B.I.G. Safety Guidelines

Guidelines for the Safe Handling, Transportation, Collection, and Storage of Large Used Batteries

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eunomia

Report for B.I.G. Safety and Logistics (S&LG) Working Group

Prepared by Hannah Blumhardt, Eunomia Research & Consulting NZ

Approved by

Duncan Wilson (Project Director)

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Eunomia Research & Consulting (NZ)
35 Gilfillan Street
Blockhouse Bay
Auckland 0600

New Zealand

Tel: +64 (9) 376 1909
Fax: +64 (9) 360 5187

Web: www.eunomia-consulting.co.nz

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DISCLAIMER STATEMENT

Note these Guidelines are not law and do not supersede the regulatory frameworks for dangerous goods and hazardous substances or any manufacturer's guidelines related to their new product or the removal or handling of their product.

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Context & background from Juhi Shareef, Chair of B.I.G.

Context

Batteries are critical to the current 'Fourth Industrial Revolution'[1] and rapid decarbonisation to meet the Paris climate Agreement.

Greater demand for high-energy capacity, storage, and output from batteries has led to significant developments in battery technology. A diverse range of industries is now utilising large, high-energy batteries for uses such as energy storage systems (ESS) or electric vehicles (EVs).

Large batteries can be part of a circular economy by ensuring their value is maintained as long as possible through e.g. second-life use and that maximum value is extracted from them at end of life.

*"A **circular**, **responsible** and **just** battery value chain is one of the major near-term drivers to realize the 2°C Paris Agreement goal in the transport and power sectors, setting course towards achieving the 1.5°C goal if complemented with other technologies and collaborative efforts."*

- World Economic Forum report by the Global Battery Alliance[2]

However, while large batteries have a vital role to play in a more circular future they also come with a number of risks. In addition to supply chain risks, risks such as of thermal runaway fires are created during battery use and end of life, for example in the transportation, storage, handling and disposal of batteries.

Background

Energy company Vector Ltd recognised the need to proactively manage these risks by creating a sustainable value chain for large batteries in New Zealand and convened the Battery Leaders Group comprised of selected representatives from the energy, transport and waste sectors.

Led by Vector, the Battery Leaders Group, supported by Eunomia Research & Consulting and Forum for the Future undertook two years of research, stakeholder engagement and 2030 scenario planning.

The research was summarised in a **New Energy Futures Paper on Batteries and the Circular Economy** and research findings and data were transparently shared in a **Technical Addendum**.

These papers provided the environmental, social, technological and economic context for the wider **Battery Industry Group (B.I.G.)**, which was launched in November 2019 with the aim of **co-designing a proposal for a *circular* product stewardship scheme for large batteries**.

B.I.G. now has over 170 members – businesses, individuals, organisations and academics – across energy, transport, waste and battery sectors. B.I.G. has three sub-groups: a Battery Innovation

[1] https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/
[2] http://www3.weforum.org/docs/WEF_A_Vision_for_a_Sustainable_Battery_Value_Chain_in_2030_Report.pdf - 2019

Hub, a Battery User Group and the **Safety & Logistics Group**, which led the development of this Safety Guidance.

Safety Guidelines for large batteries

B.I.G. is committed to enabling a circular economy for batteries. A circular economy for large batteries necessarily implies the extension of use of batteries through repair and reuse in a second life. To proactively address safety concerns in a circular system, and in recognition of the lack of local guidance (on safe handling, collection, transportation, and storage of large batteries after their initial use), B.I.G. tasked the Safety and Logistics Group (S&LG) working group with providing **practical, evidence-based guidelines on safety issues through the large battery value chain**.

The project collated learning from international research and local stakeholders to provide recommended voluntary best practice guidance for industry, regulators and the wider community.

Note

The aim of these Safety Guidelines is to support the use and uptake of this important technology in a safe manner. Where possible, we have aligned with international best practice and engaged widely with industry stakeholders but we would welcome feedback, particularly from industry experts who would be willing to put in the time to help further develop these Guidelines.

To learn more or to join B.I.G., contact us at www.big.org.nz.

1.0 Purpose of these Guidelines & How to use them

Our society is using increasing numbers of large batteries as we move to electrify energy storage systems and modes of transport. In New Zealand, over the coming years, a steady stream of large batteries will reach the end of their first life. For example, by 2030, as many as 84,000 electric vehicle (EV) batteries could reach end of life each year in New Zealand.[1] Some of these batteries may be reusable for another purpose, e.g. EV batteries can be reused for ESS. Others will be recycled so that the finite resources they contain can be retrieved and used again.[2]

This document provides safety guidance for transitioning large batteries from the end of their first use to the beginning of their second, or to safe recycling/disposal. These guidelines are needed because batteries can be dangerous and can cause serious harm to people and property if they are not handled, stored and transported correctly.

The guidelines describe some of the key risks that large, used batteries pose, and the steps you can take to reduce these risks. The guidelines also consider what to do if things go wrong.

The main topics covered are:

- Safe handling and removal of a large battery from an ESS or EV
- Transportation
- Collection
- Storage

The guidelines start at the end of a battery's first, initial use, and end at the time when the battery is presented for its second use, or for safe recycling or disposal.

The guidelines do not explain how to test, reuse or recycle large batteries.

The guidelines provide basic safety guidance about the safe handling, collection, transportation and storage of large, use batteries, generally. However, not all batteries are the same, and some batteries may be constructed in a way that makes them more or less safe than others. Nevertheless, these guidelines apply to all large batteries, regardless of their design. Alongside this document, it is always appropriate to seek safety guidance specific to your battery, by consulting the relevant battery manufacturer's guidelines.

2.0 Preliminary Matters

2.1 Definition of Large Batteries

For the purposes of this document 'large batteries' are as defined by the Battery Industry Group (B.I.G.) product stewardship scheme proposal. See www.big.org.nz.

2.2 Battery Types and Risks

Large batteries come in different chemistry and technology types. The most common are:[3]

- Lead-acid
- Lithium-ion (including lithium polymer batteries)
- Nickel-based (metal hydrides and cadmium)
- Flow batteries
- Sodium-ion analogue

Large, lithium-ion batteries are the main focus of these guidelines because lithium-ion batteries:

- are widely used for applications where large batteries are needed;
- are very energy and power dense with high voltage;[3]
- contain electrolyte with components that can cause chemical burns if released;
- emit potentially hazardous off-gassing during handling and processing; and
- pose a particular fire risk because of their propensity for thermal runaway.

However, all large battery types carry risks – see Table 1 for a comparison of the risks presented by different battery chemistries and technologies (note that this table presents general risks. However, within each battery type, the level of risk can vary based on the quality of the battery and its design features).

Unless otherwise stated, the precautions in these guidelines apply to large batteries generally. Where a different precaution is needed to reduce the safety risk from a battery other than a lithium-ion battery, the guidelines will say so.

Table 1 General Risks based on Battery Chemistry/Technology

Chemistry Type/Battery Technology	**Risks** ***(For a full explanation of the risks presented by different battery types, see Section 3.2 of AS/NZS 5139:2019 'Electrical installations – Safety of battery systems for use with power conversion equipment')***
Lithium-ion	• *Electrical hazard; Energy hazard; mechanical hazard; Level 1 fire hazard; Explosive gas hazard (lithium chemistries that release hydrogen under fault conditions, e.g. lithium manganese); Toxic fume hazard.*[4]

[3] While we acknowledge that under the Electricity (Safety) Regulations 2010, high voltage means voltage exceeding 1500V for DC systems, for the purposes of these guidelines, we consider any battery over 50V as having high voltage.

	• Risk of fire and thermal runaway.[5] Releases toxic fumes when burning, such as hydrogen fluoride.[6] • Potential hazardous off-gassing during handling and processing.[7] • High voltage electrical hazard.[8]
Lead acid	• *Electrical hazard; Energy hazard; mechanical hazard; Level 2 fire hazard; Explosive gas hazard; Chemical hazard; Toxic fume hazard.*[9] • Can ignite and start a fire if shorted.[10] • Emits a corrosive and explosive mix of hydrogen and oxygen gases during the final stages of charging that can potentially ignite if exposed to a spark or flame.[11] • Contains sulfuric acid electrolyte that can cause serious burns if spilt.[12] • Lead is a toxic metal.[13]
Nickel-Based	• *Electrical hazard; Energy hazard; mechanical hazard; Level 2 fire hazard; Explosive gas hazard; Chemical hazard; Toxic fume hazard.*[14] • Emit explosive gas, such as hydrogen, while charging, presenting an explosive gas hazard.[15] • Contains potassium hydroxide that can cause serious burns if spilt.
Flow	• *Electrical hazard; Energy hazard; mechanical hazard; Explosive gas hazard and toxic fume hazard (Flow batteries having an acidic water-based solution have a significant risk of producing explosive gases and toxic fumes); Chemical hazard.*[16]

These guidelines focus on large, used batteries. Large batteries carry high voltage so can cause serious electrocution. They are also very heavy, so moving them incorrectly can cause injury. Large batteries contain many cells within a single pack, so if one cell fails and ignites, the fire can spread to the other cells in the pack, causing thermal runaway that is hard to control. This risk is magnified when multiple large batteries are collected, stored or transported at the same time.

For these reasons, large batteries are usually designed to incorporate safety features, such as cooling and ensuring that terminals are not accessible. Nevertheless, when things go wrong with a large battery, the results can be catastrophic and can cause serious injury or death. All measures must be taken to prevent failure events, and to respond quickly and properly if things go wrong.

2.3 Manufacturer Guidelines and Safety Data Sheets

Any person working with a large, used battery should refer to the manufacturer's guidelines and the safety data sheets, which provide important handling information, and what to do in the event of an emergency.[17]

2.4 Battery History and Chain of Custody

From a safety perspective, it is useful to keep a record of every battery's history or chain of custody (ideally on a shared, centralised database, where available, such as the blockchain-based technology demonstrated in this video), including:

- A battery's origin and how it has been used or modified.
- The reasons the battery has reached the end of its first life or use.
- Any exposure to possible abuse events.

An accessible, recorded history informs anyone who comes into contact with the battery about possible risks, as well as the battery's suitability for reuse.[18] Some commentators believe that batteries should only be reused for a second life if their ageing history is sufficiently known.[19]

Where possible, any person handling, collecting, storing and transporting a large, used battery should:

1) seek to access information about the battery's history/chain of custody; and
2) add their own interactions with the battery to the battery's history/chain of custody, if a record of such is found to exist.

2.5 Staff Training

All employees involved in handling, collecting, storing and/or transporting large, used batteries should be:[20]

a) informed about the risks;
b) trained about the relevant safety precautions or content of any relevant regulations;
c) introduced to the content of these guidelines during training; and
d) trained to respond appropriately to a battery failure event, such as a lithium battery fire.

Certain activities related to batteries should only be undertaken by qualified professionals. See, for example, Sections 2.7 and 3.2.

2.6 Safety and Emergency Planning

Any site where large, used batteries are handled or removed, collected, stored or transported should have relevant, thorough and readily available response plans in case of a battery failure event, such as fire, or toxic chemical or gas leakage.

2.7 Assessment of Large, Used Batteries

At various points between the end of a battery's first life and the beginning of its second life, the battery should be assessed for state of safety, which includes but is not limited to understanding its state of health.[21] This assessment should be:[22]

- based on safety criteria produced by the battery manufacturer, and
- carried out by a technical expert, such as an electrician, electrical engineer or a certified high-voltage expert, with knowledge of the battery's safety features, or a person trained in these areas for the purposes of assessing battery safety.

Where possible, an assessment and report from the original battery manufacturer regarding the battery's state of safety should be sought.

In addition to a professional assessment, any large, used battery should be deemed damaged or unsafe if it exhibits any of the following characteristics:[23]

- Partially disassembled, opened, or the casing visibly deformed or miscoloured.
- Leaking fluid.
- Emitting an unusual smell.
- Changing shape, e.g. swelling or bulging.
- Overheating and/or smoking.
- Making a hissing sound.
- Visible crystallisation or white powder formation.
- Signs of water or fire damage (i.e. water stains or char marks).

A battery should also be deemed unsafe or damaged if it is known to have sustained physical or mechanical damage. For example, if it was removed from an EV that was involved in a moderate to severe car accident; if it was removed from an ESS in a building that has sustained damage, such as fire or earthquake; or if the battery has been dropped.

Even if a large, used battery does not display any of the above characteristics, it must still have its state of safety assessed as set out by this section because problems may be occurring internally that are not yet obvious.

2.8 What to Do If a Battery is Deemed Unsafe or Damaged

If a battery begins to overheat or smell, arc, release any gas or liquids, or make a hissing sound, call emergency services immediately.

If the battery is not showing these signs, but has been damaged or deemed defective for safety reasons, take the following steps:

1) Put the battery in a fireproof container, for example:
    a. A bespoke container with an in-built smoke detector and automatic fire extinguishing system.

   b. Enclosed steel containers filled with non-conductive material, such as sand or vermiculite.
2) Clear the surrounding area, for example:
   a. Remove any nearby source of heat and electricity.
   b. Move the battery (if possible, bearing in mind that the battery may be too heavy to move safely – see **Section 3.5**) into a separate room with non-combustible building materials, such as concrete walls, or outside, well away from any structures, on a concrete floor.
3) If the battery is in a home, or other location where appropriate containers are unavailable, the battery cannot be moved safely (for example, it is too heavy), or the area around the battery cannot be cleared, evacuate any people from the area.
4) Refer to the instructions provided by the EV manufacturer or ESS installer for the appropriate person to contact to remove or service the battery.

3.0 Handling of Used Battery Packs, Modules, Cells and Other Elements

Inside a large battery pack there are many individual cells. An underperforming pack is determined by the capacity of its ***weakest*** cell. This means that a discarded large battery may still contain many cells with considerable electrical and chemical energy.[24] Misuse can result in fire or explosion, electrocution or harm from leaking chemicals. Treat all large, used batteries as though they are a fully live pack and handle with caution.[25]

3.1 Technical Measures and Precautions

1) When handling batteries always refer to the manufacturer's guidelines and do not treat the battery in any way that goes against those guidelines.
2) Never use a damaged battery.[26] Do not use unadapted charging systems and do not use the unit without an electronic management system.[27]
3) Do not mix different types of battery cells (i.e. chemistries or capacities) in a battery assembly.[28]
4) Only technical experts should replace battery cells or modules in a battery assembly (see section 3.2).
   a. If cells are replaced within a battery, this should be recorded in the battery's history/chain of custody (see **Section 2.4**).

3.2 Only Qualified Professionals or Trained People to Open or Disassemble Packs

Opening or disassembling a large battery pack can be very dangerous and can cause electrical shock, spontaneous combustion, explosion or chemical leakage, resulting in serious injury or death.

1) Do not attempt to open, break down, dismantle, or disassemble a large used battery. Only qualified professionals, such as an electrician, electrical engineer, or certified high voltage expert, with knowledge of the particular battery system, or a person specifically trained in these areas for the purpose of working on, maintaining or refurbishing batteries,[29] should open or break down packs or replace battery cells in designated facilities for battery processing.[30]

3.3 Protect Against Mechanical Abuse and Short Circuit

If large, used batteries suffer mechanical abuse they can short circuit, ignite or emit noxious gases, substances and liquids. To protect human and environmental health, exercise caution when handling batteries.

