Department for Transport

Recovery operators: working with electric vehicles

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Introduction

There has been a rapid increase in vehicles with an electric powertrain on the public roads, which use high voltage systems incorporating a high energy battery and this trend will continue. The high voltage (HV) systems used in these vehicles pose different hazards to those you may find on an internal combustion engine vehicle and these need to be considered while working with these vehicles.

The information in this document provides a reference for professionals involved in the roadside recovery of electric vehicles, to better understand the hazards associated with these vehicles and the expectations on themselves and others. This document is not exhaustive, is not intended to be a training document and should not be used as an alternative for undertaking suitable training.

Electric Vehicles

There are many different types of vehicles incorporating electrified powertrains, including Battery Electric Vehicles (BEV), Hybrid Electric Vehicles (HEV), Mild Hybrid Electric vehicles (MHEV), Range Extended Electric Vehicles (REEV) and Fuel Cell Electric Vehicles (FCEV). The term “xEV” may be used to describe any of these.

All xEVs use a battery for energy storage. The battery, along with an electric motor, can be used to propel the vehicle either by itself or in conjunction with an internal combustion engine. There are several different types of battery on different xEVs and while they may be manufactured differently, they do share common hazards.

Vehicles with large energy requirements, such as BEVs, PHEVs and REEVs usually incorporate a lithium-ion (Li-ion) battery. There are six main types of Li-ion battery used in automotive applications, which use slightly different materials, but the hazards are the same. The batteries in these vehicles pose a higher risk to recovery operations than for other xEVs, due to their physical size and mass, and the amount of energy they contain, HEVs tend to use smaller batteries, with a lower capacity. Often these batteries are of Nickel Metal Hydride (NiMH) chemistry, which is more stable than Li-ion, so pose a reduced risk.

MHEVs frequently use a 48V system which is not designated as high voltage, and there is low risk of fatal electrocution. While many MHEVs use a NiMH battery, some may use a Li-ion battery.

In addition to batteries, FCEVs use hydrogen stored at high pressure and a fuel cell stack to generate electricity. Additional safety training and the use of gas detectors to determine if a gas leak has occurred will be required for these types of vehicles. FCEVs are rarely seen on the roads, but in the future, they could become more common, especially in HGVs and buses.

This document has been created to help recognise if an xEV is in a condition that could pose a hazard and understand what level of training and knowledge is required for the situation in hand. This information should be used in conjunction with BS PAS 43 and the SURVIVE Group Best Practice guidelines for safe vehicle recovery operations and does not replace the need for suitable training.

This document does not consider the hazards posed by conventional powertrains (petrol or diesel) which may also be present in the case of a HEV nor does this document consider the hazards posed by the high-pressure hydrogen systems found in FCEVs.

Training

Both first and second responders should receive suitable safety training on the dangers posed by xEVs, in addition to that for normal vehicle recovery operations. Training is offered by many independent organisations, and each may cover different aspects of dealing with xEVs and in different levels of detail. The information in this document may serve as guidance to understand which aspects of xEV recovery should be covered by training.

For undamaged vehicles, or those that have only sustained very minor damage, then a basic level of training is appropriate. This will cover an understanding of xEVs, their operation, and awareness of the dangers they may pose when working around them. A more advanced level of training is required for vehicles that pose a higher risk, for example where a vehicle has sustained damage to the HV systems or batteries. Training should cover how to mitigate against hazards that may exist around a damaged xEV. This should include chemical, fire, and electrocution hazards, including isolation of the HV systems from the battery.

In all circumstances, it is important to recognise the limits of your knowledge and experience. You should not attempt to work on a vehicle that is in an unsafe condition if you do not understand the hazards it may pose and how to mitigate against them.

Safety Equipment

Most xEV recoveries, where the vehicle is undamaged or has only sustained cosmetic damage, can be undertaken in the usual manner using conventional procedures and protective equipment.

