component or circuit that has a working voltage of > 60 V and ≤ 1 500 V d.c. or > 30 V and ≤ 1 000 V a.c

Note 1 to entry: These thresholds are taken from United Nations Regulation No 100.

Note 2 to entry: These thresholds apply to the automotive industry only and differ to those in electrical standards where HV is above 1 000 V a.c. and 1 500 V d.c.

1.3.10
hybrid electric vehicle
HEV
vehicle that combines a traditional internal combustion engine system with an electric propulsion system

1.3.11
insulated tool
electrical insulated tool that is routinely electrically tested to ensure its integrity for the rated voltage

Note 1 to entry: Electrical tests are typically conducted annually.

1.3.12
live circuit
circuit that has not been isolated and tested

1.3.13
low voltage
LV
voltage not exceeding 30 V a.c. or 60 V d.c. that still presents a risk of electric shock

Note 1 to entry: These thresholds are taken from United Nations Regulation No 100.

Note 2 to entry: This threshold applies to the automotive industry only and differs to those in electrical standards where LV is above 50 V a.c. and 120 V d.c. and below HV.

1.3.14
may
indicates the existence of an option

1.3.15
NiMH battery
rechargeable battery operating on nickel metal hydride chemistry

1.3.16
original equipment manufacturer
OEM
original manufacturer of the vehicle, battery or rechargeable storage system and related parts

1.3.17
plug-in electric vehicle
PEV
motor vehicle that can be recharged from an external source of electricity

1.3.18
plug-in hybrid electric vehicle
PHEV
vehicle that combines a traditional internal combustion engine system with an electric propulsion system and can be recharged from an external electrical energy source

1.3.19
powered down
condition of components after the *rechargeable electric energy storage system* (1.3.20) is confirmed to be free of voltage and considered safe to work on

Note 1 to entry: Verification of the vehicle's non-live state may include the residual charge present when the HV REESS has been disconnected.

1.3.20
rechargeable electric energy storage system
REESS
rechargeable electric energy storage system that provides electric energy for electric propulsion

Note 1 to entry: The REESS may include any subsystem(s) together with the necessary ancillary systems for physical support, thermal management, electronic control and enclosures.

1.3.21
safety data sheet
SDS
information provided by the original equipment manufacturer on the safe use of equipment

1.3.22
shall
indicates that a statement is mandatory

1.3.23
should
indicates a recommendation

1.3.24
special service tool
SST
tool specified by the *original equipment manufacturer* (1.3.16) for use with a specific maintenance task

1.4 New designs and innovations

This document does not prevent the use of materials, methods of assembly, procedures and the like that do not conform with the specific requirements of this document, or are not mentioned in it, provided the minimum dimensional and performance requirements specified herein are met.

Section 2 Safe working practices

2.1 General

The level of harm to the body is a result of the amount of electric shock current. Higher voltage allows for the production of higher, more dangerous currents. Therefore, as resistance opposes current, producing high resistance is a good protective measure against shock.

Any voltage above 50 V d.c. or 50 V a.c. is generally considered to be capable of delivering dangerous shock currents.

Low voltages may still be dangerous, even if they are too low to directly cause shock injury. They may be enough to startle a person, causing them to jerk back and contact something more dangerous in the near vicinity.

A short circuit while working on a.c. or d.c. components will cause an arc flash that can cause serious injury to workers, particularly the eyes and face. Clothing may also ignite as a result of an arc flash depending on the arc energy and type of clothing.

Persons with a pacemaker or other medical device susceptible to magnetic interference shall not perform work on PEVs, HEVs, BEVs, PHEVs or FCEVs that contain powerful magnets capable of affecting those devices.

Where electric vehicle equipment, components or systems are not specifically covered by this document, a competent person shall undertake their own risk assessment, applying the principles and techniques contained within this document and any specific advice from the supplier/manufacturer, to achieve an equivalent or better safety outcome.

The work health and safety (WHS) hierarchy of control should always be applied for any risk or hazard in the following order:

(a) Eliminate the risk or hazard.

(b) Substitute the risk or hazard for a smaller risk.

(c) Apply engineering controls.

(d) Apply administrative controls.

(e) Apply Personal Protective Equipment (PPE).

EXAMPLE The hierarchy of controls could be applied in the following ways:

(i) Completely removing the battery from an electric vehicle (if practicable) is an example of eliminating hazards associated with the battery.