1) Do not disassemble, crush, drop, throw, or puncture a battery, or expose large, used batteries to shock or vibration.[31]
2) Do not handle batteries with exposed terminals and do not allow battery terminals to contact the terminals of other batteries.[32] Any work that may require handling batteries with exposed terminals shall be carried out by a qualified person (see section 3.2).
3) Insulate terminals and electrical contacts with electrical tape or other safe means of assuring electrical safety suitable for the application.[33]

3.4 Personal Protective Measures and Equipment

Large, used batteries may retain significant high voltage that can cause electrocution and serious injury or death. When handling large, used batteries:

1) Use personal protective equipment, such as insulating gloves and non-metallic toe cap safety boots with HV insulated soles.[34]
2) Ensure that all tools used are properly insulated.
3) Avoid wearing metal jewellery (bracelets, rings etc.), exposed metal zips, watches and other conductive items.[35]
4) Avoid strapping or securing batteries with metal tie-down straps.[36]
5) Ensure terminals cannot come into contact with a conductive material, e.g. metal surfaces or tables.[37]

3.5 Moving Large, Used Batteries

Batteries should be moved carefully because they can be heavy and lifting them can cause injury.[38] Mechanical damage can occur if boxes or pallets of batteries are dropped or damaged by forklift accidents.[39]

1) Adhere to Worksafe's existing *Code of Practice for Manual Handling* if preparing to move a large battery. This guidance may be reviewed, updated, replaced or revoked from time to time – so make sure you access the most recent version.[40]
2) In addition:

a. Where available, use a suitably weight-rated trolley or lift to move large, used batteries.[41] Ensure any workplace that collects, stores, transports or processes batteries has procedures and training for forklift operators.[42]
b. Where a trolley or lift is not available, lift the battery with the assistance of one or more people, and use correct lifting procedures to avoid risk of injury: bend your knees, use a whole hand grip, have a secure footing and a wide stance, keep the load close to your body, and do not twist or bend sideways.[43]

3.6 Removing Batteries from an ESS or an EV

If de-installation of an ESS or removal of a battery from an EV occurs incorrectly or without appropriate equipment, electrocution, fire, acid spills, and serious personal injury or death can result.

1) Only qualified professionals or service personnel with recognised electrical expertise or training in high-voltage systems or in dealing with large batteries should de-install an ESS or remove a battery from an EV.
2) Removal of either an ESS or an EV battery should occur according to the manufacturer's instructions, which should be made readily accessible and available to allow professionals to remove used batteries safely.[44] Basic levels of information for removal of EV batteries are also available within the International Dismantling Information System established by OEMs trading in EU member states.[45]
3) Those removing batteries from an ESS or EV should always wear personal protective equipment, such as insulated gloves, shoes, and a safety shield, and remove any metal jewellery or accessories.
4) Before and during the removal of an EV or ESS battery, place high-voltage safety signs on the ESS or EV, and set up cordons and safety notices to prevent unauthorised personnel entering the area.

3.6.1 De-installing an ESS

1) Do not attempt to de-install a battery or service an ESS yourself - only qualified professionals with recognised expertise in high voltage systems and battery systems, should remove batteries from ESS, such as an accredited installer, electrical engineer or electrician.[46]
2) Batteries used for ESS can be large and heavy and some are hung from walls rather than ground mounted, which increases risk of injury upon removal. Ideally, large used batteries should not be removed from an ESS by one person alone and/or without the assistance of industrial trolleys and/or lifting tools and equipment.[47]
3) Always document the reason a battery was removed from an ESS and keep that documentation with the battery (see **Section 2.4**). This is helpful information for battery processors and will likely be required for the battery warranty.[48]

3.6.2 Removing Batteries from an EV

EV batteries present a particular risk to those managing end-of-life vehicles, e.g. mechanics, scrap metal yards or car wreckers, and to first responders to an emergency situation involving an EV, such as a car accident. Following a car accident, the battery may be damaged, making it particularly dangerous.

3.6.2.1 General precautions

1) Never place an EV in a vehicle shredder if the batteries have not been removed.[49]
2) Only trained service personnel with the necessary, specialist tools and expertise in high voltage systems should remove batteries from an EV, such as those certified by manufacturers to replace EV batteries.[50]
3) Mechanics and workers at car wreckers, scrap yards and similar should only remove batteries from an EV if they have received specific training and have referred to the manufacturer's dismantling manual and vehicle specific risk assessments (if available).[51]
4) Mechanics and facilities managing end-of-life vehicles should allocate a separate and cleared outdoor area where EV batteries are removed. Where possible, this area should be at least 15m away from any structure or anything that can burn.
5) An EV damaged from a moderate to severe crash, flood, fire, or other event should be inspected as soon as possible. Until it has been inspected, it should be stored outside, at least 15m from any structure or anything that can burn. Ventilate the vehicle by opening a window or a door.[52]

3.6.2.2 Removing an EV battery due to damage or following accident

1) Emergency first responders should receive specific training on how to manage an emergency involving an EV and the specific risks presented by lithium-ion batteries.[53] For more information, see the Best Practice Guidelines and the Emergency Field Guides produced by the National Fire Protection Association in the United States.[54]
2) Where cutting devices or blowtorches are needed for a rescue or emergency operation, extreme care is required to avoid risks such as electrocution or explosion.[55]
3) If an EV battery is being removed because it is known to be damaged or because it is being removed from a car involved in a moderate to severe crash, flood, fire or other event, an electrician and/or certified high-voltage expert must also be present for the removal.[56]
4) Clear the area surrounding the car before removing the damaged or potentially compromised battery. If possible, place the car on a forklift and move it to an outside area away from any other cars or other objects.[57]
5) Where possible, do not begin to remove the damaged or potentially compromised battery until a fireproof container is on site, into which the removed battery can be immediately placed, [58] for example:
    a. A bespoke container with an in-built smoke detector and automatic fire extinguishing system.

b. An enclosed steel container filled with non-conductive material, such as sand or vermiculite.[59]

6) If no containers or non-conductive material are available. Clear the area surrounding the car before removal. Once removed, ensure the damaged battery is kept away from other combustibles, and at least 15m away from a building where there are human activities. If possible, store on a concrete floor.[60] Refer to the manufacturer's instructions for the appropriate person to contact to remove and transport the battery, as soon as possible.

3.6.2.3 Reuse of EV batteries

1) The reason for a battery's removal should be documented and kept with the battery.[61] This is helpful information for those processing batteries, and vital for those wanting to reuse an EV battery.
2) Never reuse an EV battery (for example, for a domestic ESS) unless it has had its state of safety assessed by a person who is qualified or accredited to make such an assessment, and that person has verified the battery is safe for reuse. Ideally, professionals should consider UL 1974 – Standard for Evaluation for Repurposing Batteries.
3) An EV battery that is damaged, or which has been removed from a car involved in an accident, should not be on-sold for reuse unless it has had its state of safety assessed and has been verified as safe for reuse, according to subsection (2) above.[62]
4) An EV battery that has been removed because of reduced performance due to normal use must not be on sold for reuse unless its state of safety has been assessed and has been verified as safe for reuse according to subsection (2) above.[63]

4.0 Transporting Used Battery Packs, Modules, Cells and Other Elements

When a battery comes to the end of its first life and has been removed from an ESS or EV, it must be transported to another location to be managed, such as a used battery collection point, a recycler, or an exporter.

If battery packs suffer damage during shipping, such as short circuit or inadvertent movement, this could lead to accidental discharge and potential fire, explosion, or chemical leakage.[64] Damaged batteries present a particular risk and must only be transported with extreme caution. Furthermore, batteries that have already combusted can reignite hours or days after the initial fire, and should be treated as an ongoing fire risk.

4.1 Large, Used Batteries are Dangerous Goods

Large, used batteries are classified as Dangerous Goods under both international and New Zealand law. Dangerous Goods are 'substances internationally classified as potentially dangerous during transport'.[65]

There are nine classes of dangerous goods. Large, used batteries fall under either Class 8 or Class 9, depending on their chemistry type. **This section of the guidelines focuses mostly on Class 9 large, used batteries**, which are: Lithium-ion and Lithium Metal batteries.[66]

Dangerous goods are subject to regulations that specify how they can be transported and by whom, and prescribe appropriate measures for packaging, labelling, handling, separation, stowage and inspection.[67] The purpose of this regulatory system is to ensure that accidents do not happen, but where they do, to ensure that the amount of damage and/or injury is minimised.[68]

Requirements vary according to whether the battery is being transported by land, sea or air, but the overarching rules for all transport types come from the UN Model Regulations on the Transport of Dangerous Goods (UN Model Regulations). The UN Model Regulations are applied in New Zealand through several laws (see **Section 4.4** below). The three main regulations are:

- **Land**: Land Transport Rule: Dangerous Goods 2005
- **Sea**: Maritime Rules Part 24A: Carriage of Cargoes – Dangerous Goods
- **Air**: Civil Aviation Rules Part 92: Carriage of Dangerous Goods

This section outlines some of the key regulatory requirements you should know, and offers general guidance for the safe transportation of large, used batteries. However, these guidelines are not a complete summary of the law and do not constitute legal advice. Anyone wishing to transport large, used batteries should:

1) be familiar with the regulatory framework for transporting dangerous goods (listed in **Section 4.4** below); or
2) seek advice from a legal professional to understand the relevant regulations; or
3) contract the services of a third party certified in the transportation of dangerous goods.

Failure to comply with dangerous goods regulations can result in prosecution.

4.2 General Requirements for Transporting Large, Used Batteries

Before transportation, large, used batteries must be:[69]

- classified according to the primary danger they present;
- packaged;
- marked and labelled, and the vehicles carrying them placarded;
- documented; and
- otherwise in a fit condition for transportation.

Less stringent requirements for transportation apply to batteries that are below a certain weight or Watt-hour rating. However, because large, used batteries generally exceed these maximum limits, these lesser requirements are not considered in these guidelines.[70]

Lithium batteries can only be transported if the cells or batteries are of a type that has passed the testing requirements under the United Nations *Manual of Tests and Criteria*, Part III, sub-section 38.3,[71] except:

- if the batteries are deemed damaged or defective; or
- if the batteries are being transported for disposal or recycling.

4.2.1 Who Can Transport Large, Used Batteries

Individuals can transport large, used batteries for the purpose of domestic or residential use. However, individuals still need to follow the majority of the dangerous goods rules (with only some exceptions).

To reduce risk of non-compliance and/or injury or incident, large, used batteries should be transported by professionals who are certified to transport dangerous goods.[72]

4.2.2 Appropriate Vehicles and Modes of Transport

There are many restrictions on transporting lithium-ion batteries by air, even when they are new. In most cases, transporting large, used batteries by air will be prohibited because of their size and potential safety risk.[73]

We recommend that large, used batteries are transported by land or sea only.

All vehicles used to transport large, used batteries should be fitted with fire extinguishers.

4.2.3 Training for Personnel Transporting Large, Used Batteries

1) Anyone transporting large, used batteries as part of their trade (whether or not for hire or reward) must be trained in the contents of dangerous goods requirements, to the level of their responsibilities.[74]
    a. Employees must receive this training before assuming responsibilities.
    b. If employees are performing a task for which they have not yet received the required training, they must be directly supervised by a trained person.

4.2.4 Assess a Battery's State of Safety Before Transportation

A battery's state of safety affects the applicable transport regulations because a compromised or potentially compromised battery carries greater risk. Therefore, before a battery pack is prepared for transportation, its state of safety, including state of health, should be assessed.[75]

The assessment should be based on safety criteria produced by the battery manufacturer and carried out by a technical expert, such as an electrician, electrical

engineer, or a certified high-voltage expert, with knowledge of the battery's safety features.[76] A battery must be treated as damaged or defective if it cannot be diagnosed prior to transport.[77]

1) If a battery is assessed as damaged or potentially damaged, refer to Section 4.3.5 for specific guidelines.
2) If, following assessment, the battery is to be transported for recycling or disposal, refer to Section 4.3.6 for specific guidelines.

4.3 Preparing Batteries for Transportation

4.3.1 General Requirements

Large, used batteries should be transported in packaging that effectively protects against incidents during shipping, such as short circuit or mechanical damage, which could lead to accidental discharge and potential fire, explosion, or chemical leakage.[78]

1) Packaging used to transport large, used batteries should be:
    a. Good quality and strong enough to withstand the shocks and loadings normally encountered during transport.[79]
    b. Constructed and closed so as to prevent any loss of contents that may be caused under normal conditions of transport, by vibration, or by changes in temperature, humidity or pressure.[80]
    c. Sealed according to manufacturer's instructions.[81]
2) A battery can short-circuit if its terminals come into contact with another battery's terminals, metal objects, or conductive surfaces.[82] Cover terminals with electrical insulating tape to avoid accidental discharge or arc flash leading to electrocution, potential fire, or the leaking of hazardous chemicals.[83]
3) If the battery is an EV battery pack, ensure the safety/service plug is removed and the battery pack socket is suitably insulated using high voltage rated insulation tape or similar.
4) Ensure batteries cannot move in their packaging,[84] whether by using non-combustible cushioning material inside inner packaging or strapping if attaching batteries to a pallet.
5) Where possible, avoid packing batteries together in the same outer packaging with other dangerous goods, but especially if the batteries could react dangerously with those goods.[85]
6) Multiple battery packs can be transported together provided that none have been assessed as damaged or compromised; and the batteries are all of the same chemistry type.
    a. Transport multiple battery packs of the same chemistry type on a wrapped, steel pallet, with a layer of non-conductive material, such as cardboard, polythene or high voltage insulated mats, between each battery so they do not touch. Secure the batteries to the pallet with strapping so that they cannot move or vibrate during transport, but not so tight as to crush or distort the packs.[86] Do not use strapping with metal ties or fasteners.

b. Batteries of different chemistry types must not be loaded on the same pallet.[87]

4.3.2 Transport Large, Used Batteries in Their Original Casing

1) Where possible, transport large battery packs fully assembled in their original casing.
2) So long as they are not damaged nor defective, batteries with a strong, impact resistant casing of a gross mass of 12 kg or more, and assemblies of such batteries, can be packaged:[88]
    a. in strong outer packaging
    b. in protective enclosures (e.g. in fully enclosed or wooden slated crates); or
    c. on pallets or other handling devices capable of safely supporting the weights involved.
3) Secure batteries to prevent inadvertent movement, and ensure terminals are covered and not supporting the weight of other superimposed elements.[89]
4) Do not break down, disassemble or dismantle large, used batteries before transportation.[90] Many transport companies and exporters cannot accept batteries that have been compromised in this way.[91]
    a. However, it is appropriate for large packs to be safely dismantled down to undamaged and intact module levels prior to transportation, provided that this dismantling is undertaken by a qualified professional, such as an electrician, electrical engineer, or certified high voltage expert, with knowledge of the particular battery system, or a person specifically trained in these areas for the purpose of working on batteries.

4.3.3 Identification: Marking, Labelling and Placarding

Packages and or containers in which large, used batteries are transported must be marked or labelled according to the UN Model Regulations to identify their hazardous properties.[92] Similarly, placards should be affixed to all vehicles or cargo transport units carrying large, used batteries.[93] These identifications warn people who come into contact with the package or vehicle (including in an emergency situation) about the hazardous properties of their contents.[94]

4.3.3.1 Proper Shipping Name and UN Number

For identification purposes, dangerous goods are given a “proper shipping name” and a UN number. The proper shipping name and UN number for common types of large batteries are shown in

Table 2 UN Number and Proper Shipping Name for Large Batteries.