In some cases, especially if a vehicle is badly damaged, specialist personal protective equipment (PPE) may be necessary to protect against the specific hazards that may exist for xEVs. An outline of relevant PPE is given here; its use should be covered in relevant training. All PPE should be certified to appropriate standards to ensure its suitability, Table 1 gives recommendations for this.

Electrical safety gauntlets should be used to protect against an electrocution hazard. They can be easily damaged on sharp edges that could be present on damaged vehicles and must always be visually inspected before use. It is therefore also recommended that a set of electricians' over-gloves are available to protect the electrical safety gauntlets when in use. The over-gloves can only be used in conjunction with the electrical safety gauntlets – used by themselves they will not protect against an electrocution hazard.

If a chemical hazard exists, suitable gloves and respiratory protection equipment (RPE) should be worn. RPE must shield for both particulates and gases or vapour, and filters should protect against hydrogen fluoride (HF). Electrical safety gauntlets should not be used for chemical hazards.

It is recommended that eye protection is worn whenever using safety gloves for either electrical or chemical protection. Additionally, when an xEV has been on fire, there is a risk of hydrofluoric acid contamination. Calcium gluconate gel should be carried in the first aid kit to neutralise the acid if it contacts the skin.

As well as PPE, general safety equipment for working with high voltage and battery systems will also reduce exposure to unnecessary risk. High voltage safety hooks can be used to remove an incapacitated person away from a high voltage source. An automatic external defibrillator (AED) may also save someone's life in the event of an electric shock induced cardiac arrest.

When dealing with badly damaged vehicles, especially around the HV systems, an infrared non-contact digital thermometer should also be available to help monitor a battery pack to assess its stability. If required, specialised fire blankets for xEVs can reduce the severity of a lithium battery fire, however, these should only be deployed if the operator has received specific training in their use.

Table1: Recommended standards for personal protective equipment.

Personal Protective Equipment (PPE)	**Recommended standards**
Electrical safety gauntlets	BS EN 60903 Class 0 (1000V)
Over-gloves	BS EN 388 and BS EN 420
Safety gloves (chemical protection)	BS EN 374 for chemical protection
Respiratory protective equipment	BS EN 14387 and BS EN 405
Eye protection	BS EN 166

How to be SAFE

When undertaking recovery work on any vehicle, remember the acronym SAFE.

Study
Study the area to recognise if an xEV is involved in the incident. Consider its location and condition to determine if that will impact the recovery operation.

Assess
Assess the risks for the recovery operation and identify any potential dangers, including those for any bystanders or surroundings. Consider if these dangers can be removed or if they could cause an additional hazard as the recovery operation begins.

Formulate
After completing a risk assessment, formulate a plan, or method statement. This will consider how to mitigate the identified risks and reduce the likelihood of causing additional dangers. Consideration should be made of how the plan will change if things do start to go wrong.

Execute
Execute and monitor the plan to complete the recovery operation. Use a dynamic risk assessment to monitor the environment and if circumstances change, reassess the situation and modify the plan. Further help may be needed from specialist staff or the emergency services.

S: study

Before starting any recovery operation, take time to study the situation and collect as much information as possible. Taking time to collect this information will allow any potential hazards to be identified. You should assess whether you have the necessary competency and training to deal with the situation in hand, or whether you will need assistance to complete the operation.

Vehicle recognition

On arrival at an incident, it is very important that any vehicles equipped with an HV system are identified. This will influence the actions needed to ensure safety. Most xEVs outwardly look like their petrol and diesel counterparts.

One way of identifying an xEV is to use the DVLA vehicle enquiry website. Entering the vehicle registration will identify if the vehicle is a hybrid or electric model under the “Fuel Type” field.

There may be vehicle labels such as “Hybrid”, “PHEV”, “EV” or other markings. Blue or blue tinged logos or body trim may also help to identify these types of vehicles. Some manufacturers, such as Tesla, only produce vehicles with electric powertrains.