(ii) The wearing of insulating gloves of suitable rated voltage, that have been manufactured and tested in accordance with the relevant standard, as well as visually inspected and air tested before each use, is an engineering control.

(iii) The use of warning signs and/or exclusion zones is an example of an administrative control.

(iv) The wearing of an arc-rated face shield and/or arc-rated clothing are examples of PPE and the "last line of defence" in the hierarchy of controls.

NOTE Exclusion zones minimize distractions to competent persons and unwanted "walk-throughs".

2.2 Apparel

2.2.1 PPE for routine service

Suitable PPE should be worn if exposure to energized components or electrolytes is expected as part of the routine service work.

Suitable PPE for handling electrolytes, a damaged battery or battery coolant that may be leaking includes the following:

(a) Gloves suitable for organic solvents (e.g. rubber, latex or nitrile).

(b) An apron or over-garment suitable for organic solvents (e.g. rubber or resistant synthetic materials).

(c) Boots suitable for organic solvents (e.g. rubber).

2.2.2 PPE for energized components

PPE suitable for working on energized components (a.c. or d.c.) should include the following:

(a) Insulating gloves of an appropriate rated voltage (refer to AS/IEC 60903).

(b) The wearing of an arc-rated face shield (with chin guard) while making or breaking electrical connections.

(c) The wearing of arc-rated clothing with a 4 cal/cm^2 rating or greater (refer to ENA NENS 09).

2.2.3 Jewellery

Metal jewellery should not be worn when working around electric circuits. Rings, watchbands, necklaces, bracelets, and other metallic articles provide excellent electrical contact with the body and can conduct enough current to produce skin burns, even with low voltages. Metal jewellery also has the potential to damage PPE, especially insulating gloves.

2.3 Live circuits

When work on a live circuit is required, the service or repair shall be performed by a competent person in accordance with the manufacturer's repair procedure included in the relevant workshop manual.

When working on live circuits, insulated or covered tools should be used. Temporary insulation should be applied to exposed parts using insulating mats or covers.

NOTE 1 This may include standing on an insulated mat.

When servicing or repairing PEVs, HEVs, BEVs, PHEVs or FCEVs, access and use of PPE should follow Clause 2.2.1.

NOTE 2 Additional precautions may include use of the manufacturer's special service tools (SST).

While critical live connections are being performed, a competent person should be appointed to observe the work and an automated external defibrillator (AED) be made available (see Clause 4.2.5).

2.4 First aid

2.4.1 General

This clause covers first aid procedures for non-routine maintenance work where the vehicle body has incurred structural damage or the REESS has been exposed. Where applicable, the manufacturer's procedures should be referred to when initiating first aid.

2.4.2 Battery exposure

2.4.2.1 General

Exposure to HV battery electrolytes is unlikely, except where the REESS has been breached by accident. Preliminary inspection of the HV casing prior to service and repair may be needed. Clauses 2.4.2.2 to 2.4.2.5 provide first aid procedures for exposure to electrolytes. Clause 2.4.3.1 covers arc flash first aid.

2.4.2.2 Contact with skin

In the event of contact with HV battery electrolytes, the following steps shall be followed:

(a) Remove contaminated clothing.

(b) Flush affected skin with water for 20 min.

(c) Seek medical attention.

NOTE Refer to the relevant SDS for further information.

2.4.2.3 Contact with eyes

In the event of contact with the eyes, the following steps shall be taken:

(a) Immediately flush eyes that have come into contact with electrolytes for 15 to 20 min. Ensure adequate flushing by separating the eyelids with fingers.

(b) Seek medical attention immediately.

NOTE Refer to the relevant SDS for further information.

2.4.2.4 If swallowed

If battery electrolytes have been swallowed, the following steps shall be taken:

(a) For lithium-ion (Li-ion) electrolytes, rinse out the person's mouth without swallowing.

For electrolytes other than Li-ion, make the person drink large quantities of water to dilute the electrolyte. Do not administer water to an unconscious person.

(b) Do not induce vomiting. If vomiting occurs spontaneously, keep the person's head lowered and forward to reduce the risk of asphyxiation. If unconscious, keep the person's head to the side and have suction ready.

(c) Seek immediate medical attention.

NOTE Refer to the relevant SDS for further information.