Table 2 UN Number and Proper Shipping Name for Large Batteries

Battery type	UN Number	Proper Shipping Name
Lead Acid Batteries	2794	BATTERIES, WET, FILLED WITH ACID
Lithium Metal	3090	LITHIUM METAL BATTERIES
Lithium Ion	3480	LITHIUM ION BATTERIES

1) Before transporting a large, used battery, mark the packaging with the battery's proper shipping name, along with its UN number preceded by the letters "UN". The markings should be at least 12 mm high.[95]
2) Packaging marks must:[96]
    a. Be readily visible and legible.
    b. Be able to withstand open weather exposure
    c. Be displayed on a contrasting background colour on the external surface of the package
    d. Not be located with other package marks that could reduce their effectiveness.

4.3.3.2 Danger Class Label

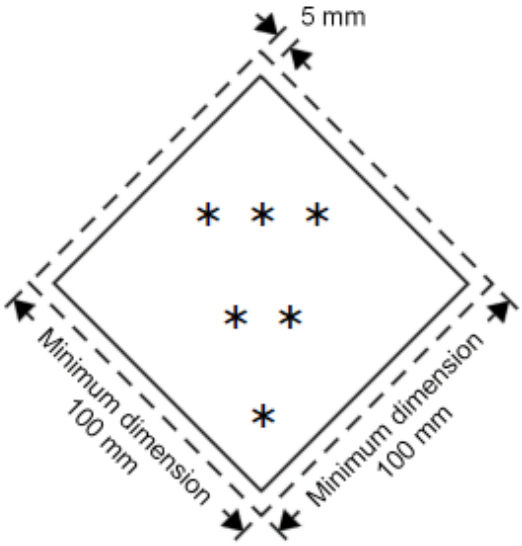
1) The relevant UN Danger Class Label must also be affixed to the packaging.[97] These are shown and explained in **Table 3** UN Danger Class Specimen Labels (plus explanatory details).
2) Labels must use the exact same colour, symbols and general format as the UN Specimen Labels (as they appear in **Table 3** UN Danger Class Specimen Labels (plus explanatory details).[98]
3) Labels must be diamond-shaped (i.e. a square set at a 45 degree angle) and at least 100 mm x 100 mm in dimension. There should be a line inside the edge forming the diamond which should be parallel and approximately 5 mm from the outside of that line to the edge of the label (as shown in **Figure 1** - How to Configure the Danger Class Label).[99]
4) The label should be:[100]
    a. Located near the proper shipping name mark, and on the same surface of the package;
    b. Placed on the packaging so that it is not covered or obscured by any part or attachment to the packaging or any other label or mark; and
    c. Affixed on a surface of contrasting colour (otherwise, ensure the label has either a dotted or solid outer boundary line).[101]
5) Labels must be able to withstand open weather exposure without a substantial reduction in effectiveness.[102]

6) If using an intermediate bulk container or large packaging of more than 450 litres capacity then the container or packaging should be labelled and marked on two opposing sides.[103]
7) If batteries are packaged with other types of dangerous goods in the same outer packaging then the outer package should be labelled and marked as required for each substance.[104]

Table 3 UN Danger Class Specimen Labels (plus explanatory details)

Class 8 – Corrosive substance (Lead acid and other Class 8 batteries)	**Class 9A – Miscellaneous dangerous substances and articles (Lithium Metal and Lithium Ion Batteries)**
	
Explanatory details **Symbol** (liquids, spilling from two test tubes and attacking metal and a hand): black; **Background**: upper half: white; lower half: black with white border; **Number '8'**: in bottom corner: white. **Text**: 'Corrosive': white.	***Explanatory details*** **Symbol** (seven vertical stripes in upper half and battery group, one broken and emitting flame in lower half): black; **Background**: white; **Number '9'**: underlined, in bottom corner: black.

Figure 1 - How to Configure the Danger Class Label



4.3.3.3 Placarding, UN Number and Emergency Information Panel

1) Placards must be affixed to the outside of vehicles, cargo transport units and bulk containers to warn that they contain large, used batteries.
2) The placard should be diamond-shaped (i.e. a square set at a 45 degree angle) and at least 250 mm x 250 mm in dimension (to the edge of the placard). The line inside the edge should be parallel and 12.5 mm from the outside of that line to the edge of the placard. The symbol and line inside the edge should be the same colour as the danger class label, with the class number positioned and sized in the same proportions to the label (as shown in **Figure 2** Size and configuration of placards).[105]
3) Vehicles or cargo transport units carrying a full load of large, used batteries, should also display the UN number in black digits at least 65 mm high. As shown in **Figure 3** Two options for placing the UN Number on the placard, these should be either:[106]
    a. against a white background in the area below the pictorial symbol and above the class number; or
    b. on an orange rectangular panel at least 120 mm high and 300 mm wide, with a 10 mm black border, placed immediately next to the placard.
4) The UN Number can also be part of an emergency information panel, as shown in **Figure 4** Placard with Emergency Information Panel Containing UN Number.

Figure 2 Size and configuration of placards

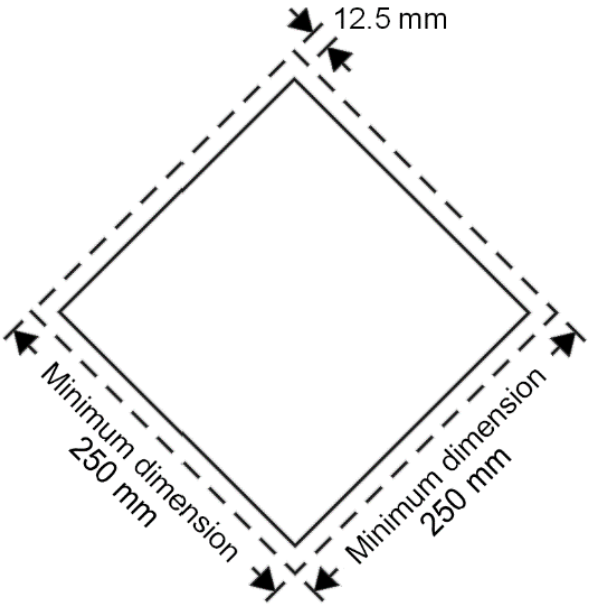


Figure 3 Two options for placing the UN Number on the placard

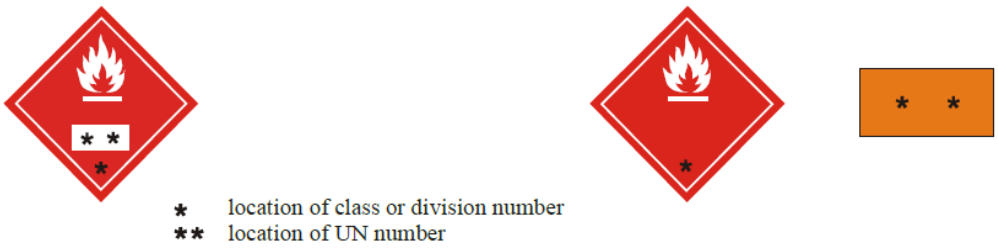


Figure 4 Placard with Emergency Information Panel Containing UN Number

4.3.4 Documentation

Large, used batteries must be transported with adequate documentation, which is important for conveying information to the transporter and, where necessary, to emergency services and enforcement agencies. Documentation is essential in order to know:[107]

- What is being carried;
- Where is it stowed;
- How it is packaged; and
- How to deal with emergencies.

1) Anyone carrying large, used batteries must have or be given a relevant dangerous goods transport document for those batteries.[108] This document must contain the following information:[109]
    a. The UN number preceded by the letters "UN"
    b. The proper shipping name
    c. The danger class
    d. Where assigned, the packaging group roman numeral preceded by "PG" (e.g. "PG II")

    For example:

    UN 3480 LITHIUM ION BATTERIES 9 PG II

2) Documentation must also provide information on the total quantity of large, used batteries transported (by volume or mass, as appropriate).[110]
3) The transport document must include a certification or declaration that verifies the above. For example:[111]

    "I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labelled/placarded, and are in all respects in proper condition for transport according to applicable international and national rules and regulations."

4) If the large, used batteries are packed or loaded into a closed, prepacked freight container or vehicle, a Container Packaging Certificate or Vehicle Packaging Certificate must be carried to indicate that:[112]
    a. The freight container or vehicle was clean, dry and fit to receive the goods
    b. Packages that need to be segregated have been
    c. All packages have been externally inspected for damage and only sound packages have been loaded;
    d. All goods have been properly loaded and sufficiently secured to suit the mode(s) of transport for the intended journey;
    e. Goods loaded in bulk have been evenly distributed within the container/vehicle;
    f. All packages are appropriately marked and labelled
    g. A dangerous goods transport document has been received for each consignment of large, used batteries loaded in the container/vehicle.

5) Emergency response information should accompany consignments of large, used batteries. The information must be available away from the packages containing the batteries and immediately accessible in the event of an accident or incident.[113]

4.3.5 Preparing Damaged or Defective Batteries for Transportation

Damaged batteries present a particular risk and must be transported with extreme caution.

1) Inform the company transporting the battery that the battery is damaged. Some freight companies will not transport damaged batteries.[114]
2) Inform the intended destination company that the battery arriving to them is damaged and check that they accept damaged batteries. Exporters are unlikely to accept damaged batteries.[115]
3) Note that damaged or defective batteries cannot be transported on aircraft.

4.3.5.1 Damaged or defective batteries not liable to sudden incident

1) If a large, used battery has been assessed as damaged or defective, but not liable to rapidly disassemble, dangerously react, produce a flame or a dangerous evolution of heat or a dangerous emission of toxic, corrosive of flammable gases or vapours under normal conditions of transport then in addition to the general requirements of **Section 4.3.1**:[116]
    a. Individually package the battery in inner packaging, placed inside an outer packaging. Either the inner or outer packaging must be leakproof to prevent potential release of electrolyte.
    b. The packaging should be rigid large packaging conforming to packaging group II performance level, made of steel, aluminium, metal other than steel or aluminium, rigid plastics, or plywood.
    c. The inner packaging must be surrounded by sufficient non-combustible and electrically non-conductive thermal insulation material to protect against a dangerous evolution of heat, such as sand or vermiculite.
    d. Fit sealed packaging with a venting device, when appropriate.
    e. Take appropriate measures to minimize the effects of vibrations and shocks, and prevent movement of the cells or batteries within the package. For example, through using a non-combustible and electrically non-conductive cushioning material.
    f. For leaking cells or batteries, add sufficient inert absorbent material, such as sand or vermiculite, to the inner or outer packaging to absorb any release of electrolyte.

4.3.5.2 Damaged or defective batteries liable to sudden incident

1) If a large, used battery has been assessed as damaged or defective AND liable to rapidly disassemble, dangerously react, produce a flame or a dangerous evolution of heat or a dangerous emission of toxic, corrosive of flammable gases

or vapours under normal conditions of transport then in addition to the general requirements of **Section 4.3.1**:[117]

a. Package the battery into rigid large packaging conforming to packaging group I performance level, made of steel, aluminium, metal other than steel or aluminium, rigid plastics, or rigid fibreboard.
    i. For example, a fireproof container with an in-built smoke detector and automatic fire extinguishing system. Where such containers are not available, transport damaged batteries in enclosed steel containers filled with non-conductive material, such as sand or vermiculite.
b. The packaging must meet the following additional performance requirements:
    i. The outside surface temperature of the completed package must not exceed 100°C. A momentary spike in temperature up to 200°C is acceptable.
    ii. Capable of containing all flames.
    iii. Capable of containing all projectiles.
    iv. Capable of maintaining its structural integrity; and
    v. Have a gas management system (e.g. filter system, air circulation, gas containment, gas tight packaging etc.), as appropriate.
c. The additional performance requirements in (b) must be verified by a test specified by the Environmental Protection Authority.

4.3.5.3 Marking, labelling and documentation for damaged and defective batteries

1) In addition to the proper shipping name and UN number, packages carrying damaged or defective batteries must also be marked with the words "DAMAGED/DEFECTIVE".[118]
2) The markings should be at least 12 mm high, readily visible and legible, able to withstand open weather exposure, displayed on a contrasting background colour on the external surface of the package, and not located with other package marks that could reduce their effectiveness.[119]
3) On large packaging, the markings should be made on two opposing sides of the package.[120]
4) The transport document accompanying the consignment must also include the following statement: "Transport in accordance with special provision 376".[121]

4.3.6 Preparing Batteries that are Being Transported for Disposal or Recycling

A large, used lithium battery that has not been deemed damaged or defective, but which is being transported for disposal or recycling must, in addition to the general requirements of Section 4.3.1, be packaged accordingly:[122]

1) In packaging that conforms to the packing group II performance level.
2) If metal packaging is used, it must be fitted with an electrically non-conductive lining material (e.g. plastics) of adequate strength for the intended use.

3) For cells or batteries with a gross mass of 12 kg or more with a strong, impact resistant outer casing then:
    a. Strong outer packaging constructed of suitable material and of adequate strength and design in relation to the packaging's capacity and its intended use, may be used, such as a steel container.
4) Batteries must be packed to prevent short circuits and the dangerous evolution of heat, which includes:
    a. Individual protection of the battery terminals
    b. Inner packaging to prevent contact between cells and batteries,
    c. Ensuring terminals are covered with insulating material
    d. The use of an electrically non-conductive and non-combustible cushioning material to fill empty space between the cells or batteries in the packaging, such as sand or vermiculite.
5) Cells and batteries shall be secured within the outer packaging to prevent excessive movement during transport (e.g. by using a non-combustible and electrically non-conductive cushioning material or through the use of a tightly closed plastic bag).

4.3.6.1 Marking, labelling and documentation for batteries transported for disposal or recycling

1) In addition to the proper shipping name and UN number, packages carrying damaged or defective batteries must also be marked with the words "LITHIUM BATTERIES FOR DISPOSAL" or "LITHIUM BATTERIES FOR RECYCLING".[123]
2) The markings should be at least 12 mm high, readily visible and legible, able to withstand open weather exposure, displayed on a contrasting background colour on the external surface of the package, and not located with other package marks that could reduce their effectiveness.[124]
3) On large packaging, the markings should be made on two opposing sides of the package.[125]

4.4 Further Information

The international regulatory framework for the safe and effective transport of dangerous goods is made up of:[126]

- The United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations)
- The International Civil Aviation Organization's Technical Instructions for the Safe Transport of Dangerous Goods by Air
- International Air Transport Association Dangerous Goods Regulations
- International Maritime Organisation's International Maritime Dangerous Goods Code

The domestic regulatory framework for the transport of dangerous goods in New Zealand is made up of:[127]

- Civil Aviation Act 1990, Maritime Transport Act 1994, Land Transport Act 1998, their associated offences regulations, and the Railways Act 2005.
- Civil Aviation Rules Part 92: Carriage of Dangerous Goods; Advisory Circulars under Rules Part 92.
- Maritime Rules Part 24A: Carriage of Cargoes – Dangerous Goods.
- Land Transport Rule: Dangerous Goods 2005 (45001/1)
- Land Transport (Driver Licensing) Rule 1999 (SR1999.100)
- NZ Standard 5433:2012 'Transport of dangerous goods on land'.

5.0 Collection Process for Large Used Batteries

Battery collection points are temporary locations where end-of-life batteries can be dropped off to be stewarded through to the next phase of their lifecycle. Collection points present particular risks. For example:

- batteries are likely to be aggregated in large numbers before being sent to processing centres or for reuse;
- some of the batteries dropped off at collection points may be damaged and defective; and/or
- the collection point may also be operating as a collection point for a range of other end of life products and materials.