The following features could also indicate the vehicle has a high voltage system:

- Registration plate with a green band (from December 2020 onwards)
- Orange cables – all high voltage cables and connectors on xEVs are orange in colour
- Large HV components, such as the battery pack, motor or invertor
- Warning stickers on components, usually yellow with the ISO electrocution symbol
- Electrical charging socket, this could be under the vehicle symbol on the front grille, or under a “fuel cap” cover on the side or rear of the vehicle
- Vehicle has a charging cable stored in it
- Lack of an exhaust pipe, although hybrids will still have an exhaust pipe
- Electric vehicles don't use a manual gearbox, so the gear lever is likely to look more like the selector of an automatic model

If it is safe to enter the vehicle or you can see through the windows from outside, the vehicle dashboard and instruments may show information relating to the high voltage system:

- “Ready” light or EV indicator
- EV power mode switches
- Rev counter replaced with a power flow indicator
- Battery State of Charge (SOC) information
- HV diagnostic lights

Vehicles without any of these features may still have a high voltage system.

Location and condition

The location of the incident and condition of the vehicle need to be considered. Undertake an initial visual inspection of the vehicle and, if the vehicle is damaged, do not touch it with bare hands.

Many xEVs have an Emergency Response Guide (ERG) that can be downloaded from the manufacturer’s website. This may help to identify locations on the vehicle that contain HV systems and will also include additional emergency safety information. There are also online systems that can help, such as the Euro RESCUE app for mobile phones, which is a comprehensive database of ERGs for offline viewing, or professional mobile data terminal (MDT) systems that are often used by the emergency services.

Moving an xEV

It is not recommended to tow xEVs on their wheels because this can cause electrical power to be generated, which can cause damage to the HV systems. Many manufacturers recommend that the vehicle should only be transported on a flat-bed truck or on a trailer, with all 4 wheels off the ground, but some may allow towing if the driven wheels are off the ground.

However, it is always permitted to tow or push an electric/hybrid vehicle a short distance out of immediate danger (e.g. a live traffic lane), provided that:

- **It is done so at walking pace,**
- **The distance is kept to a minimum, to remove the vehicle from immediate danger only,**
- **The vehicle's transmission is in neutral and parking brake is disengaged, and**
- **The vehicle has not been involved in a road traffic collision and is not visibly damaged.**

Further information on towing or pushing a vehicle may be found in the owner's manual or vehicle manufacturer's website or in the ERG for the vehicle.

Connection to a charger

If the vehicle is connected to a charger, then ensure that the charger power is isolated and the charger cable disconnected. If the charger station has been damaged or vandalised, then inform the operator of the charging station. If there is any damage to the charging lead itself, then electrical safety gauntlets should be used.

Submersion in water

If an xEV is submerged in water, then refer to the ERG for guidance and follow current industry guidelines on vehicle recovery from water. If the submerged vehicle is still attached to a charger, then the charger should be made safe, and the charge lead removed before any recovery operation. In general, the HV systems are isolated from the chassis and are designed for protection against water ingress and being in the water next to the vehicle does not pose any additional risk of electric shock.

Damage inspection

A visual inspection of the xEV is required to identify the severity of damage that the vehicle has sustained. Vehicles with only minor damage, for example superficial damage or where the damage is far away from the HV componentry, can be recovered using the normal recovery techniques as defined in publications such as BS PAS 43 or the SURVIVE Best Practice guidelines. This will not require the attendance of the emergency services.

Vehicles that have sustained major damage could have unstable battery systems and may need the attendance of the emergency services if the battery is assessed to be in an unstable condition (see the following Assess and Formulate section).

General considerations

The batteries of xEVs are generally located low in the floor of the vehicle creating a low centre of gravity. If an xEV is lying on its side, it may be more unstable than an equivalent internal combustion engine vehicle in a similar position. Always be wary that a vehicle may topple until it is stabilised to prevent movement.