2.4.2.5 Inhalation of electrolyte vapour

If electrolyte leaks and is exposed to the air, electrolyte vapours could be released. Even in a non-fire situation, the electrolyte vapours may be toxic or severely irritating.

If electrolyte vapour has been inhaled, the following steps shall be taken:

(a) Immediately move the person who inhaled the electrolyte to fresh air.

(b) Administer oxygen and transport the person to a medical facility.

2.4.3 Electrical hazards

2.4.3.1 Arc flash

An arc flash may cause fire to clothing and severely burn human skin. In the event of an arc flash, the following steps shall be taken:

(a) Remove affected clothing.

(b) Douse affected skin in cold water.

(c) Transport the person to a medical facility.

2.4.3.2 Electric shock

Where a worker receives an electric shock, any or all of the following responses may be required:

(a) External cardiac compressions or application of an AED.

(b) Expired Air Resuscitation (EAR).

(c) Close observation by another worker for 2 h (as reactions may be delayed).

(d) Transport to a medical facility for further assessment (necessary when the victim has lost consciousness for any period).

2.4.3.3 Electrical burns

In the case of an electrical burn, cold water should be applied, followed by burns dressings. Electrical burns are often more serious than they appear on the surface of the skin due to the passage of current through the body and internal damage that therefore occurs. Any significant electrical burn should be assessed at a medical facility.

2.5 Safety data sheets

There are several types of battery technology deployed and not all OEMs use the same approach. The original equipment SDS should be referred to.

2.6 Safe handling REESS

Handling a damaged HV REESS should be avoided where possible.

If handling a damaged HV REESS is absolutely necessary, PPE shall be worn.

2.7 Damaged PPE

Any clothing or PPE that has come into contact with electrolytes should be either decontaminated or discarded.

Section 3 General service working areas

3.1 Application

This section applies to general or specialist automotive working areas and servicing workshops which may be required to do work on the vehicle but not on the HV REESS (e.g. service station and lubrication bays, and premises specializing in engine tuning, suspension, tyres or brakes, body repairs, cleaning or detailing).

NOTE Where the HV REESS is free of residual voltage, the vehicle presents no special hazard and may be treated in the same manner as any other vehicle.

3.2 Premises

The premises housing or garaging normally operating PEVs, HEVs, BEVs, PHEVs or FCEVs shall be weatherproof, have appropriate ventilation and adequate working space. The operations described in Clause 1.1 (b) or (c) shall be undertaken in an area designated for working with PEVs, HEVs, BEVs, PHEVs or FCEVs, which utilizes hazardous voltages.

Availability of an AED located within 200 m of a competent person is recommended (see Clause 4.2.5).

3.3 Competent person

Where work on PEVs, HEVs, BEVs, PHEVs or FCEVs is carried out, a competent person shall carry out or oversee the work in accordance with this document.

NOTE 1 Qualifications for the competent person may comprise completion of a nationally recognized hybrid and BEV unit of competency or equivalent OEM units of competency.

Where service or repair work on PEVs, HEVs, BEVs, PHEVs or FCEVs that excludes work on or to the HV system or components is carried out, a competent person shall carry out and oversee the work, and be able to identify all HV systems and components.

NOTE 2 Qualifications for the competent person may include completion of a nationally recognized automotive trade qualification or equivalent OEM units of competency.

3.4 Prevention of overheating warning label

Electric vehicle REESSs, including traction batteries, may be damaged by exposure to high temperatures, such as in a body repairer's paint oven. Manufacturer's warning labels may appear on PEVs, HEVs, BEVs, PHEVs and FCEVs specifying that the battery temperature does not exceed 60 °C (140 °F) and provide a maximum time of exposure to extreme heat. Refer to the manufacturer's service and repair instructions for details on the vehicle being repaired and painted.

Section 4 Plug-in electric vehicle, hybrid electric vehicle, battery electric vehicle, plug-in hybrid electric vehicle and fuel cell electric vehicle repair

4.1 General

This section applies to vehicles with a known or required service and repair procedure for PEVs, HEVs, BEVs, PHEVs and FCEVs.

4.2 PPE for depowering REESS process

4.2.1 General

PPE shall be used for all stages of the depowering process.

4.2.2 Glove types

4.2.2.1 Insulating gloves

To protect from electrical current, insulating gloves of an appropriate rated voltage shall be worn any time work is performed with HV electrical sources. Insulating gloves shall conform to AS/IEC 60903. They shall also conform to the following:

(a) The surface of the insulating gloves shall be inspected for cuts, holes and imbedded materials. The gloves shall also be examined for punctures and other defects.