1) To minimise risks, it is important that:
    a. Any collection point is registered with the product stewardship organisation (PSO) responsible for large batteries (to be established), and its location communicated to the public via the PSO's website.
    b. Those who operate or work at collection points are familiar with the risks associated with handling, storing and transporting batteries.
    c. Limits are set on how many batteries can be held at a collection point at any one time. [128]
    d. Batteries are not kept at temporary collection points for extended periods of time.
    e. Batteries of different chemistry types are stored separately from each other.
2) Where possible, collection points should be close to pre-treatment or recycling plants to minimise transport distances. A network of storage and recycling facilities would be the safest and most efficient way to manage large, used batteries.[129]

5.1 Safety Features for Collection Points of Large, Used Batteries

5.1.1 Appropriate Signage and Supervision

Collection points may be located at facilities that are used by members of the public (such as transfer stations or resource recovery centres). Clear signage and qualified

supervision of the space where large, used batteries are collected will reduce the risk of things going wrong.

1) Collection facilities should have clear and visible signage to communicate relevant information, including:[130]
    a. safety warnings;
    b. instructions to the public;
    c. site access times for the public; and
    d. details of the batteries that are or are not accepted at the facility.
2) Public collection points for batteries should be easily accessible and kept clean and free of hazards.[131]
3) All battery collection points should be supervised by trained staff, and must be clearly labelled to avoid confusion and accidental cross-contamination.

5.1.2 Battery Storage Considerations

Where possible, the battery storage areas at collection points will have the features of an appropriate storage facility outlined in **Section 6.2**. However, this may not be practicable as collection points are not designated, long-term storage spaces.

1) At a minimum, collection points will have a temporary storage area for batteries that is:
    a. Cool and dry, under cover and out of direct sunlight, and protected from water, humidity and any water condensation.[132]
    b. Away from any sources of heat or ignition.[133]
    c. Protected from extreme and fluctuating temperatures.[134]
    d. Bunded with impermeable surfaces and weatherproof coverings to retain any contaminated run-off, e.g. heavy metals.[135] Measures should be taken to prevent potentially hazardous material entering stormwater drainage.[136]
    e. Fitted with emergency response equipment specific to the risks inherent to lithium, including suitable fire extinguishing media, such as CO_2, sand, vermiculite, copper powder, sodium bicarbonate; and personal protective equipment.[137]
    f. Capable of keeping unsupervised batteries under external surveillance. For example, infra-red cameras to detect any excessive temperatures.[138]
    g. Installed with a sacrificial roof if the storage area is enclosed, in order to disperse air pressure in case of serious fires or explosions from lithium-ion batteries.
    h. Ensures that batteries of different chemistry types are able to be stored separately.

5.2 How to Manage Used Batteries at Collection Points

If they have not already been assessed at the point of removal large, used batteries that arrive at collection points should have their state of health immediately assessed by a person who is qualified to make such an assessment,[139] as set out in **Section 2.7**.

5.2.1 Damaged or Compromised Batteries

If a battery is assessed as damaged, partially disassembled, or otherwise compromised, take the following steps:

1) Put the battery in a fireproof container, for example:
    a. A bespoke container with an in-built smoke detector and automatic fire extinguishing system.
    b. Enclosed steel containers filled with non-conductive material, such as sand or vermiculite.
2) Clear the surrounding area, for example:
    a. Remove any nearby source of heat and electricity.
    b. Move the battery (if possible) into a separate room with non-combustible building materials, such as concrete walls, or outside, well-away from any structures, on a concrete floor.
    c. Evacuate any people from the area.
3) Refer to the instructions provided by the manufacturer's guidelines for the appropriate person to contact to remove or service the battery.

4) Store damaged batteries separately from all other batteries in a clearly labelled and segregated area of the collection facility.

5.2.2 All Other Large, Used Batteries

1) Batteries that are not assessed as damaged or compromised must still be kept separate from other material and waste streams.[140] Batteries in a mixed waste bin can cause fire or electric shock.[141]
2) Ensure batteries of different chemistry types are also segregated from each other.[142] Cross-contamination creates risks because different battery types need to be processed differently.[143]
    a. Organise a separate storage area for lithium-ion batteries, maintaining a distance of 2.5 metres between the lithium-ion battery storage area and other goods.[144]
3) Cover all battery terminals with electrical insulating tape to avoid accidental discharge or arc flash leading to electrocution or potential fire, or the leaking of hazardous chemicals.[145]
4) Collection containers for batteries should:
    a. meet environmental, health and safety standards;[146]
    b. be strong enough and durable enough for their purpose as a collection container of large, used batteries;[147]
    c. be constructed such that any components of the packaging that may come into direct contact with the large, used batteries inside are compatible with large, used batteries;[148]
5) Where multiple batteries are being aggregated at the collection point and palletised:

a. Batteries of the same chemistry type can be stacked on a wrapped pallet with a layer of cardboard, polythene or high voltage insulation mats on top of the terminals and between each battery so they do not touch.[149]
b. Use of damp vermiculite is appropriate for lithium battery aggregation.[150]
c. Ensure the batteries are firmly strapped to the pallet so there can be no movement or potential damage,[151] using strapping without metal buckles or connectors.
d. It is recommended that batteries or pallets of batteries are ideally not stacked higher than 1m, or 2m maximum. [152]

6.0 Storing Used Battery Packs, Modules, Cells and Other Elements

Batteries can present a significant fire risk, especially lithium-ion batteries. Although the failure rate continues to reduce as battery technology improves, caution is still required when storing tonnes of batteries in one place. Fires in warehouses of stored batteries are not uncommon.[153]

Batteries are both a source of ignition and a fuel, so once a battery fire starts, it is difficult to put out. Lithium-ion battery fires, in particular, do not respond well to traditional fire suppression systems.[154] These concerns justify stringent measures to prevent fire, combined with early detection and robust systems of containment.

6.1 Important Starting Points

1) All batteries presented for storage should be treated as though they are fully charged and a risk.[155]
2) Always store batteries in accordance with manufacturer's recommendations.[156]
3) Any person who intends to store a large, used battery for an extended period of time should develop and implement a storage, fire and emergency management plan that outlines how the person will prevent or manage a battery failure event.[157]
4) If multiple large, used batteries are to be stored, then the storage and fire management plan should be developed in consultation with a fire engineer, emergency services and/or the relevant regulatory authority.[158]
5) Any person storing large, used batteries must source the relevant Safety Data Sheet for each battery kept in storage, and keep this information in an easily accessible location somewhere outside the storage building. If available, a record of each battery's history/chain of custody (see **Section 2.4**) should also be kept.
6) All personnel employed on the premises must be trained in:[159]
    a. the nature of the work and safe methods of operation
    b. the properties and hazards of large, used batteries

c. the correct use of personal protective equipment, its care and maintenance; and
d. actions (including emergency procedures) to be taken in various emergencies.

7) Before being placed in storage, all batteries should be initially inspected to assess their state of safety, state of health and state of charge.[160] This assessment should be undertaken by a qualified electrician or certified high voltage expert, as set out in **Section 2.7**.
8) Do not store batteries in the same storage facility as other incompatible products or materials, such as corrosive products.

6.2 Features of an Appropriate Storage Facility for Large, Used Batteries

A battery storage facility could be:[161]

- A room, enclosure or area within a building.
- A roofed structure or room, attached to an external wall of a building.
- A free-standing, roofed structure or building.
- A storage cabinet.
- An outdoor storage area which is secured against unauthorised access.

6.2.1 Location

1) Locate battery storage facilities in appropriately zoned areas, with a separation distance of at least 3 m from:[162]
   a. critical infrastructure or protected places, such as dwellings, places of work, public buildings, child-care facilities, schools, hospitals, theatres, or any building or open area in which people assemble; and
   b. surrounding buildings where people are employed.
2) Battery storage facilities should also be located a minimum distance away from potential ignition sources, such as petrol storage tanks or petrol stations.[163]

6.2.2 Signage, Lighting and Security

1) Label all buildings, containers and packages in which large, used batteries are stored with their relevant UN Number and Danger Class Label (see **Section 4.3.3**).[164]
2) At all times, battery storage areas must be appropriately secured against unauthorised access,[165] and feature a warning sign to restrict unauthorised entry.[166]
3) During hours of operation, lighting shall be sufficient to provide safe working conditions and clear visibility of all signs, labels, instruments and other necessary items.[167]

6.2.3 Temperature and Ambient Conditions

Exposure to the elements or extreme temperatures can cause lithium batteries to rupture, ignite or explode, and can cause other battery chemistry types to leak chemicals.[168]

1) Store large, used batteries in cool and dry conditions, under cover and out of direct sunlight, and protected from water, humidity and any water condensation.[169]
2) Store large, used batteries away from any heat sources or sources of ignition.[170]
3) Protect storage locations against extreme and fluctuating temperatures. It is not recommended that stored batteries be exposed to temperatures below freezing or above 50-60 degrees Celsius.[171]

6.2.4 Ventilation

Stored batteries should be kept well ventilated.[172] Most batteries emit toxic or explosive gases if electrolyte is released or cells vent, and buildings with ventilation reduce concentration of hydrogen to a safe level.[173] Ventilation systems also allow a reduction of heat energy in the room in the case of a fire.[174]

1) Avoid closed coverage of storage areas for large, used batteries.[175]
2) Storage facilities should have forced ventilation or oversized flue gas windows.[176]
3) Ventilation systems should be capable of scrubbing and dilution, as gases emitted during a battery failure event can be noxious.[177]

6.2.5 Design and Construction Requirements for Potential Hazards

1) Storage facilities should have fire resistant walls, floors, and roof sheeting with a passive fire protection of at least 2 hours (i.e. concrete, not gypsum board).[178]
2) If the facility is fully enclosed and a single story only, consider installing a sacrificial roof in order to disperse air pressure in case of serious fires or explosions from lithium-ion batteries.
3) Storage facilities should be bunded with impermeable surfaces and weatherproof coverings to retain any contaminated run-off, e.g. heavy metals.[179]
4) Measures should be taken to prevent potentially hazardous material entering stormwater drainage.[180]
5) Ideally, where large amounts of batteries are stored in the same building, the building should be of fire rated construction so that any fire can be contained.[181]
6) Outdoor storage areas must have an escape route that does not run through the storage area; any emergency exist gate or door must not open inwards to the storage area.[182]
7) If an office is inside a store there must be a means of escape from the office that does not run through the storage area.[183]

6.2.6 Personal Protective Equipment (PPE) and First Aid Kit

1) All personnel must be provided with appropriate PPE.[184]

2) The PPE should be kept in designated, clearly-marked locations, ready for use and maintained in a fit state of repair.[185]
3) A first aid station must also be provided and maintained, in a clean area. At least one person on the premises should be trained in first aid.[186]

6.2.7 Heat and Fire Detection Equipment

1) Conduct frequent facility inspections through a detection routine.[187]
2) Ensure buildings have detection equipment, including fire and smoke detectors, and an infra-red camera to detect any excessive temperature raise in stored quantities. [188] Having access to an individual handheld infrared camera is also recommended.[189]

6.2.8 Fire Suppression Equipment

1) The advice of the appropriate fire authority or suitably qualified consultant should be sought on fire protection and prevention measures, and the adequacy and suitability of fire-fighting equipment.[190]
2) Storage buildings should be fitted with automatic sprinkler protection systems,[191] and on-site CO_2 tanks to replace oxygen if a storage area reaches a set temperature that could trigger fire. [192]
3) Storage buildings should also have a fire extinguishing system installed that provides 4cbm water/h for every 1cbm of stored lithium-ion batteries (excluding packaging weight).[193]
4) Buildings storing more than 10m^3 of batteries should have a fire extinguishing system installed that includes fire hydrants of at least 6cbm/h, 3 bar.[194]
5) Emergency response equipment specific to the risks inherent to lithium (Class D rated fire extinguisher or other suitable fire extinguishing media, such as CO_2, sand, vermiculite, copper powder, sodium bicarbonate; and personal protective equipment) shall be available at all sites where lithium batteries are handled, stored or may be physically damaged.[195]

6.3 Preparing Batteries for Storage

6.3.1 Refer to Manufacturer's Guidelines

Refer to the relevant manufacturer's guidelines for how best to store end-of-life batteries.

6.3.2 Do not Disassemble Batteries Prior to Storage

1) Where possible, store large battery packs fully assembled in their original casing, or in the original module casing.[196]
2) However, if the batteries are being stored at a battery processing facility with recognised pre-treatment capacity, pre-treat batteries to remove chemicals prior to storage, if possible, as this reduces storage risk.[197]

6.3.3 Cover All Terminals and Store at Appropriate State of Charge

1) If the used lithium batteries are to be recycled, store them at a reduced state of charge and/or at the value recommended by the manufacturer for transportation. This reduces the likelihood that any mishandling or external heating will lead to combustion.[198]
2) If the used lithium batteries are to be reused, store them at nominal constant state of charge.
3) Ensure terminals are covered with electrical insulating tape to avoid accidental discharge or arc flash leading to electrocution or potential fire, or the leaking of hazardous chemicals.[199] For EV batteries, ensure that the service plug is removed and the socket covered with high voltage insulation tape.
4) If batteries remain in their original casing, a layer of cardboard, polythene or high voltage insulation mat on top of the terminals before the battery is strapped to a pallet should be sufficient.[200]
5) Do not place metal or conductive objects on top of battery storage systems or touch across the terminals.[201]

6.3.4 Put batteries in Fire Resistant Container or Packaging

1) Store large, used batteries in closed containers and packaging to prevent short circuits and damage.[202] If the battery is intended for reuse, avoid filling the container with types of non-conductive material that could make it difficult to repurpose the battery, such as sand or vermiculite.
2) Ensure palletised batteries are securely strapped to the pallet. Cover all terminals and do not allow battery terminals to touch the terminals of other batteries.[203]
3) Damaged, partially disassembled, or compromised batteries must be stored separately from other batteries in fireproof containers with an in-built smoke detector and automatic fire extinguishing system. Where such containers are not available, store damaged batteries in sealed steel containers filled with non-conductive material, such as sand or vermiculite.
4) Damaged batteries should not be kept in storage for longer than three weeks.[204]

6.3.5 Keep Batteries Separate and Labelled

1) If storing multiple batteries together – for example, on a pallet – ensure they are physically separated by non-conductive material, such as high voltage rated insulation mats.
2) Segregate batteries of different chemistry types in separate storage areas because cross-contamination creates risks. For example, lithium-ion batteries must be kept separate from lead acid batteries because of fire risk.
3) Ensure all separate storage areas are clearly labelled to avoid confusion and accidental cross-contamination.
4) Organise a separate storage area for lithium-ion batteries, maintaining a distance of 2.5 metres between the lithium-ion battery storage area and other goods.
5) Damaged, partially disassembled, or compromised batteries must be stored separately from other batteries in a clearly marked area of the facility.[205]

6) Ideally, where large amounts of batteries are stored in the same building, the building should have clear fire districts, with batteries located within a fire district so that any fire can be contained. However, in spaces where this is impracticable, a fireproof, sealed container is appropriate.[206]

6.4 Limit the Quantity of Batteries in Storage and the Time Kept in Storage

1) There is no clear guidance on how long to store large, used batteries prior to processing. Contact the relevant manufacturer.
2) Batteries that have been deemed damaged or defective should not be held in storage for longer than 3 weeks.[207]
3) Keep a limit on the batteries stored in a given areas. For a 60m^2 area, the quantity should not exceed 6 euro pallets or an equivalent of 6.0m^3 of batteries.[208]
4) Do not stack batteries or pallets of batteries higher than 2m.[209] Maintain a segregation distance of at least 1 m around stacks for access and housekeeping.[210]

7.0 Managing Safety-Related Battery Failure Events During the Handling, Collection, Storage and Transportation of Large, Used Batteries

7.1 Indicators of an Unsafe Failure Event

A large battery may be entering a failure event if it does any of the following:

- Overheats or begins to smoke.
- Hisses.
- Changes shape, such as bulging or swelling.
- Emits an unusual smell.
- Leaks fluid.