Before recovery of the vehicle, always check that the vehicle systems have been switched off. Because xEVs operate very quietly, it may not be evident that the vehicle is still operational and could potentially move if the accelerator is accidentally pressed while the vehicle is still in drive. Do not enter a vehicle if there are any concerns that it could be unsafe to do so.

A and F: assess and formulate

Use the knowledge and observations from the study to assess any potential hazards and determine the dangers that these may present during the recovery operation.

As well as the normal hazards associated with any vehicle recovery operation, you should also consider those specific to xEVs. Electrical hazards may exist due to the high voltage systems on a crash damaged xEV. There may also be chemical hazards or the risk of a thermal runaway if the battery has been damaged or been involved in a fire. Table 2 can help to assess what level of competence is needed to deal with different hazards.

When the situation and the potential hazards that may exist are understood, a recovery plan can be finalised to ensure that it can be completed safely and will not cause any additional dangers. Enough information should be collected to decide if help from other trained specialist recovery operators or from the emergency services is required. If additional help is needed, secure the area and await help before starting any recovery operations.

Electrical hazards

The HV systems on an xEV are completely isolated from the chassis of the vehicle. There are many protection systems in place to monitor for any hazards and to switch off the HV system if an incident occurs. However, there is currently no requirement for vehicles to have an indicator to show if the HV systems have been deactivated.

If the vehicle airbags have been activated, then this is a good indicator that the high voltage systems should be inactive. However, an electrical hazard could exist if any high voltage components or cables have been damaged or exposed in a serious incident. Using the ERG or mobile phone apps can be useful in discerning if any high voltage components could have been damaged. The initial vehicle study should identify any areas of possible danger.

Where possible the HV systems on the vehicle should be deactivated and isolated before commencing any recovery operation. This is especially important if the vehicle has sustained major damage. Remote keyless operation fobs should be removed to a safe distance from the vehicle to avoid them initiating any HV systems. Also consider the potential of smart phone apps which may also interact remotely with the vehicle systems.

For most vehicles disconnecting the low voltage supply (12V/24V) will also deactivate the vehicle HV systems, because it removes power to the battery control system, which is designed to fail to a safe state. For some vehicles there is a dedicated low voltage first responder loop that can be cut to shut down the high voltage system, this will be described in the ERG. Ensure that the low voltage supply cannot be inadvertently reconnected.

Many EVs have a means to isolate the HV systems, either through a manual service disconnect (MSD) or by cutting through a designated separation point as defined in the manufacturers ERG. Do not work on high voltage systems unless you have had the correct training. Isolation of the HV system should not be undertaken if a vehicle is submerged in water; remove the vehicle from the water before undertaking an isolation procedure. Once the HV system has been deactivated or isolated, it may take time for the voltage to drop to a safe level. For newer vehicles, with active discharge systems, this can take up to 15 seconds, for older vehicles, without an active discharge system, this may take up to 10 minutes.

Observations and information obtained from the ERGs can be used to assess how different areas of the vehicle could be accessed to undertake these tasks in a safe manner, especially if vehicle damage could prevent access to these areas.

If there is any possibility that any area of the vehicle could be live, for example due to severe damage to a HV area, then electrical safety gauntlets should be worn. Use leather over gloves if the electrical safety gauntlets could be damaged while undertaking the recovery operation.

Fire or thermal runaway hazard

Emergency services will need to attend if a vehicle is on fire, has been on fire or there is a possibility that a fire could start. ‘Thermal runaway’ occurs when the battery becomes unstable and an uncontrolled chemical reaction causes it to overheat, often leading to a battery fire. A fire to the main HV battery is a very severe incident and should not be tackled. Only fire service personnel with self-contained breathing apparatus and specialist training should tackle these types of fires.