An air test shall be conducted before each use by rolling the cuff of the glove to trap air in the palm and fingers of the glove and holding each glove in turn to the cheek to listen and feel for any escaping air.

(b) Insulating gloves shall be kept clean of oil, grease or other damaging substances.

(c) Insulating gloves shall not be marked or have any adhesive tapes or labels applied to them.

4.2.2.2 Storage of insulating gloves

Insulating gloves shall be stored in a location that is as free as practicable from chemicals, oils, solvents, damaging vapours, fumes, electrical discharge and sunlight, and stored as follows:

(a) They shall be stored in their natural shape and inside a bag, box or container that is designed for, and used exclusively, for them.

(b) They shall not be stored folded, creased, inside out, compressed or in any manner that will cause stretching or compression.

4.2.2.3 Cloth inner gloves

Cloth inner gloves may be worn inside the insulating gloves for warmth in cold weather, to absorb perspiration in hot weather and for the easy removal of any protector outer gloves.

4.2.2.4 Protector outer gloves

Protector outer gloves may be worn over insulating gloves to prevent mechanical damage. The use of protector outer gloves shall conform to the following:

(a) Protector outer gloves shall be of a type and size recommended by the manufacturer of the insulating gloves.

(b) Protector outer gloves shall not be used if they have tears, holes or other defects that affect their ability to protect the insulating gloves.

(c) Protector outer gloves shall be kept as free as possible from oils, greases, chemicals and other material that may damage the insulating gloves.

(d) The inner surface of the protector gloves shall be inspected for sharp pointed objects.

4.2.3 Chemical aprons

To protect from possible contact with battery acids, an apron providing front of body outer protection should be worn. Rubber aprons may be worn to protect against alkaline substances.

Chemical splash aprons should be worn over standard work clothes to provide an extra layer of protection against dangerous and corrosive chemicals.

Where worn, aprons shall be inspected before each use and disposed of when damaged.

Where worn, aprons shall be stored in a manner to prevent damage and exposure to dust, moisture and damaging chemicals.

NOTE Refer to the manufacturer's specifications for correct storage procedures.

4.2.4 Protective eyewear

A suitable arc-rated full face shield should be worn when breaking high current and arcing can occur.

Splash goggles are designed to protect the wearer from liquid splash by using covered vents or a ventless design.

NOTE Splash goggles are not arc rated.

When cleaning protective eyewear, the manufacturer's instructions should be followed. In the absence of such instructions, protective eyewear should be washed thoroughly with non-abrasive soap, warm water and a soft cloth, then rinsed and dried. Any substance likely to scratch the surface of the lenses should be avoided.

Protective eyewear should be stored properly and inspected before each use.

Protective eyewear should be repaired or replaced when faulty.

4.2.5 AEDs

Immediate availability (within 200 m of the competent person) of an AED is recommended (see Clause 1.3.2) in a workshop environment where any electric vehicle is undergoing repairs to its electrical systems. An AED should be applied as quickly as possible (ideally within 3 min).

4.2.6 Protective boots

When the HV REESS is compromised, boots conforming to AS/NZS 2210.1 shall be worn.

4.3 Disable procedures

4.3.1 Isolate

PEVs, HEVs, BEVs, PHEVs and FCEVs typically confine HV within the REESS when the ignition or power button is turned to the off position and the dashboard ready indicator is off. The non-live state shall be verified for all conductive parts that could be live and hazardous, and assumed live until verified.

4.3.2 Disable

Before servicing any HV circuit or component other than the REESS battery, the voltage shall be disabled. Refer to the OEM's specifications to ensure that correct disabling procedures and precautions are followed.

4.3.3 Special service tools

OEM SSTs shall be used only in accordance with the OEM's specifications.

If SSTs are not supplied, insulated or covered tools should be used where relevant (see Clause 1.3.6 and 1.3.11).

4.4 Isolate REESS vehicles

4.4.1 General

Each manufacturer may have unique procedures, making it essential to be familiar with original equipment procedures prior to commencing depowering.

4.4.2 Isolate

The HV power supply service plug or manual service disconnect shall be located and isolated according to the manufacturer's safety procedures to perform the operations in Clause 1.1 (b) and (c).