If a battery exhibits any of the above behaviours, if possible, immediately move it away from any flammable materials and place it on a non-combustible surface. If possible, put the battery outdoors where it can burn out if it ignites.[211]

If the misbehaving battery is inside an EV, where possible, use a forklift to place the car outside in an area away from other cars and other objects.[212] Do not attempt to use the car.

Cordon off the area and put up signage to ensure people do not get close to the battery.

Contact emergency services.

7.2 Managing a Battery Fire

Once a battery pack catches fire it can be difficult to put out and it may need to be left to burn out on its own in a safe and controlled manner.[213] However, if a battery overheats and begins to smoke, water can be used to cool the battery down and stop the spread of fire.[214] It is also important to know that when a battery burns it emits toxic gases (such as hydrogen fluoride).

If a battery pack is smoking or on fire, take the following steps:

1) Call emergency services immediately.
2) Ventilate the affected area and avoid inhalation of fumes.[215]
3) If possible, remove and isolate the battery and compartmentalise the fire and maintain frequent checks[216]
4) If possible, use available fire extinguishers or water to cool and extinguish the fire, and take action to stop the fire from spreading by cooling the surrounding area with water.[217]
5) Consider use of non-combustible products, such as sand or vermiculite.
6) If the fire of a burning battery cannot be extinguished, allow the pack to burn out on its own in a controlled and safe manner.[218]
7) Reinstate fire protection systems.
8) Be aware that international experience has shown lithium batteries can reignite several days after an initial fire. A seemingly burnt-out battery should be monitored for some time after the fire has been extinguished.
9) Only re-enter a building or site where a battery fire has occurred after the site has been professionally remediated.[219]

7.3 Exposure to High Voltage

Prevention measures to be taken when approaching a high voltage battery or to rescue a victim:[220]

- Immediately contact emergency services.
- Use insulating gloves or protections.
- Turn off the source of electricity, if possible. If not possible, move the source away from you and the person (victim), using high voltage rescue hooks, or a dry, non-conducting object made of cardboard, plastic or wood.
- Check for signs of life (breathing, coughing or movement). If absent, begin cardiopulmonary recovery (CPR) immediately.
- Prevent shock. Lay the person down and, if possible, position the head slightly lower than the body with the legs elevated.

- After coming into contact with electricity, the person should see a doctor to check for internal injuries, even if he or she has no obvious signs or symptoms.

7.4 Leaking Chemicals or Electrolyte

Batteries can contain a range of hazardous elements, including lead and cadmium that are very hazardous to humans and the environment. The electrolyte in lithium batteries contains corrosive salt; if it reacts with water or humidity, it can generate hydrofluoric acid and irritate the eyes, nose and throat or cause chemical burns.[221]

7.4.1 Personal Precautions

1) If a battery spill occurs or a battery pack is leaking fluids, do not touch any fluids.[222]
2) Use appropriate personal protective equipment, avoid contact with skin and eyes, ventilate the area and position yourself in the wind direction.
    a. Appropriate PPE includes a protective mask for acidic vapours or a self-contained breathing apparatus, neoprene gloves or equivalent, safety glasses with side-shields, boots, an apron, and long sleeved clothing.[223]

7.4.2 First Aid Measures

1) In the case of inhalation, skin contact, eye contact or ingestion of electrolytes, vapours or leaking battery fluids, seek immediate medical attention.
2) Before medical support arrives, take the following actions:
    a. In case of inhalation, move to fresh air.[224]
    b. In case of eye contact, do not rub eyes, but remove contact lenses. Immediately flush eyes thoroughly with water for at least 15 minutes, lifting upper and lower lids, until no evidence of the fluid remains.[225]
    c. In case of skin contact, wash affected area immediately with plenty of water for at least 15-20 minutes. Remove and wash contaminated clothing before re-use.[226]
    d. In case of ingestion, gently wipe or rinse the inside of the mouth with water. Do not induce vomiting. Never give anything by mouth to an unconscious person.[227]

7.4.3 Environmental Precautions

1) Eliminate all possible sources of heat or ignition.
2) Prevent further leakage or spillage if safe to do so using a chemical spill kit, or else an absorbent cloth or other inert absorbent non-conductive material mineral such as sand, sodium bicarbonate, alumina or vermiculite. [228]
3) Dry clothes can also be used as absorbent material in absence of fire.
4) Do not allow material to contaminate ground water system.[229] For example, establish emergency procedures to block of cover drains in the event of an emergency.[230]

7.5 After a Battery Failure Event: Managing Effluent, Toxic Gas and Waste Water

Batteries emit toxic gases and liquids during a battery failure event. Any water used to douse a fire or wash off battery fluid becomes toxic effluent. Measures must be taken to contain these toxic materials and remediate the site.

1) After a fire, any sites where the fire occurred should be compartmentalised and ventilated.[231]
2) Any effluent or contaminated material, including water used to extinguish a fire, should be contained and collected for further treatment as hazardous waste.[232] Transfer the material to properly labelled containers and dispose of in accordance with law.[233]
3) Anyone conducting remediation work should wear appropriate PPE, such as gloves and safety shields and avoid contact with skin.[234]
4) The site should be thoroughly remediated by qualified professionals.[235]

APPENDICES

A.1.0 Dangerous Goods Transport Document Template Form (Example Only)

HAZARDOUS SUBSTANCES / DANGEROUS GOODS DECLARATION AND PACKAGING DECLARATION

PROPER SHIPPING NAME CORROSIVE LIQUID, ACIDIC, INORGANIC, N.O.S. Contains Sulphuric acid & Phosphoric acid.		**CLASS** 8	**UN NUMBER** 3264
COMMON NAME Aquaklenz HV		**SUBSIDIARY RISK** --	**HAZCHEM CODE** 2X
NUMBER & KIND OF PACKAGES		**PACKAGING GROUP** III	**FLASH POINT**
GROSS WEIGHT (NETT WEIGHT FOR EXPLOSIVES)	**VOLUME** **(CUBIC METRES)**	**MARINE POLLUTANT :** NO **IF DECLARED UNDER AN NOS OR GENERIC ENTRY THE RECOGNISED CHEMICAL OF THE MARINE POLLUTANT IS REQUIRED**	
ADDITIONAL INFORMATION **EMPTY**			
SHIPPER / CONSIGNOR **NAME:** **ADDRESS:** **SUBURB:** **CITY:**	**RECEIVER / CONSIGNEE** **NAME:** **ADDRESS:** **SUBURB:** **CITY:**	**SHIPPER / CONSIGNOR PHONE:** **RECEIVER / CONSIGNEE PHONE:**	
AFTER HOURS EMERGENCY CONTACT PHONE		**CARRIER:**	
DANGEROUS GOODS DECLARATION I HEREBY DECLARE THAT THE CONTENTS OF THIS CONSIGNMENT ARE FULLY AND ACCURATELY DESCRIBED ABOVE BY THE PROPER SHIPPING NAME AND ARE CLASSIFIED, PACKAGED, MARKED AND LABELLED / PLACARDED, AND ARE IN ALL RESPECTS IN PROPER CONDITION FOR TRANSPORT ACCORDING TO THE APPLICABLE INTERNATIONAL AND NATIONAL GOVERNMENT REGULATIONS AND LEGISLATION.		**NAME:** **TITLE:** **COMPANY / LOCATION:** **SIGNATURE** **DATE**	
THE SECTION BELOW IS TO BE COMPLETED BY THE PERSON PACKING THE TRANSPORT UNIT AND / OR THE CARRIER			
RAIL ☐ ROAD ☐ SEA ☐	**CONTAINER / TANK NO.** **WAGON NO.** IF RAIL	**SAILING** IF SEA **DATE:** **TIME:**	
CARGO TRANPORT UNIT TYPE OF CONTAINMENT OPEN ☐ CLOSED ☐	CONTAINER SPECIAL CONDITIONS APPLY IN AS CONTAINED SEC. 12 OF THE IMDG CODE ☐	TANK SPECIAL CONDITIONS APPLY AS CONTAINED IN SEC. 12 OF THE IMDG CODE ☐	IBC SPECIAL CONDITIONS APPLY AS CONTAINED IN SEC. 12 OF THE IMDG CODE ☐
POSITION OF DANGEROUS GOODS IN UNIT MARK WITH X	**RAILWAGON / CONTAINER** HANDBRAKE	**PANTECH / ARTIC / TRUCK AND TRAILER** CAB	
PACKING DECLARATION I HEREBY DECLARE THAT THE GOODS HAVE BEEN LOADED INTO THE VEHICLE / CONTAINER ID NO. ..... IN ACCORDANCE WITH THE PROVISIONS OF SECTION 12.3.7 OR 17.7.7 OF THE GENERAL INTRODUCTION OF THE IMDG CODE		NAME: TITLE: COMPANY / LOCATION: SIGNATURE: **DATE:**	

SEE WRITING SHIELD FOR NOTES & ADDITIONAL INFORMATION FOR N.Z. FIRE BRIGADE & POLICE DIAL 111

A.2.0 Sources cited

A.2.1 Law and Standards

AS/NZS 5139:2019 'Electrical installations – Safety of battery systems for use with power conversion equipment'

AS/NZS 5377:2013: 'Collection, Storage, Transport and Treatment of End-of-Life Electrical and Electronic Equipment'

AS/NZS 4681:2000 'The storage and handling of Class 9 (miscellaneous) dangerous goods and articles'

New Zealand Land Transport Rule (Dangerous Goods) 2005 Rule 45001/2005

NZS 5433:Part 1:2012: 'Transport of Dangerous Goods on Land: Part 1: Technical Information'.

NZS 5433:Part 2:2012: 'Transport of Dangerous Goods on Land: Part 2: List of dangerous goods'.

United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21.

A.2.2 Reports and Other Secondary Sources

Australian Battery Recycling Initiative (ABRI) and Clean Energy Council (2019) 'Consumer Guide to Responsible Recycling of Battery Storage Systems: Steps to Safe Handling, Collection, Storage, and Processing of Batteries at End of Life'. Retrieved from https://batteryrecycling.org.au/resources/abri-cec-consumer-guide-to-recycling-responsible-end-of-life-management-of-battery-energy-systems/

Cavanagh K, Behrens S, Price C, Lim O, Haigh N, Fleming A, Oliver E, Mankad A, and Bhatt A I (2015) Energy *Storage Safety: Responsible installation, use and disposal of domestic and small commercial battery systems* (CSIRO report EP156209, prepared for the Clean Energy Council, Australia.

Eliud Cabrera-Castillo, Florian Niedermeier, Andreas Jossen (2016) "Calculation of the state of safety (SOS) for lithium ion batteries" *Journal of Power Sources* 324 (2016).

Gerry Morvell and Libby Chaplin (2019) 'Proposed Stewardship Scheme for Batteries' (Battery Stewardship Council, November 2019). Retrieved from https://bsc.org.au/wp-content/uploads/2020/09/BSC-Proposed-Stewardship-Scheme-for-Batteries-20191126.pdf.

Helen Lewis (2016) *Lithium-ion battery consultation report* (Prepared for Australia's Department of Environment, 6 June 2016).

Helen Lewis (2016) 'Responsible Transport and Recycling of Lithium-Ion Batteries' (Presentation at the Lithium-ion Battery Forum, 20 October 2016).

IATA (2020) 'Transport of Lithium Metal and Lithium Ion Batteries: 2020 Lithium Battery Guidance Document'.

Juhi Shareef (2019) *New Energy Futures Paper: Batteries and the Circular Economy* (Vector Ltd).

Juhi Shareef (2019) *New Energy Futures Paper: Batteries: Technical Addendum* (Vector Ltd).

Karen McCandless (15 April 2019) 'Still got it: How reuse and recycling can give batteries a new lease of life' *Automotive Logistics*. Retrieved from https://www.automotivelogistics.media/supply-chain-management/still-got-it-how-reuse-and-recycling-can-give-ev-batteries-a-new-lease-of-life/37938.article.

Kelleher Environmental (2019) *Research Study on Reuse and Recycling of Batteries Employed in Electric Vehicles: The technical, environmental, economic, energy and cost implications of reusing and recycling EV batteries* (Project report prepared for Energy API, September 2019, United States of America).

Libby Chaplin and Nick Florin (2017) Battery Stewardship: Accessing International Experience (Australian Battery Recycling Initiative and Institute for Sustainable Futures, Australia).

Mikolajczak C, Kahn, M, White, K, Thomas Long, R (2011) *Lithium-Ion Batteries Hazard and Use Assessment* (The Fire Protection Research Foundation and Springer: Menlo Park, California).

Ministry of Transport (2020) *Dangerous Goods Regulatory System Map*. Retrieved from https://www.transport.govt.nz/assets/Uploads/Report/DangerousGoodsRegulatorySystemMap.pdf.

National Fire Protection Association (n.d.) *Electric Vehicle Emergency Field Guide* (Electric Vehicle Safety Training, Classroom Edition). Retrieved from https://www.ncdoi.com/OSFM/RPD/PT/Documents/Coursework/EV_SafetyTraining/EV%20EFG%20Classroom%20Edition.pdf.

Occupational Safety and Health Service of the Department of Labour and the Accident Compensation Corporation (2001) *Code of Practice for Manual Handling* (Wellington). Accessed at https://www.worksafe.govt.nz/topic-and-industry/manual-handling/preventing-manual-handling-injuries-acop/.

Paul Randell (2016) *Waste Lithium-ion battery projections* (Blue Environment and Randell Environmental Consulting: Woodend, Victoria).

RECHARGE and CTIF (2014) "Template Rescue and Training Manual For First and Second Responders to Car Accident with HEV, PHEV, EV, FCEV".

RECHARGE (2017) 'Lithium-Ion Battery Information Factsheet'. Retrieved from https://rechargebatteries.org/wp-content/uploads/2020/03/Li_Ion-BIF_EN-Jan-2017-PART-1-2-3-4.pdf.

R. Thomas Long Jr et al (2013) *Best Practices for Emergency Response to Incidents Involving Electric Vehicles Battery Hazards: A Report on Full-Scale Testing Results* (Massachusetts: Fire Protection Research Foundation). Retrieved from https://www.nfpa.org/News-and-Research/Data-research-and-tools/Electrical/Emergency-Response-to-Incident-Involving-Electric-Vehicle-Battery-Hazards.

The Faraday Institution (2019) *Electric Vehicle and Battery Safety Skills for Emergency Services, Vehicle Repair, and Auto Retailers* (Faraday Insights November). Retrieved from https://faraday.ac.uk/wp-content/uploads/2019/11/Faraday_Insights_4.pdf.

A.2.3 Websites

Australian Battery Recycling Initiative (ABRI), https://batteryrecycling.org.au

Battery University, https://batteryuniversity.com

End of Life Vehicle Solutions, http://elvsolutions.org/.

Recharge, http://rechargebatteries.org/

A.3.0 Endnotes

[1] Juhi Shareef (2019) *New Energy Futures Paper: Batteries: Technical Addendum* (Vector Ltd), p.27.