In the event of a main battery fire, evacuate all people around the vehicle and retreat to a safe place well away from the fire and any smoke or fumes. A battery fire or thermal event will release toxic chemicals which can pose a risk to health.

If a fire is starting from the low voltage supply (12/24 V battery) then a suitable extinguisher can be used to suppress the fire and stop it from spreading.

During a thermal event, xEV batteries should not explode in a dangerous manner due to the safety systems built into them. If some cells have been damaged, these may be heard to “pop”. In some circumstances these cells could be ejected from the vehicle if the battery has been exposed by crash damage.

Current industry guidance is that a vehicle is deemed to be in a safe location if it is at least 15 metres away from anything else, but further guidance should be sought from the vehicle manufacturer's guidelines.

Assessing the possibility of thermal runaway

A non-contact infrared thermometer can be used to measure the temperature of the HV battery pack. Use the ERG or other information to identify the location of the HV battery to undertake any measurements to ensure they are as accurate as possible. Due to the location of HV battery packs it may be that the easiest area to measure is on the underside of the vehicle. Measure the battery temperature periodically during the recovery process to establish if it is stable or if it is changing.

A battery pack which is hotter than 50°C, or which is seeing a temperature increase, may indicate that the battery pack is undergoing a thermal event. If this is observed, then stop any other actions and monitor the HV battery pack temperature until there is confidence that it has stabilised, and the temperature is remaining constant or is reducing. If emergency services are in attendance, they may be able use thermal cameras to help monitor the condition of the HV battery pack.

HV battery fires can ignite unexpectedly. When assessing a vehicle, ensure that you do not put yourself in danger. E.g. Do not lie on the floor beside a vehicle with a suspect HV battery condition. Retreat to safety if you see any flame, ejection of gas or other material, smell irritating chemicals, or hear unexpected noises, such as the loud hiss of a release of gas.

Fire blankets

You may be equipped with a specialist vehicle fire blanket which is designed for battery fires. If you are trained in its use, it can be deployed over a vehicle when there is a danger of thermal runaway, for instance, if measurements show that the battery pack temperature is increasing. While the fire blanket itself will not stop a battery fire, it will contain any flame to stop a fire spreading, diminish its severity, and reduce the amount of chemicals and particulates released into the surrounding environment.

Do not attempt to deploy a fire blanket if an xEV is already on fire. Doing so risks exposure to both the fire itself and its chemical emissions. Retreat to a safe location well away from any fumes and await the emergency services to attend. If suitable RPE is available, then it should be worn for protection. Emergency services may deploy a fire blanket over the vehicle if they have staff who are trained and wearing the correct protective equipment.

Loading operation

xEV batteries which have been extinguished after a fire are susceptible to reignition, especially during the loading operation as the vehicle may be subjected to shock loads. Ensure that you monitor the HV battery condition and be prepared to respond to any incident.

Chemical hazard

A chemical hazard could be present if the battery system has been severely damaged, it is on fire, has been on fire, or is undergoing a thermal event. When a thermal event occurs, chemical gases and particulates can be released, many of which may be toxic. It is important not to attempt to deal with a vehicle in this condition without appropriate training and equipment.

When studying the scene of the incident a chemical hazard may be identified by liquids or gases leaking from the HV battery area. If the vehicle has been on fire, inspect for residues, especially those of an unusual colour or with a strong acrid smell which would not usually be found at a vehicle recovery incident.

During an xEV battery fire it is highly likely that hydrogen fluoride gas as well as other harmful compounds will be released. Hydrogen fluoride can irritate the eyes, nose, and throat, and in high enough levels can even be fatal. Stay well clear of a burning vehicle and away from any fumes or smoke.