4.4.3 Separated extra-low voltage power disconnect

Separated extra-low voltage (SELV) power supply shall be located and disconnected according to the manufacturer's service instructions.

4.4.4 Low voltage service disconnects

Any external power sources, such as a low voltage battery charger or a charge cord used for a PEV, shall be removed if the electrical circuits involved are to be worked on.

4.4.5 Manual disconnect

The manual disconnect shall be removed or the disconnect switch turned to the off position. This physically opens the electrical circuit within the HV battery.

4.4.6 Depower interval

The OEM's specified wait duration shall be followed to allow capacitors to discharge. While waiting, vehicle functions shall not be operated. Capacitors store residual power which may cause harm.

4.4.7 Volt check

HV systems shall be checked to confirm that they are zero volts. This confirms that the HV system is actually disabled.

4.4.8 Manufacturer's specifications

OEM service specifications shall be followed to perform zero volt checks so that residual voltage is isolated correctly.

4.4.9 Precaution

When working within an HV battery assembly, HV is present at all times and insulating gloves of an appropriate rated voltage conforming to AS/IEC 60903 shall be worn.

4.4.10 Zero volt check

A digital multimeter and leads used for zero volt checks shall be rated to at least category III/1 000 V, category IV/600 V or as specified by the OEM.

4.4.11 Multimeter check

Multimeters shall be checked to be working properly before and after testing the HV REESS.

This check may be conducted on a known voltage source.

4.5 Service and maintenance of PEVs, HEVs, BEVs, PHEVs and FCEVs

4.5.1 Service requirements

Service and maintenance requirements shall comprise the OEM's service procedures.

4.5.2 Identify workplace hazards

Workplace hazards shall be identified and precautions taken to minimize those hazards.

NOTE Refer to relevant legislation for work health and safety procedures.

Hazards may include wet floors, poor ventilation, untidy or cluttered work areas, trip hazards (such as charging leads) and working on live electric components (both a.c. and d.c.).

4.5.3 Reference material

Procedures and information shall be sourced and interpreted, and followed according to OEM instructions.

4.5.4 Tools and equipment

Tools and equipment shall be selected and checked according to workplace procedures as specified by the OEM.

Covered or insulated tools should be used when working on energized components (see Clause 1.3.6 and 1.3.11).

4.5.5 Technical data

Technical, calibration and servicing procedures specified by the OEM and relevant to testing the vehicle battery system shall be established.

4.5.6 Electrical efficiency

Tests and checks for electrical efficiency shall be carried out on battery systems according to the OEM's service specifications and test procedures.

4.5.7 Battery fixtures

Battery fixtures and connections shall be checked to confirm they are secure.

4.5.8 Faults identified and recorded

Faults with battery systems shall be identified and corrective action be taken.

Faults and corrective action shall be recorded.

4.5.9 Auxiliary components

Checks shall be conducted on the condition and operation of associated electrical components.

Problems with the performance of electrical components shall be identified and corrective action taken.

Faults with associated electrical components shall be identified and corrective action taken.

Faults and corrective action shall be recorded.

4.5.10 Final inspection

Final inspection shall be made to confirm that work is to the OEM's specifications, and that vehicles and equipment are presented ready for use.

4.5.11 Tools examined and stored

Tools and equipment shall be checked and stored according to workplace procedures.

4.5.12 Tagging faulty equipment

Faulty equipment shall be identified, tagged and isolated according to workplace procedures.

4.5.13 Processing documentation

Workplace documentation shall be processed according to workplace procedures.

4.6 Moving a PEV, HEV, BEV, PHEV or FCEV within a workshop

4.6.1 General

After a PEV, HEV, BEV, PHEV or FCEV has been serviced, it may be necessary to move the vehicle to another part of, or outside, the workshop as parts are ordered. Clause 4.6 provides safety requirements and guidance for this movement.

4.6.2 Direct drive motor

Some vehicle designs incorporate a permanent magnetic electric motor or generator connected directly to the drive wheels. If this type of vehicle is pushed by hand, current will be generated in the windings with the rotation of the wheels. If the vehicle is in a state of repair and components are disconnected, dangerous HV arcs may occur.

When the vehicle is manually moved suitable methods for isolating the drive wheels from the floor surface shall be used. An electric vehicle shall be jacked at its designated jacking points to prevent damage or penetration of the REESS which often forms the bottom of the vehicle.