[2] Juhi Shareef (2019) *New Energy Futures Paper: Batteries: Technical Addendum* (Vector Ltd), p.38; Libby Chaplin and Nick Florin (2017) *Battery Stewardship: Accessing International Experience* (Australian Battery Recycling Initiative and Institute for Sustainable Futures, Australia).

[3] Cavanagh K, Behrens S, Price C, Lim O, Haigh N, Fleming A, Oliver E, Mankad A, and Bhatt A I (2015) Energy *Storage Safety: Responsible installation, use and*

disposal of domestic and small commercial battery systems (CSIRO report EP156209, prepared for the Clean Energy Council, Australia), p.7.

[4] AS/NZS 5139:2019 'Electrical installations – Safety of battery systems for use with power conversion equipment', Section 3.2.2.

[5] Cavanagh K, Behrens S, Price C, Lim O, Haigh N, Fleming A, Oliver E, Mankad A, and Bhatt A I (2015) Energy *storage safety: Responsible installation, use and disposal of domestic and small commercial battery systems* (CSIRO report EP156209, prepared for the Clean Energy Council, Australia), p.9; Libby Chaplin and Nick Florin (2017) Battery Stewardship: Accessing International Experience (Australian Battery Recycling Initiative and Institute for Sustainable Futures, Australia), p.6

[6] AS/NZS 5139:2019 'Electrical installations – Safety of battery systems for use with power conversion equipment', Section 3.2.6.3, NOTE 3.

[7] Libby Chaplin and Nick Florin (2017) Battery Stewardship: Accessing International Experience (Australian Battery Recycling Initiative and Institute for Sustainable Futures, Australia), p.5.

[8] RECHARGE (2017) 'Lithium-Ion Battery Information Factsheet'. Retrieved from https://rechargebatteries.org/wp-content/uploads/2020/03/Li_Ion-BIF_EN-Jan-2017-PART-1-2-3-4.pdf.

[9] AS/NZS 5139:2019 'Electrical installations – Safety of battery systems for use with power conversion equipment', Section 3.2.2.

[10] Battery University 'How to Transport Batteries'. Retrieved from https://batteryuniversity.com/learn/article/how_to_transport_batteries.

[11] Cavanagh K, Behrens S, Price C, Lim O, Haigh N, Fleming A, Oliver E, Mankad A, and Bhatt A I (2015) Energy *storage safety: Responsible installation, use and disposal of domestic and small commercial battery systems* (CSIRO report EP156209, prepared for the Clean Energy Council, Australia), p.8; AS/NZS 5139:2019 'Electrical installations – Safety of battery systems for use with power conversion equipment', Sections 3.2.6.2 and 3.2.7.

[12] Cavanagh K, Behrens S, Price C, Lim O, Haigh N, Fleming A, Oliver E, Mankad A, and Bhatt A I (2015) Energy *storage safety: Responsible installation, use and disposal of domestic and small commercial battery systems* (CSIRO report EP156209, prepared for the Clean Energy Council, Australia), p.8; Battery

University 'How to Transport Batteries'. Retrieved from https://batteryuniversity.com/learn/article/how_to_transport_batteries.

[13] Battery University 'Battery Safety in Public' Accessible at https://batteryuniversity.com/learn/article/bu_304c_battery_safety_in_public.

[14] AS/NZS 5139:2019 'Electrical installations – Safety of battery systems for use with power conversion equipment', Section 3.2.2.

[15] AS/NZS 5139:2019 'Electrical installations – Safety of battery systems for use with power conversion equipment', Sections 3.2.6.2 and 3.2.7.

[16] AS/NZS 5139:2019 'Electrical installations – Safety of battery systems for use with power conversion equipment', Sections 3.2.2.

[17] Language partly drawn from AS/NZS 5139:2019 'Electrical installations – Safety of battery systems for use with power conversion equipment', Section 3.2.8.

[18] Juhi Shareef (2019) *New Energy Futures Paper: Batteries and the Circular Economy* (Vector Ltd), p.41.

[19] Eliud Cabrera-Castillo, Florian Niedermeier, Andreas Jossen (2016) "Calculation of the state of safety (SOS) for lithium ion batteries" *Journal of Power Sources* 324 (2016), p.514.

[20] Based on the Notes in Appendix B, 'B4 Batteries and Accumulators' in AS/NZS 5377:2013: 'Collection, Storage, Transport and Treatment of End-of-Life Electrical and Electronic Equipment', pp.28-29. See also AS/NZS 4681:2000 'The storage and handling of Class 9 (miscellaneous) dangerous goods and articles', section 5.3.2; UN Model Regulations on the Transport of Dangerous Goods, cl. 1.3.3 and 1.3.2; Battery University "Battery Safety in Public" from https://batteryuniversity.com/learn/article/bu_304c_battery_safety_in_public

[21] Eliud Cabrera-Castillo, Florian Niedermeier, Andreas Jossen (2016) "Calculation of the state of safety (SOS) for lithium ion batteries" *Journal of Power Sources* 324 (2016), pp.513-514.

[22] Broadly based on the criteria for battery safety assessment outlined in Special Packaging Provision 376 in the United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.1).

[23] Broadly based on the criteria for battery safety assessment outlined in Special Packaging Provision 376 in the United Nations Recommendations on the

Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.1).

[24] Mikolajczak C, Kahn, M, White, K, Thomas Long, R (2011) *Lithium-Ion Batteries Hazard and Use Assessment* (The Fire Protection Research Foundation and Springer: Menlo Park, California), p.82.

[25] Suggested in a stakeholder/expert interview.

[26] Cavanagh K, Behrens S, Price C, Lim O, Haigh N, Fleming A, Oliver E, Mankad A, and Bhatt A I (2015) Energy *storage safety: Responsible installation, use and disposal of domestic and small commercial battery systems* (CSIRO report EP156209, prepared for the Clean Energy Council, Australia), p.28.

[27] RECHARGE (2017) 'Lithium-Ion Battery Information Factsheet'. Retrieved from https://rechargebatteries.org/wp-content/uploads/2020/03/Li_Ion-BIF_EN-Jan-2017-PART-1-2-3-4.pdf, Section 1.1 'Handling'

[28] RECHARGE (2017) 'Lithium-Ion Battery Information Factsheet'. Retrieved from https://rechargebatteries.org/wp-content/uploads/2020/03/Li_Ion-BIF_EN-Jan-2017-PART-1-2-3-4.pdf, Section 1.1 'Handling'.

[29] Suggested in a stakeholder/expert interview.

[30] Suggested in a stakeholder/expert interview.

[31] 'B4 Batteries and Accumulators' in AS/NZS 5377:2013: 'Collection, Storage, Transport and Treatment of End-of-Life Electrical and Electronic Equipment'; Cavanagh K, Behrens S, Price C, Lim O, Haigh N, Fleming A, Oliver E, Mankad A, and Bhatt A I (2015) Energy *storage safety: Responsible installation, use and disposal of domestic and small commercial battery systems* (CSIRO report EP156209, prepared for the Clean Energy Council, Australia), p.28; RECHARGE (2017) 'Lithium-Ion Battery Information Factsheet'. Retrieved from https://rechargebatteries.org/wp-content/uploads/2020/03/Li_Ion-BIF_EN-Jan-2017-PART-1-2-3-4.pdf, Section 1.1 'Handling'; Battery University, 'Making Lithium-Ion Safe'. Accessible at https://batteryuniversity.com/learn/article/bu_304b_making_lithium_ion_safe; Mikolajczak C, Kahn, M, White, K, Thomas Long, R (2011) *Lithium-Ion Batteries Hazard and Use Assessment* (The Fire Protection Research Foundation and Springer: Menlo Park, California), p.78; see cl 3.2.4.1 in AS/NZS 5139:2019

'Electrical installations – Safety of battery systems for use with power conversion equipment'.

[32] RECHARGE (2017) 'Lithium-Ion Battery Information Factsheet'. Retrieved from https://rechargebatteries.org/wp-content/uploads/2020/03/Li_Ion-BIF_EN-Jan-2017-PART-1-2-3-4.pdf, Section 1.1 'Handling'.

[33] AS/NZS 5377:2013: 'Collection, Storage, Transport and Treatment of End-of-Life Electrical and Electronic Equipment', Section 2.4.4(a).

[34] RECHARGE (2017) 'Lithium-Ion Battery Information Factsheet'. Retrieved from https://rechargebatteries.org/wp-content/uploads/2020/03/Li_Ion-BIF_EN-Jan-2017-PART-1-2-3-4.pdf, Section 1.1 'Handling'.

[35] Based on AS/NZS 5139:2019 'Electrical installations – Safety of battery systems for use with power conversion equipment', section 3.2.4.4; Cavanagh K, Behrens S, Price C, Lim O, Haigh N, Fleming A, Oliver E, Mankad A, and Bhatt A I (2015) Energy *storage safety: Responsible installation, use and disposal of domestic and small commercial battery systems* (CSIRO report EP156209, prepared for the Clean Energy Council, Australia), p.13.

[36] Cavanagh K, Behrens S, Price C, Lim O, Haigh N, Fleming A, Oliver E, Mankad A, and Bhatt A I (2015) Energy *storage safety: Responsible installation, use and disposal of domestic and small commercial battery systems* (CSIRO report EP156209, prepared for the Clean Energy Council, Australia), p.13.

[37] Cavanagh K, Behrens S, Price C, Lim O, Haigh N, Fleming A, Oliver E, Mankad A, and Bhatt A I (2015) Energy *storage safety: Responsible installation, use and disposal of domestic and small commercial battery systems* (CSIRO report EP156209, prepared for the Clean Energy Council, Australia), p.13.

[38] Suggested in a stakeholder/expert interview.

[39] Mikolajczak C, Kahn, M, White, K, Thomas Long, R (2011) *Lithium-Ion Batteries Hazard and Use Assessment* (The Fire Protection Research Foundation and Springer: Menlo Park, California), p.78.

[40] Occupational Safety and Health Service of the Department of Labour and the Accident Compensation Corporation (2001) *Code of Practice for Manual Handling* (Wellington). Accessed at https://www.worksafe.govt.nz/topic-and-industry/manual-handling/preventing-manual-handling-injuries-acop/.

[41] Australian Battery Recycling Initiative (ABRI) 'Battery Safety'. Accessed at https://batteryrecycling.org.au/battery-safety/.

[42] Libby Chaplin and Nick Florin (2017) *Battery Stewardship: Accessing International Experience* (Australian Battery Recycling Initiative and Institute for Sustainable Futures, Australia), p.6.

[43] Cavanagh K, Behrens S, Price C, Lim O, Haigh N, Fleming A, Oliver E, Mankad A, and Bhatt A I (2015) Energy *storage safety: Responsible installation, use and disposal of domestic and small commercial battery systems* (CSIRO report EP156209, prepared for the Clean Energy Council, Australia), p.13;

Australian Battery Recycling Initiative (ABRI) 'Battery Safety'. Accessed at https://batteryrecycling.org.au/battery-safety/.

[44] RECHARGE and CTIF (2014) "Template Rescue and Training Manual For First and Second Responders to Car Accident with HEV, PHEV, EV, FCEV", section 1.2. A range of battery removal manuals from OEMs can be found at this website: http://elvsolutions.org/?page_id=1717.

[45] Accessible at https://www.idis2.com/.

[46] Australian Battery Recycling Initiative (ABRI) and Clean Energy Council (2019) 'Consumer Guide to Responsible Recycling of Battery Storage Systems: Steps to Safe Handling, Collection, Storage, and Processing of Batteries at End of Life'. Retrieved from https://batteryrecycling.org.au/resources/abri-cec-consumer-guide-to-recycling-responsible-end-of-life-management-of-battery-energy-systems/.

[47] Suggested in a stakeholder/expert interview.

[48] Suggested in a stakeholder/expert interview.

[49] Paul Randell (2016) *Waste Lithium-ion battery projections* (Blue Environment and Randell Environmental Consulting: Woodend, Victoria), p.11.

[50] Helen Lewis (2016) *Lithium-ion battery consultation report* (Prepared for Australia's Department of Environment, 6 June 2016), p.7; and suggested in a stakeholder/expert interview.

[51] Suggested in a stakeholder/expert interview.

[52] Recharge and CTIF (2014) "Template Rescue and Training Manual For First and Second Responders to Car Accident with HEV, PHEV, EV, FCEV", section 6.1.

[53] For a commentary on the importance and requisite level of upskilling for emergency services, vehicle repairers, and auto retailers in the area of electric vehicle and battery safety, see The Faraday Institution (2019) *Electric Vehicle and Battery Safety Skills for Emergency Services, Vehicle Repair, and Auto Retailers* (Faraday Insights November). Retrieved from https://faraday.ac.uk/wp-content/uploads/2019/11/Faraday_Insights_4.pdf.

[54] R. Thomas Long Jr et al (2013) *Best Practices for Emergency Response to Incidents Involving Electric Vehicles Battery Hazards: A Report on Full-Scale Testing Results* (Massachusetts: Fire Protection Research Foundation). Retrieved from https://www.nfpa.org/News-and-Research/Data-research-and-tools/Electrical/Emergency-Response-to-Incident-Involving-Electric-Vehicle-Battery-Hazards; National Fire Protection Association (n.d.) *Electric Vehicle Emergency Field Guide* (Electric Vehicle Safety Training, Classroom Edition). Retrieved from https://www.ncdoi.com/OSFM/RPD/PT/Documents/Coursework/EV_SafetyTraining/EV%20EFG%20Classroom%20Edition.pdf.

[55] Suggested in a stakeholder/expert interview.

[56] Kelleher Environmental (2019) *Research Study on Reuse and Recycling of Batteries Employed in Electric Vehicles: The technical, environmental, economic, energy and cost implications of reusing and recycling EV batteries* (Project report prepared for Energy API, September 2019, United States of America), p.45.

[57] Suggested in a stakeholder/expert interview.

[58] Suggested in a stakeholder/expert interview.

[59] Recharge and CTIF (2014) "Template Rescue and Training Manual For First and Second Responders to Car Accident with HEV, PHEV, EV, FCEV", section 6.2.

[60] Recharge and CTIF (2014) "Template Rescue and Training Manual For First and Second Responders to Car Accident with HEV, PHEV, EV, FCEV", section 6.2.

[61] Suggested in a stakeholder/expert interview.

[62] Suggested in a stakeholder/expert interview.

[63] Suggested in a stakeholder/expert interview.

[64] Juhi Shareef (2019) *New Energy Futures Paper: Batteries: Technical Addendum* (Vector Ltd), p.43.

[65] Ministry of Transport (2020) *Dangerous Goods Regulatory System Map*. Retrieved from https://www.transport.govt.nz/assets/Uploads/Report/DangerousGoodsRegulatorySystemMap.pdf, p.3.

[66] Lithium Metal batteries are UN 3090 and Lithium-ion batteries are UN 3480. Both fall under packaging code II in the New Zealand Land Transport Rule (Dangerous Goods) 2005 Rule 45001/2005.

[67] Ministry of Transport (2020) *Dangerous Goods Regulatory System Map*. Retrieved from https://www.transport.govt.nz/assets/Uploads/Report/DangerousGoodsRegulatorySystemMap.pdf, p.5.

[68] NZS 5433:Part 1:2012: 'Transport of Dangerous Goods on Land: Part 1: Technical Information', section 2.0.3.

[69] United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.1), Sections 1.1.1 and 5.1.1.2.

[70] See United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol. 1), Special Provision 188 for the less stringent requirements that apply to a lithium metal battery that contains no more than 2g of aggregate content or for a lithium

ion battery for which the Watt-hour rating is not more than 100 Wh and the package as a whole (i.e. battery plus packaging) is no more than 30kg mass.