If a vehicle has been on fire, there is a high possibility that many of the chemical residues left behind could pose a hazard to you and any bystanders. Hydrofluoric acid is of particular concern. This can be created during an xEV battery fire by the combination of water used to extinguish the fire, and hydrogen fluoride released from the battery during a thermal event. Hydrofluoric acid can cause very severe skin burns and must be treated immediately using copious amounts of calcium gluconate gel for at least 15 minutes. Ensure any person contaminated receives medical assistance as soon as possible. When moving an xEV that has been involved in a fire, it is always recommended to wear suitable gloves to protect against chemical hazards.

If any chemicals may be present, especially if the vehicle has been on fire, ensure that you, any bystanders, and the local environment will not be contaminated by moving the vehicle.

Overall risk assessment

Table 2 gives the risk level of the recovery operation based on vehicle observations and will help to assess the adequate level of training and knowledge to deal with different situations.

Table 2: Table showing risk levels for different observed hazards.

Observation	Low Risk (GREEN)	Medium Risk (AMBER)	High Risk (RED)
Airbags	Not deployed	Deployed	Deployed and another RED condition observed (But Not Electrical Isolation)
Vehicle structural damage	Minor or no damage	Major damage but not intruding into HV locations	Severe damage into HV locations, especially battery area
Chemical smell	No smell	Slight smell or smell like that expected from petrol or diesel vehicles	Strong pungent or acrid smell that may also cause irritation to the eyes or nose/throat

Sound	No sound	Intermittent electrical sparking or gas release hiss heard	Continuous electrical sparking, frequent gas release hiss or popping heard
Battery temperature	Battery at ambient temperature with no temperature rise observed or temperature reducing	Battery temperature not significantly hotter than ambient (max 50°C) and no temperature rise observed.	Hot battery (greater than 50°C) or increasing temperature observed.
Fire	No fire	No fire	On fire or has been on fire
Smoke and gas	No smoke	Light smoke or vapour	Thick dark smoke or white/grey acrid smoke
Electrical isolation	Low voltage disconnected and MSD removed or HV systems undamaged	Possible damage to HV systems and only low voltage disconnected	No isolation possible and another RED condition observed (But Not Airbags)
Dashboard fault codes	No fault codes	Fault code displayed	Fault code displayed and severe damage to HV locations
Recommended recovery procedure	Normal recovery with basic EV awareness training	Normal recovery with basic EV awareness training but the situation should be monitored. Specialist recovery with advanced training may be required if conditions change	Emergency Service attendance required and specialist recovery with advanced training

E: execute

Once a risk-based recovery plan is in place, all relevant information has been collected and any additional support has been requested, then the recovery process can commence. Always ensure that the recovery operation progress is monitored and respond to any issues that may occur.

An unstable HV battery can ignite unexpectedly; checking battery temperatures regularly and responding promptly to assess any unusual sounds or smells will provide additional time to react. This could be critical in enabling a reassessment of the situation and to understand if the vehicle recovery operation risk level has changed and poses a higher danger to operators or any bystanders.

When moving a vehicle any shock loads or body movement should be minimised. These may exacerbate any internal damage to the HV battery system that may not have been apparent from the initial visual inspection. There have been some rare instances of vehicles igniting during the loading operation.

If conditions change and it is believed that risk levels have increased, then consider requesting support from specialist recovery teams with advanced training or from emergency services, especially if evidence suggests that a vehicle fire or thermal event could occur.

Hand over

If there is a need to hand over the xEV, for instance if a specialist recovery team needs to take over, passing on all the information gathered will help them with their own assessment.

If you are receiving the vehicle, for example during a hand over from the emergency services, then make sure you obtain all information that may be needed to complete your work in a safe manner.

If there is no direct hand over to allow information to be exchanged, then a full assessment of the scene should be made, to confirm that there is no danger to the recovery operation and that the condition of the vehicle has not changed since the previous personnel left.

Transportation and Storage Considerations

Towing or moving an xEV

It is not recommended to tow xEVs on their wheels because this can damage the HV systems. The recommended method of transportation is on a flatbed or trailer, but you should always refer to the manufacturer's instructions or ERG for further information. Some vehicles, HGVs and buses for instance, may have some means by which the drive axles can be disconnected from the electric motors to allow them to be safely towed on their wheels.