4.6.3 OEM pushing specifications

Vehicles should only be moved in accordance with the OEM's specifications. Disconnected HV cables from the motor generator should be insulated with electrical insulation tape to prevent arcing.

4.6.4 Warning cover

A steering wheel warning cover shall be fitted or the OEM service procedure be followed to alert personnel that the HV REESS battery is disconnected.

4.6.5 Temporary warning sign and exclusion zones

A temporary warning or exclusion zone sign shall be placed adjacent to the exclusion zone to indicate the presence of a PEV, HEV, BEV, PHEV or FCEV vehicle.

Example signs are shown in Figure 1 and 2.

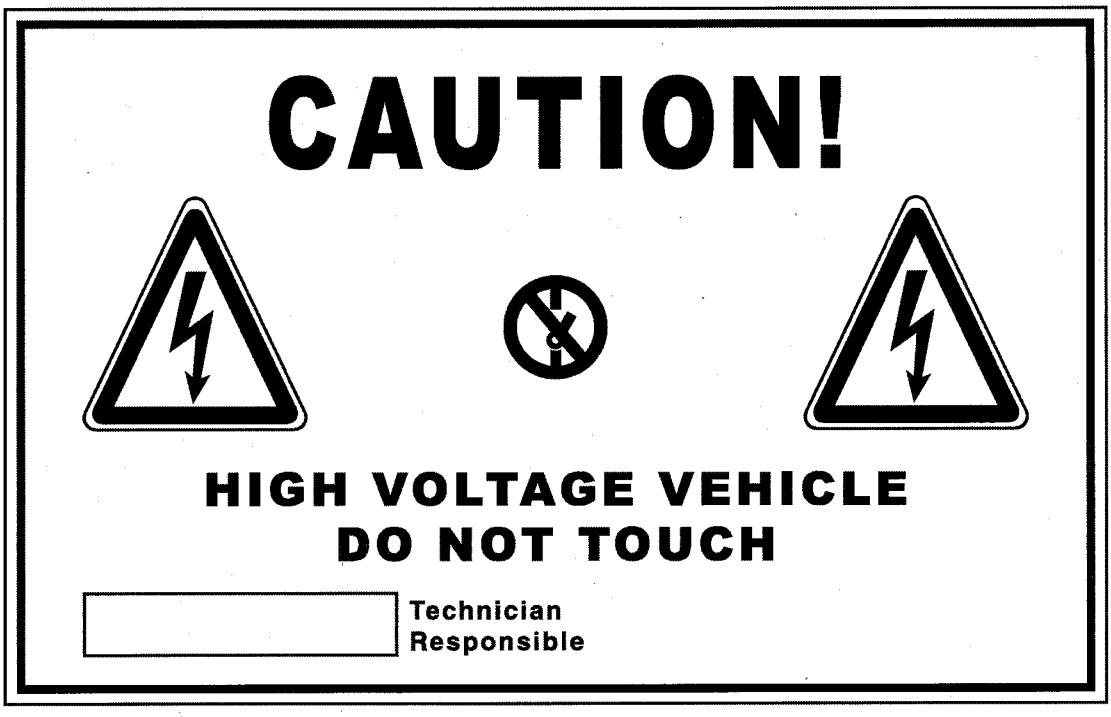

Figure 1 — Example high voltage sign

Figure 2 — Example caution sign

NOTE Exclusion zones minimize distraction to competent persons and unwanted "walk-throughs".

Section 5 Damaged high voltage batteries

5.1 General

This section sets out the procedure where the REESS needs to be removed and isolated from the PEV, HEV, BEV, PHEV or FCEV. This procedure may be needed due to damage to the REESS, which can lead to additional dangers such as leakage of electrolytes.

5.2 Inspection of HV batteries

5.2.1 Safety procedures — Odour

If damaged, HV batteries can give off harmful fumes. If unusual odours are detected, or eye, nose, throat or skin irritation is experienced, designated personnel shall wear PPE. Refer to the relevant SDS or OEM's workshop manual for emergency response procedures.

5.2.2 Safety procedures — Fluids

Where leaking fluids or bubbling noises are detected emanating from the HV battery, if it is safe to do so, the vehicle should be ventilated by opening the windows and trunk of the vehicle to prevent the build-up of fumes.