[71] United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.1), section 2.9.4.

[72] Suggested in a stakeholder/expert interview.

[73] IATA (2020) *Lithium Battery Guidance Document: Transport of Lithium Metal and Lithium Ion Batteries*.

[74] United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.1), Section 1.1.1.

[75] Suggested in a stakeholder/expert interview.

[76] Broadly based on the criteria for battery safety assessment outlined in Special Packaging Provision 376 in the United Nations Recommendations on the

Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.1).

[77] United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.1), SP 376.

[78] From interview with John Evans (ITRecycla); Juhi Shareef (2019) *New Energy Futures Paper: Batteries: Technical Addendum* (Vector Ltd), p.43.

[79] United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.1), s 4.1.1.1.

[80] United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.1), s 4.1.1.1.

[81] United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.1), s 4.1.1.1.

[82] IATA (2020) 'Transport of Lithium Metal and Lithium Ion Batteries: 2020 Lithium Battery Guidance Document', p.11.

[83] Juhi Shareef (2019) *New Energy Futures Paper: Batteries: Technical Addendum* (Vector Ltd), p.29.

[84] Juhi Shareef (2019) *New Energy Futures Paper: Batteries: Technical Addendum* (Vector Ltd), p.43.

[85] United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.1), s 4.1.1.6.

[86] Suggested in a stakeholder/expert interview.

[87] Cavanagh K, Behrens S, Price C, Lim O, Haigh N, Fleming A, Oliver E, Mankad A, and Bhatt A I (2015) Energy *storage safety: Responsible installation, use and disposal of domestic and small commercial battery systems* (CSIRO report EP156209, prepared for the Clean Energy Council, Australia), p.15.

[88] United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.2), P903.

[89] United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.2), P903.

[90] Suggested in stakeholder/expert interviews.

[91] Suggested in a stakeholder/expert interview.

[92] Ministry of Transport (2020) *Dangerous Goods Regulatory System Map*. Retrieved from

https://www.transport.govt.nz/assets/Uploads/Report/DangerousGoodsRegulatorySystemMap.pdf, p.8.

[93] NZS 5433:Part 1:2012: 'Transport of Dangerous Goods on Land: Part 1: Technical Information', section 9.1.

[94] Ministry of Transport (2020) *Dangerous Goods Regulatory System Map*. Retrieved from

https://www.transport.govt.nz/assets/Uploads/Report/DangerousGoodsRegulatorySystemMap.pdf, p.8.

[95] United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.1), section 5.2.1.1

[96] United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.1), section 5.2.1.2

[97] United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.1), section 5.2.2.1.1.

[98] United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.1), section 5.2.2.2.1.

[99] United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.1), section 5.2.2.2.1.

[100] United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.1), section 5.2.2.1.6.

[101] United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.1), section 5.2.2.1.8.

[102] United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.1), section 5.2.2.2.1.7.

[103] United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.1), sections 5.2.1.4 and 5.2.2.1.7.

[104] United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.1), section 5.1.4.

[105] United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.1), section 5.3.1.

[106] United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.1), section 5.3.2.

[107] NZS 5433:Part 1:2012: ‘Transport of Dangerous Goods on Land: Part 1: Technical Information’, sections 6.1 and 6.2.

[108] United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.1), section 5.4.1.

[109] United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.1), section 5.4.1.4.

[110] United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.1), section 5.4.1.5.

[111] United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.1), section 5.4.1.6.

[112] United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.1),

section 5.4.2; NZS 5433:Part 1:2012: ‘Transport of Dangerous Goods on Land: Part 1: Technical Information’, section 6.3.

[113] United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.1), section 5.4.3.

[114] Suggested in a stakeholder/expert interview.

[115] Suggested in a stakeholder/expert interview.

[116] United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.2), LP904.

[117] United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.2), LP906.

[118] United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.1), Special Provision 376.

[119] United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.2), sections 5.2.1.1 and 5.2.1.2.

[120] United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.2), section 5.2.1.2.

[121] United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.1), Special Provision 376.

[122] United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.1), Special Provision 377

[123] United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.1), Special Provision 377.

[124] United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.2), sections 5.2.1.1 and 5.2.1.2.

[125] United Nations Recommendations on the Transport of Dangerous Goods – Model Regulations (UN Model Regulations), ST/SG/AC.10/1/Rev.21 (Vol.2), section 5.2.1.2.

[126] Ministry of Transport (2020) *Dangerous Goods Regulatory System Map*. Retrieved from

https://www.transport.govt.nz/assets/Uploads/Report/DangerousGoodsRegulatorySystemMap.pdf, p.3.

[127] Ministry of Transport (2020) *Dangerous Goods Regulatory System Map*. Retrieved from https://www.transport.govt.nz/assets/Uploads/Report/DangerousGoodsRegulatorySystemMap.pdf, p.3.

[128] RECHARGE (2017) 'Lithium-Ion Battery Information Factsheet'. Retrieved from https://rechargebatteries.org/wp-content/uploads/2020/03/Li_Ion-BIF_EN-Jan-2017-PART-1-2-3-4.pdf, section 1.2 ‘Storage’.

[129] Karen McCandless (15 April 2019) ‘Still got it: How reuse and recycling can give batteries a new lease of life’ *Automotive Logistics*. Retrieved from https://www.automotivelogistics.media/supply-chain-management/still-got-it-how-reuse-and-recycling-can-give-ev-batteries-a-new-lease-of-life/37938.article.

[130] AS/NZS 5377:2013: ‘Collection, Storage, Transport and Treatment of End-of-Life Electrical and Electronic Equipment’, section 2.3.

[131] Based on AS/NZS 5377:2013: ‘Collection, Storage, Transport and Treatment of End-of-Life Electrical and Electronic Equipment’, section 2.2.

[132] ‘B4 Batteries and Accumulators’ in AS/NZS 5377:2013: ‘Collection, Storage, Transport and Treatment of End-of-Life Electrical and Electronic Equipment’; Australian Battery Recycling Initiative (ABRI) and Clean Energy Council (2019) 'Consumer Guide to Responsible Recycling of Battery Storage Systems: Steps to Safe Handling, Collection, Storage, and Processing of Batteries at End of Life'. Retrieved from https://batteryrecycling.org.au/resources/abri-cec-consumer-guide-to-recycling-responsible-end-of-life-management-of-battery-energy-systems/, p.3; Australian Battery Recycling Initiative (ABRI) ‘Battery Safety’. Accessed at https://batteryrecycling.org.au/battery-safety/; Cavanagh K, Behrens S, Price C, Lim O, Haigh N, Fleming A, Oliver E, Mankad A, and Bhatt A I (2015) Energy *storage safety: Responsible installation, use and disposal of domestic and small commercial battery systems* (CSIRO report EP156209, prepared for the Clean Energy Council, Australia), p.13; RECHARGE (2017) 'Lithium-Ion Battery Information Factsheet'. Retrieved from https://rechargebatteries.org/wp-content/uploads/2020/03/Li_Ion-BIF_EN-Jan-2017-PART-1-2-3-4.pdf, sections 1.1 ‘Handling’ and 1.2 ‘Storage’.

[133] RECHARGE (2017) 'Lithium-Ion Battery Information Factsheet'. Retrieved from https://rechargebatteries.org/wp-content/uploads/2020/03/Li_Ion-BIF_EN-Jan-2017-PART-1-2-3-4.pdf, section 1.2 ‘Storage’; Cavanagh K, Behrens S, Price C, Lim O, Haigh N, Fleming A, Oliver E, Mankad A, and Bhatt A I (2015) Energy *storage safety: Responsible installation, use and disposal of domestic and small*

commercial battery systems (CSIRO report EP156209, prepared for the Clean Energy Council, Australia), p.13.

[134] Battery University “BU-702: How to Store Batteries”. Accessible at https://batteryuniversity.com/learn/article/how_to_store_batteries.

[135] AS/NZS 5377:2013: ‘Collection, Storage, Transport and Treatment of End-of-Life Electrical and Electronic Equipment’, section 2.4.2; from interview with Simon Davis (FENZ).

[136] AS/NZS 5377:2013: ‘Collection, Storage, Transport and Treatment of End-of-Life Electrical and Electronic Equipment’, section 2.4.2.

[137] From ‘B4 Batteries and Accumulators’ in AS/NZS 5377:2013: ‘Collection, Storage, Transport and Treatment of End-of-Life Electrical and Electronic Equipment’.

[138] RECHARGE (2017) 'Lithium-Ion Battery Information Factsheet'. Retrieved from https://rechargebatteries.org/wp-content/uploads/2020/03/Li_Ion-BIF_EN-Jan-2017-PART-1-2-3-4.pdf, section 1.2 ‘Storage’.

[139] Suggested in a stakeholder/expert interview.

[140] Based on AS/NZS 5377:2013: ‘Collection, Storage, Transport and Treatment of End-of-Life Electrical and Electronic Equipment’, cl 2.4.3; From interview with Simon Davis (FENZ).

[141] Paul Randell (2016) *Waste Lithium-ion battery projections* (Blue Environment and Randell Environmental Consulting: Woodend, Victoria), p.11.

[142] Suggested in a stakeholder/expert interview.

[143] Helen Lewis (2016) ‘Responsible Transport and Recycling of Lithium-Ion Batteries’ (Presentation at the Lithium-ion Battery Forum, 20 October 2016); Paul Randell (2016) *Waste Lithium-ion battery projections* (Blue Environment and Randell Environmental Consulting: Woodend, Victoria), p.12.

[144] RECHARGE (2017) 'Lithium-Ion Battery Information Factsheet'. Retrieved from https://rechargebatteries.org/wp-content/uploads/2020/03/Li_Ion-BIF_EN-Jan-2017-PART-1-2-3-4.pdf, section 1.2 ‘Storage’, p.4.

[145]AS/NZS 5377:2013: ‘Collection, Storage, Transport and Treatment of End-of-Life Electrical and Electronic Equipment’, section 2.4.4(a); Juhi Shareef (2019) *New Energy Futures Paper: Batteries: Technical Addendum* (Vector Ltd), p.29; Australian Battery Recycling Initiative (ABRI) and Clean Energy Council (2019) 'Consumer Guide to Responsible Recycling of Battery Storage Systems: Steps to Safe Handling, Collection, Storage, and Processing of Batteries at End of Life'. Retrieved from https://batteryrecycling.org.au/resources/abri-cec-consumer-guide-to-recycling-responsible-end-of-life-management-of-battery-energy-systems/, p.3.

[146] Gerry Morvell and Libby Chaplin (2019) ‘Proposed Stewardship Scheme for Batteries’ (Battery Stewardship Council, November 2019). Retrieved from

https://bsc.org.au/wp-content/uploads/2020/09/BSC-Proposed-Stewardship-Scheme-for-Batteries-20191126.pdf.

[147] AS/NZS 4681:2000 ‘The storage and handling of Class 9 (miscellaneous) dangerous goods and articles’, section 1.5(a).

[148] AS/NZS 4681:2000 ‘The storage and handling of Class 9 (miscellaneous) dangerous goods and articles’, section 1.5(b).

[149] Suggested in stakeholder/expert interviews.

[150] Libby Chaplin and Nick Florin (2017) *Battery Stewardship: Accessing International Experience* (Australian Battery Recycling Initiative and Institute for Sustainable Futures, Australia), p.6.

[151] Suggested in a stakeholder/expert interview.

[152] RECHARGE (2017) 'Lithium-Ion Battery Information Factsheet'. Retrieved from https://rechargebatteries.org/wp-content/uploads/2020/03/Li_Ion-BIF_EN-Jan-2017-PART-1-2-3-4.pdf, section 1.2 ‘Storage’.

[153] Battery University “Safety of Lithium Ion Batteries” Accessible at https://batteryuniversity.com/learn/article/safety_of_lithium_ion_batteries.

[154] Suggested in a stakeholder/expert interview.

[155] Suggested in a stakeholder/expert interview.

[156] Australian Battery Recycling Initiative (ABRI) ‘Battery Safety’. Accessed at https://batteryrecycling.org.au/battery-safety/.

[157] AS/NZS 4681:2000 ‘The storage and handling of Class 9 (miscellaneous) dangerous goods and articles’, section 6.2.2. Suggested in stakeholder/expert

interviews. One stakeholder noted that insurance companies may soon require such a plan before they grant insurance.

[158] AS/NZS 4681:2000 'The storage and handling of Class 9 (miscellaneous) dangerous goods and articles', section 6.2.2.

[159] AS/NZS 4681:2000 'The storage and handling of Class 9 (miscellaneous) dangerous goods and articles', section 5.3.2.

[160] Suggested in a stakeholder/expert interview. Another stakeholder recommended initial inspection of batteries to check if damaged.

[161] AS/NZS 4681:2000 'The storage and handling of Class 9 (miscellaneous) dangerous goods and articles', section 3.2.1.

[162] AS/NZS 4681:2000 'The storage and handling of Class 9 (miscellaneous) dangerous goods and articles', sections 1.4.32 and 3.2.2. Also suggested in a stakeholder/expert interview.

[163] Suggested in a stakeholder/expert interview. Nothing in the RMA that would require this in law.

[164] AS/NZS 4681:2000 'The storage and handling of Class 9 (miscellaneous) dangerous goods and articles', sections 1.6 and 6.5.

[165] AS/NZS 4681:2000 'The storage and handling of Class 9 (miscellaneous) dangerous goods and articles', section 1.7.

[166] AS/NZS 4681:2000 'The storage and handling of Class 9 (miscellaneous) dangerous goods and articles', section 6.5.2.

[167] AS/NZS 4681:2000 'The storage and handling of Class 9 (miscellaneous) dangerous goods and articles', sections 3.3.2 and 4.2.1.

[168] From 'B4 Batteries and Accumulators' in AS/NZS 5377:2013: 'Collection, Storage, Transport and Treatment of End-of-Life Electrical and Electronic Equipment'.

[169] 'B4 Batteries and Accumulators' in AS/NZS 5377:2013: 'Collection, Storage, Transport and Treatment of End-of-Life Electrical and Electronic Equipment'; Australian Battery Recycling Initiative (ABRI) and Clean Energy Council (2019) 'Consumer Guide to Responsible Recycling of Battery Storage Systems: Steps to Safe Handling, Collection, Storage, and Processing of Batteries at End of Life'. Retrieved from https://batteryrecycling.org.au/resources/abri-cec-consumer-guide-to-recycling-responsible-end-of-life-management-of-battery-energy-systems/, p.3; Australian Battery Recycling Initiative (ABRI) 'Battery Safety'. Accessed at https://batteryrecycling.org.au/battery-safety/; Cavanagh K, Behrens S, Price C, Lim O, Haigh N, Fleming A, Oliver E, Mankad A, and Bhatt A I (2015) Energy *storage safety: Responsible installation, use and disposal of domestic and small commercial battery systems* (CSIRO report EP156209, prepared for the Clean Energy Council, Australia), p.13; RECHARGE (2017) 'Lithium-Ion Battery Information Factsheet'. Retrieved from https://rechargebatteries.org/wp-

content/uploads/2020/03/Li_Ion-BIF_EN-Jan-2017-PART-1-2-3-4.pdf, sections 1.1 ‘Handling’ and 1.2 ‘Storage’.