However, it is always permitted to tow or push an electric/hybrid vehicle a short distance out of immediate danger (e.g. a live traffic lane), provided that:

- **It is done so at walking pace,**
- **The distance is kept to a minimum, to remove the vehicle from immediate danger only,**
- **The vehicle's transmission is in neutral and parking brake is disengaged, and**
- **The vehicle has not been involved in a road traffic collision and is not visibly damaged.**

Further information on towing or pushing a vehicle may be found in the owner's manual or vehicle manufacturer's website or in the ERG for the vehicle.

Keep up to date with new developments as there are new emerging recovery systems, processes and equipment, such as freewheeling hubs and foldable trailers, that could be used to tow vehicles as they prevent the drive train from turning during the recovery process.

Tunnels

Be aware that while the ADR (European Agreement concerning the International Carriage of Dangerous Goods by Road) does not govern the transport of xEVs, if the vehicle is in a potentially unsafe state, then travel through tunnels should be avoided to prevent the risk of a serious incident.

Recovery operators must also ensure that they comply with any guidelines set by the tunnel operators.

If travel through a tunnel cannot be avoided, then consider covering the vehicle with a specialist vehicle fire blanket to reduce the severity of any potential incident.

Storage

Just like any conventional vehicle, xEVs can reignite hours or even days after an incident, although the likelihood of this happening may be higher with xEVs. Isolation of the HV systems by disconnection of the low voltage system and removal of the HV system manual service disconnect is advised; refer to the vehicle ERG or manufacturers' guidelines for additional information.

When storing an xEV with a suspected damaged HV system, they should be in an outside quarantine area which is a safe distance away from any other nearby objects. Currently 15 metres is considered a safe distance, however you should always refer to the vehicle manufacturer's guidelines. This distance can be reduced if a suitable fire-resistant barrier is placed in between or if they are parked in dedicated fire protected parking areas.

Monitor xEVs which pose a fire risk for up to 48 hours after an incident. If the HV battery temperature does not drop to ambient temperatures, then leave the vehicle in its safe quarantine location. xEVs whose battery temperatures do stabilise can be stored closer together – current recommendations are that a 2-metre gap is still provided to allow access around the vehicle for inspection purposes.

There have been some instances of vehicles igniting up to 2 weeks after an accident due to internal damage caused during an incident, which may result in a slow or delayed thermal event. This could be caused by additional movement of the vehicle around a storage area or by an internal fault such as coolant leakage, ingress of water from the environment or coolant drying out leaving behind conductive material. This potential hazard can be reduced by periodically measuring the battery temperature and inspection of the vehicle to establish that the condition of the battery is not changing during storage. Remote temperature sensors that can constantly monitor and send a warning to a mobile phone can be used effectively to protect against this hazard.

xEVs stored outside, especially those with major damage exposing HV locations, should be covered with a weatherproof tarpaulin to protect against exposure to the elements.
If xEVs need to be stored for prolonged periods of time, then arrangements should be made for a technical specialist to remove the HV battery pack at the earliest opportunity and dispose of it safely. The vehicle can then be stored in the usual manner with no other additional safety measures amongst conventional vehicles.

When storing xEVs it is recommended that the safety level of the vehicle is displayed to inform people who work in the area. Best practice would be to use the industry standard traffic light colour coded safety status signage to identify the risk level of vehicles as follows:

- RED – Danger, vehicle is unstable and/or a high voltage hazard exists, people must stay at least 1 metre away from the vehicle.
- AMBER – Normal, vehicle is stable and while the high voltage system is active and operational it poses no hazard.
- GREEN – Safe, vehicle is stable and the HV systems have been isolated.

Figure 1: Examples of vehicle safety status colour coded signs.