NOTE Vehicles equipped with a HV battery cooling system may have water dripping from the HV battery internal evaporator drain. Always refer to the OEM's workshop manual procedures or emergency response procedures in the event of a fluid leak, fire, smoke or an unusual noise emanating from the HV battery.

5.2.3 Safety inspection

The HV battery shall be inspected for sparks, smoke or bubbling noises, which are signs of a potentially overheating battery that could result in delayed fire.

5.2.4 Corrosive material

Contents of HV batteries are potentially corrosive, toxic and flammable. Appropriate precautions shall be taken if the REESS is to be removed or damage is suspected.

5.2.5 Damaged HV battery — Shock hazard

Wherever possible, contact with a damaged HV battery should be avoided, because a significant shock hazard may exist.

5.2.6 OEM service centre

For the recovery of the HV REESS, where an HV REESS case is physically damaged or wetness is evident, the OEM customer service centre should be contacted as specific handling or dismantling procedures may be required.

5.3 Removal of REESS HV batteries

5.3.1 HV power cables

Orange HV power cables and HV components shall not be cut or opened.

5.3.2 Recalibrate meter

The voltage meter reading shall be 0 V before touching any HV terminals that are not insulated.

5.3.3 PPE

Before dismantling the HV system, precautions shall be taken by wearing all PPE and removing the service plug according to the OEM's procedures to prevent electrocution.

5.3.4 OEM removal instructions

The OEM's REESS removal instructions shall be followed to perform zero volt checks before proceeding to remove HV REESS from the vehicle.

5.3.5 Battery storage

Interim storage of the REESS should be in a secure environment that provides suitable electrical isolation and protection against chemical leakage with signage indicating presence of REESS. A warning sign should be placed on the REESS. A sample sign is shown in Figure 3 and should read as follows:

CAUTION — HIGH VOLTAGE RECHARGEABLE ELECTRIC ENERGY STORAGE SYSTEM PRESENT. DO NOT TOUCH. COMPETENT PERSON ONLY TO MOVE.

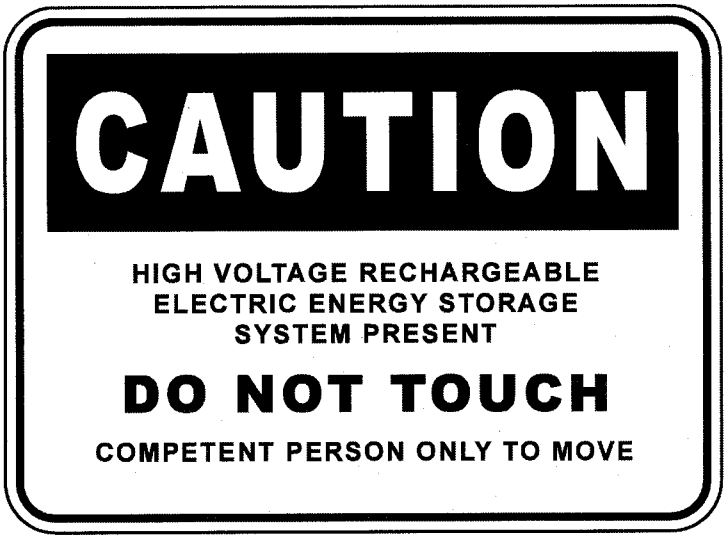

Figure 3 — Example caution sign

Section 6 Fire safety

6.1 General

This section provides guidance for PEV, HEV, BEV, PHEV and FCEV fire suppression.

6.2 Procedure

6.2.1 Fire suppression

Firefighting measures and equipment (extinguishing media and PPE) required for PEV, HEV, BEV, PHEV and FCEV shall be available as listed in the SDS relevant for the vehicle. PEVs, HEVs, BEVs, PHEVs and FCEVs do not require special fire suppression or extinguishment equipment to be carried on the vehicle.

6.2.2 Fire containment

If a HV REESS catches fire, a large, sustained volume of water shall be used to extinguish the fire. The use of water may present an additional electrical hazard to firefighting personnel.

6.2.3 Fire propagation

HV batteries are encased in protective cases, making it difficult to get water directly onto the burning cells. Large continuous volumes of water should be applied to cool the HV battery and prevent the propagation of fire to adjacent cells.

6.2.4 Toxic gases

Hazmat equipment shall be used whenever there is the possibility of an EV fire capable of producing toxic gases.