[170] RECHARGE (2017) 'Lithium-Ion Battery Information Factsheet'. Retrieved from https://rechargebatteries.org/wp-content/uploads/2020/03/Li_Ion-BIF_EN-Jan-2017-PART-1-2-3-4.pdf, section 1.2 ‘Storage’; Cavanagh K, Behrens S, Price C, Lim O, Haigh N, Fleming A, Oliver E, Mankad A, and Bhatt A I (2015) Energy *storage safety: Responsible installation, use and disposal of domestic and small commercial battery systems* (CSIRO report EP156209, prepared for the Clean Energy Council, Australia), p.13; AS/NZS 4681:2000 ‘The storage and handling of Class 9 (miscellaneous) dangerous goods and articles’, section 5.2.1.

[171] Libby Chaplin and Nick Florin (2017) *Battery Stewardship: Accessing International Experience* (Australian Battery Recycling Initiative and Institute for Sustainable Futures, Australia), p.6; Cavanagh K, Behrens S, Price C, Lim O, Haigh N, Fleming A, Oliver E, Mankad A, and Bhatt A I (2015) Energy *storage safety: Responsible installation, use and disposal of domestic and small commercial battery systems* (CSIRO report EP156209, prepared for the Clean Energy Council, Australia), p.13.

[172] Cavanagh K, Behrens S, Price C, Lim O, Haigh N, Fleming A, Oliver E, Mankad A, and Bhatt A I (2015) Energy *storage safety: Responsible installation, use and disposal of domestic and small commercial battery systems* (CSIRO report EP156209, prepared for the Clean Energy Council, Australia), p.13; RECHARGE “Battery Safety” https://rechargebatteries.org/battery-safety/.

[173] AS/NZS 5139:2019 ‘Electrical installations – Safety of battery systems for use with power conversion equipment’, Section 3.2.2, Table 3.1, p.25; Mikolajczak C, Kahn, M, White, K, Thomas Long, R (2011) *Lithium-Ion Batteries Hazard and Use Assessment* (The Fire Protection Research Foundation and Springer: Menlo Park, California), p.78; Libby Chaplin and Nick Florin (2017) *Battery Stewardship: Accessing International Experience* (Australian Battery Recycling Initiative and Institute for Sustainable Futures, Australia), p.5.

[174] Suggested in a stakeholder/expert interview.

[175] Libby Chaplin and Nick Florin (2017) *Battery Stewardship: Accessing International Experience* (Australian Battery Recycling Initiative and Institute for Sustainable Futures, Australia), p.6.

[176] Libby Chaplin and Nick Florin (2017) *Battery Stewardship: Accessing International Experience* (Australian Battery Recycling Initiative and Institute for Sustainable Futures, Australia), p.6.

[177] Suggested in a stakeholder/expert interview.

[178] Suggested in a stakeholder/expert interview.

[179] AS/NZS 4681:2000 ‘The storage and handling of Class 9 (miscellaneous) dangerous goods and articles’, section 3.3.4; AS/NZS 5377:2013: ‘Collection,

Storage, Transport and Treatment of End-of-Life Electrical and Electronic Equipment', cl.2.4.2; also suggested in a stakeholder/expert interview.

[180] AS/NZS 4681:2000 'The storage and handling of Class 9 (miscellaneous) dangerous goods and articles', section 3.3.4; AS/NZS 5377:2013: 'Collection, Storage, Transport and Treatment of End-of-Life Electrical and Electronic Equipment', section 2.4.2.

[181] The concept of 'fire districts' in the European context was raised in a stakeholder/expert interview.

[182] AS/NZS 4681:2000 'The storage and handling of Class 9 (miscellaneous) dangerous goods and articles', section 3.3.6.

[183] AS/NZS 4681:2000 'The storage and handling of Class 9 (miscellaneous) dangerous goods and articles', section 3.3.7.

[184] AS/NZS 4681:2000 'The storage and handling of Class 9 (miscellaneous) dangerous goods and articles', section 5.4.1.

[185] AS/NZS 4681:2000 'The storage and handling of Class 9 (miscellaneous) dangerous goods and articles', section 5.4.1.

[186] AS/NZS 4681:2000 'The storage and handling of Class 9 (miscellaneous) dangerous goods and articles', section 5.5.

[187] Libby Chaplin and Nick Florin (2017) *Battery Stewardship: Accessing International Experience* (Australian Battery Recycling Initiative and Institute for Sustainable Futures, Australia), p.6.

[188] Battery University "Battery Safety in Public" Accessible at https://batteryuniversity.com/learn/article/bu_304c_battery_safety_in_public

[189] Libby Chaplin and Nick Florin (2017) *Battery Stewardship: Accessing International Experience* (Australian Battery Recycling Initiative and Institute for Sustainable Futures, Australia), p.6; RECHARGE (2017) 'Lithium-Ion Battery Information Factsheet'. Retrieved from https://rechargebatteries.org/wp-content/uploads/2020/03/Li_Ion-BIF_EN-Jan-2017-PART-1-2-3-4.pdf, section 1.2 'Storage'.

[190] AS/NZS 4681:2000 'The storage and handling of Class 9 (miscellaneous) dangerous goods and articles', section 7.3.1.

[191] AS/NZS 4681:2000 'The storage and handling of Class 9 (miscellaneous) dangerous goods and articles', section 7.4.5; Battery University "Battery Safety in

Public" Accessible at https://batteryuniversity.com/learn/article/bu_304c_battery_safety_in_public

[192] Suggested in a stakeholder/expert interview. Also, Libby Chaplin and Nick Florin (2017) *Battery Stewardship: Accessing International Experience* (Australian Battery Recycling Initiative and Institute for Sustainable Futures, Australia), p.6.

[193] Libby Chaplin and Nick Florin (2017) *Battery Stewardship: Accessing International Experience* (Australian Battery Recycling Initiative and Institute for Sustainable Futures, Australia), p.6.

[194] Libby Chaplin and Nick Florin (2017) *Battery Stewardship: Accessing International Experience* (Australian Battery Recycling Initiative and Institute for Sustainable Futures, Australia), p.6.

[195] From 'B4 Batteries and Accumulators' in AS/NZS 5377:2013: 'Collection, Storage, Transport and Treatment of End-of-Life Electrical and Electronic Equipment'.

[196] Suggested in stakeholder/expert interviews.

[197] Suggested in a stakeholder/expert interview – though it was noted that once numbers of batteries coming to end of life increases, this may not be possible (depends on facility capacity). Another stakeholder/expert interviewee said "process them as quick as you can to make them as inert as possible".

[198] Mikolajczak C, Kahn, M, White, K, Thomas Long, R (2011) *Lithium-Ion Batteries Hazard and Use Assessment* (The Fire Protection Research Foundation and Springer: Menlo Park, California), pp.78,81; also suggested in a stakeholder/expert interview.

[199]AS/NZS 5377:2013: 'Collection, Storage, Transport and Treatment of End-of-Life Electrical and Electronic Equipment', cl 2.4.4(a); Juhi Shareef (2019) *New Energy Futures Paper: Batteries: Technical Addendum* (Vector Ltd), p.29; Australian Battery Recycling Initiative (ABRI) and Clean Energy Council (2019) 'Consumer Guide to Responsible Recycling of Battery Storage Systems: Steps to Safe Handling, Collection, Storage, and Processing of Batteries at End of Life'. Retrieved from https://batteryrecycling.org.au/resources/abri-cec-consumer-guide-to-recycling-responsible-end-of-life-management-of-battery-energy-systems/, p.3.

[200] Suggested in stakeholder/expert interviews.

[201] Cavanagh K, Behrens S, Price C, Lim O, Haigh N, Fleming A, Oliver E, Mankad A, and Bhatt A I (2015) Energy storage safety: Responsible installation, use and disposal of domestic and small commercial battery systems (CSIRO report EP156209, prepared for the Clean Energy Council, Australia), p.13.

[202] RECHARGE (2017) 'Lithium-Ion Battery Information Factsheet'. Retrieved from https://rechargebatteries.org/wp-content/uploads/2020/03/Li_Ion-BIF_EN-Jan-2017-PART-1-2-3-4.pdf, section 1.2 'Storage'.

[203] RECHARGE (2017) 'Lithium-Ion Battery Information Factsheet'. Retrieved from https://rechargebatteries.org/wp-content/uploads/2020/03/Li_Ion-BIF_EN-Jan-2017-PART-1-2-3-4.pdf, Section 1.1 'Handling'.

[204] Suggested in a stakeholder/expert interview.

[205] Suggested in a stakeholder/expert interview.

[206] The concept of 'fire districts' was raised in a stakeholder/expert interview in the European context.

[207] Suggested in a stakeholder/expert interview.

[208] RECHARGE (2017) 'Lithium-Ion Battery Information Factsheet'. Retrieved from https://rechargebatteries.org/wp-content/uploads/2020/03/Li_Ion-BIF_EN-Jan-2017-PART-1-2-3-4.pdf, section 1.2 'Storage'.

[209] RECHARGE (2017) 'Lithium-Ion Battery Information Factsheet'. Retrieved from https://rechargebatteries.org/wp-content/uploads/2020/03/Li_Ion-BIF_EN-Jan-2017-PART-1-2-3-4.pdf, section 1.2 'Storage'.

[210] AS/NZS 4681:2000 'The storage and handling of Class 9 (miscellaneous) dangerous goods and articles', section 5.2.2.

[211] Battery University "Safety Concerns with Lithium-Ion Batteries". Retrieved from https://batteryuniversity.com/learn/article/safety_concerns_with_li_ion.

[212] Suggested in a stakeholder/expert interview.

[213] Battery University "Safety Concerns with Lithium-Ion Batteries". Retrieved from https://batteryuniversity.com/learn/article/safety_concerns_with_li_ion; Battery University, 'Making Lithium-Ion Safe'. Accessible at https://batteryuniversity.com/learn/article/bu_304b_making_lithium_ion_safe.

[214] As advised by Peter Wilding, FENZ

[215] RECHARGE (2017) 'Lithium-Ion Battery Information Factsheet'. Retrieved from https://rechargebatteries.org/wp-content/uploads/2020/03/Li_Ion-BIF_EN-Jan-2017-PART-1-2-3-4.pdf, section 2.4 'Fire fighting measures'; Battery University "Safety Concerns with Lithium-Ion Batteries". Retrieved from https://batteryuniversity.com/learn/article/safety_concerns_with_li_ion.

[216] Suggested in a stakeholder/expert interview.

[217] Suggested in a stakeholder/expert interview.

[218] Battery University, 'Making Lithium-Ion Safe'. Accessible at https://batteryuniversity.com/learn/article/bu_304b_making_lithium_ion_safe; Battery

University “Safety Concerns with Lithium-Ion Batteries”. Retrieved from https://batteryuniversity.com/learn/article/safety_concerns_with_li_ion.

[219] Suggested in a stakeholder/expert interview.

[220] Taken directly from RECHARGE (2017) 'Lithium-Ion Battery Information Factsheet'. Retrieved from https://rechargebatteries.org/wp-content/uploads/2020/03/Li_Ion-BIF_EN-Jan-2017-PART-1-2-3-4.pdf, section 2.3 ‘Exposure to High Voltage’.

[221] RECHARGE (2017) 'Lithium-Ion Battery Information Factsheet'. Retrieved from https://rechargebatteries.org/wp-content/uploads/2020/03/Li_Ion-BIF_EN-Jan-2017-PART-1-2-3-4.pdf, section 2.2 ‘Measures in case of accidental release of the battery content (spillage in absence of fire)’.

[222] Cavanagh K, Behrens S, Price C, Lim O, Haigh N, Fleming A, Oliver E, Mankad A, and Bhatt A I (2015) Energy *storage safety: Responsible installation, use and disposal of domestic and small commercial battery systems* (CSIRO report EP156209, prepared for the Clean Energy Council, Australia), p.28.

[223] RECHARGE (2017) 'Lithium-Ion Battery Information Factsheet'. Retrieved from https://rechargebatteries.org/wp-content/uploads/2020/03/Li_Ion-BIF_EN-Jan-2017-PART-1-2-3-4.pdf, section 2.2 ‘Measures in case of accidental release of the battery content (spillage in absence of fire)’; Battery University, 'BU-702: How to Store Batteries'. Accessible at https://batteryuniversity.com/learn/article/how_to_store_batteries.

[224] RECHARGE (2017) 'Lithium-Ion Battery Information Factsheet'. Retrieved from https://rechargebatteries.org/wp-content/uploads/2020/03/Li_Ion-BIF_EN-Jan-2017-PART-1-2-3-4.pdf, section 2.2 ‘Measures in case of accidental release of the battery content (spillage in absence of fire)’.

[225] RECHARGE (2017) 'Lithium-Ion Battery Information Factsheet'. Retrieved from https://rechargebatteries.org/wp-content/uploads/2020/03/Li_Ion-BIF_EN-Jan-2017-PART-1-2-3-4.pdf, section 2.2 ‘Measures in case of accidental release of the battery content (spillage in absence of fire)’; Cavanagh K, Behrens S, Price C, Lim O, Haigh N, Fleming A, Oliver E, Mankad A, and Bhatt A I (2015) Energy *storage safety: Responsible installation, use and disposal of domestic and small commercial battery systems* (CSIRO report EP156209, prepared for the Clean Energy Council, Australia), p.28; Battery University, 'BU-702: How to Store Batteries'. Accessible at https://batteryuniversity.com/learn/article/how_to_store_batteries..

[226] RECHARGE (2017) 'Lithium-Ion Battery Information Factsheet'. Retrieved from https://rechargebatteries.org/wp-content/uploads/2020/03/Li_Ion-BIF_EN-Jan-2017-PART-1-2-3-4.pdf, section 2.2 ‘Measures in case of accidental release of the battery content (spillage in absence of fire)’; Battery University, 'BU-702:

How to Store Batteries'. Accessible at https://batteryuniversity.com/learn/article/how_to_store_batteries.

[227] RECHARGE (2017) 'Lithium-Ion Battery Information Factsheet'. Retrieved from https://rechargebatteries.org/wp-content/uploads/2020/03/Li_Ion-BIF_EN-Jan-2017-PART-1-2-3-4.pdf, section 2.2 ‘Measures in case of accidental release of the battery content (spillage in absence of fire)’.

[228] AS/NZS 4681:2000 ‘The storage and handling of Class 9 (miscellaneous) dangerous goods and articles’, section 6.6.

[229] RECHARGE (2017) 'Lithium-Ion Battery Information Factsheet'. Retrieved from https://rechargebatteries.org/wp-content/uploads/2020/03/Li_Ion-BIF_EN-Jan-2017-PART-1-2-3-4.pdf, section 2.2 ‘Measures in case of accidental release of the battery content (spillage in absence of fire)’.

[230] AS/NZS 4681:2000 ‘The storage and handling of Class 9 (miscellaneous) dangerous goods and articles’, section 3.3.4.

[231] Suggested in a stakeholder/expert interview.

[232] AS/NZS 4681:2000 ‘The storage and handling of Class 9 (miscellaneous) dangerous goods and articles’, section 7.3.9.

[233] Suggested in a stakeholder/expert interview; RECHARGE (2017) 'Lithium-Ion Battery Information Factsheet'. Retrieved from https://rechargebatteries.org/wp-content/uploads/2020/03/Li_Ion-BIF_EN-Jan-2017-PART-1-2-3-4.pdf, section 2.2 ‘Measures in case of accidental release of the battery content (spillage in absence of fire)’ and section 2.4 ‘Fire fighting measures’.

[234] Suggested in a stakeholder/expert interview.

[235] AS/NZS 4681:2000 ‘The storage and handling of Class 9 (miscellaneous) dangerous goods and articles’, section 7.8; Suggested in a stakeholder/expert interview.