NOTE HV REESS fires may produce toxic and/or flammable gases that are best avoided by evacuating the immediate area until fire professionals or a Hazardous Materials Specialist can be contacted.

6.2.5 Water application

When using water to extinguish or suppress an HV REESS fire, a large continuous volume of water should be used. Small amounts of water may not be effective.

NOTE Fire professionals should be consulted if more information is required.

6.2.6 Damaged vehicle isolation

If a Li-ion HV battery is involved in a fire, it may reignite after being extinguished. Therefore, a vehicle containing a damaged or burned Li-ion battery should be stored in a manner and location that will limit the spread of fire should it re-ignite, until the battery is discharged.

NOTE Fire professionals or the OEM should be consulted when storing damaged or burned Li-ion batteries.

6.3 Fire safety equipment

6.3.1 General

The location, accessibility and availability requirements of Clause 6.3 shall apply for fire safety equipment. Firefighting measures and equipment (extinguishing media and PPE) required for PEVs, HEVs, BEVs, PHEVs and FCEVs shall be available as listed in the OEM's SDS relevant for the vehicle.

NOTE Fire safety and workshop regulations and relevant building codes may also apply.

6.3.2 Work area assessment

Work area assessment is a process of identifying any potential hazards and evaluating the associated risks. Assessment requires identification and familiarization of the location of personal protective and fire safety equipment, SDS, and the potential of health and safety risks to workers or others within the work area.

6.3.3 Location

Fire protection equipment shall be located adjacent to the vehicle working area.

6.4 Hose reels

Any hose reel installed shall meet the following requirements:

(a) Hose reels shall conform to AS/NZS 1221 and be installed in accordance with AS 2441.

(b) The water supply to a hose reel shall be provided by any available water supply system, or from any form of storage system, provided that the hose reel is able to deliver at least 0.33 L/s. Where the supply is from a storage system the duration shall be at least 15 min.

(c) Maintenance shall conform to AS 1851.

6.5 Fire extinguishers

There shall be at least one fire extinguisher with a rating conforming to AS/NZS 1850 and an available capacity of at least 9 kg. Fire extinguishers shall be available within 4 m of all vehicle bays in the workshop. Fire extinguishers shall conform to AS/NZS 1841.1, AS/NZS 1841.5 and AS/NZS 1841.6, as appropriate. Maintenance shall conform to AS 1851. Extinguishers shall not be located in positions where access could present a hazard to the potential user. Where practicable, extinguishers shall be located along normal paths of travel and near exits.

Section 7 Decommissioning, reuse and recycling of hybrid electric and battery electric vehicles

7.1 General

Vehicle decommissioning and dismantling should be performed in accordance with conventional vehicle requirements with the exception of the REESS.

7.2 REESS

7.2.1 REESS disabling procedures

Refer to the OEM's specifications to confirm that correct REESS disabling procedures and precautions are followed.

7.2.2 Battery electrolyte

In rare and extreme situations the metal battery pack case and the battery module may be breached, exposing the REESS' electrolyte. When electrolyte is exposed, a competent person shall wear PPE, secure the area to contain the leakage and neutralize and solidify electrolyte with an acid spill containment mat or sand.

7.2.3 PPE

PPE designed for handling electrolytes should be used when working on a damaged battery or battery coolant that may be leaking. This can include the following:

(a) Gloves suitable for organic solvents (e.g. rubber, latex or nitrile).

(b) A garment or apron suitable for working with alkaline liquids or electrolytes.

(c) Rubber boots.

(d) Eye protection.

7.2.4 Recovery procedures

To encourage recovery and recycling the OEM should be contacted for instructions.

7.2.5 Battery storage

Once the REESS has been removed from the vehicle and discharged, the REESS should be suitably stored referring to subject matter experts for advice where appropriate.

See Clause 5.3.5 for signage suitable for a REESS that has been removed from a vehicle.

7.2.6 Battery isolation

The REESS should be stored in a secure position, away from pedestrian and vehicle traffic areas to minimize the potential of battery damage (e.g. crushed or damaged).

7.2.7 Battery composition

REESS batteries should be sorted and stored by type. Lead acid batteries, NiMH batteries and Li-ion batteries should also be separated from each other.

7.2.8 Battery disposal, recycling and reuse

NOTE Local and state government regulations and guidelines may apply to the disposal, recycling and reuse of HV REESS.

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