Safety in Ports Guidance

SiP023: Lithium-ion batteries
Members only version

First Publication: September 2026

Contents

1. Disclaimer

The Health and Safety Executive provided support to Port Skills and Safety Ltd in producing this guidance, which is aimed at improvements within the port industry. This guidance may go further than the minimum needed to do to comply with the law with regards to health and safety.

This guidance has been reviewed by Professor Paul Christensen, Emeritus of Pure and Applied electrochemistry and Director, Lithiumionsafety Ltd.

External links are provided to enhance information, but Port Skills and Safety Ltd (PSS) does not guarantee the accuracy of any external links.

Regulations in this document are referred to by title but not year, as they may have been amended post publication. The reader should always seek the current version. Note that legislation and regulation may vary between the devolved nations of the UK. Care should be taken to ensure that all relevant and applicable legislation is followed.

Following this guidance is not a legal requirement, however, by following the guidance, users may ordinarily expect to be doing enough to comply with the law. HSE and other government-appointed inspectors who seek to secure compliance with the law and may refer to this guidance in their investigations.

This document provides guidance only and due care and attention must be given to any operation being conducted.

This guidance contains lists of considerations that may mitigate the risks highlighted. These lists are not exhaustive and not all items listed may be relevant. All risks must be individually assessed and actions implemented in the context of the individual activity and relevant risk assessment.

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The Safety in Ports Guidance is made available to all interested parties for the general improvement of safety in ports. However, members of PSS will find supplementary resources in the members section of the website.

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2. Introduction

The guidance covers the increasing prevalence of lithium-ion (li-ion) batteries in ports. Whilst it refers to legislative requirements and general operations, the overall application details of such legislative expectations are provided within SiP000 and specific cargo operations in the guidance suite.

li-ion technology is an emerging and developing area. Legislation, standards, research and industry practice will continue to develop, particularly as larger batteries and end-of-life batteries become more common. This guidance should therefore be read alongside current legislation, dangerous-goods requirements, relevant standards, manufacturers' instructions and the port's own risk assessments and emergency arrangements.

Best practice in some areas may be limited when this first edition was published. This SiP will be updated as usage develops - particularly as electric cars and batteries begin to reach end of life and scrappage becomes more common.

This guidance is principally concerned with managing the risks associated with lithium-ion batteries in port environments. Electric vehicles are an important application, but the same underlying hazards can arise from many other battery-powered products and systems.

The guidance covers general risk management principles and then provides application-specific considerations. It is intended to support ports in identifying the hazards relevant to their own operations and developing proportionate controls. It does not prescribe a single approach, separation distance, detection system or emergency response that will be appropriate for every port.

SiP000 Regulatory Framework sets out the overarching principles, approach, and structure that underpin all PSS guidance. The document should be treated as the introduction for all PSS guidance, and it is recommended that it is read first to provide the necessary context for the material that follows.

This guidance uses the term EV to relate to any vehicle using a lithium-ion battery for operation. This includes cars and plant, bikes etc. Where a specific type of EV is being referred to, this will be noted, ie EV car.

3. Lithium-Ion batteries

Lithium-ion batteries have become commonplace in the port industry, most commonly in EVs – imported and exported new cars, customer cars, commercial vehicles, or operational plant. However, they are also widely found in other areas including port equipment, consumer electronics, disposable vapes and increasing in stationary energy storage systems.

EVs and other li-ion battery usage is increasingly appearing in ports due to financial incentives and sustainability programmes, in the following areas:

- Passengers with electric cars on Ro-Ro ferries.
- Import and export of new EV cars.
- Import and export of batteries in containers.
- Port plant and equipment.
- Export of older batteries in containers.
- Onsite recycling and scrap companies.
- Electric bikes, mobility scooters and other public use.
- Battery Energy Storage Systems (BESS).

The general level of awareness of the internal workings and risks associated with lithium-ion batteries and EVs is generally lower than that of traditional internal combustion engines (ICE) or alkaline battery products, due to the relative age of the technology[1].

A lithium-ion cell has four main parts[2]:

- Anode (negative electrode).
- Cathode (positive electrode).
- Electrolyte.
- Separator.

The construction and chemistry of a battery can vary between manufacturers and applications. These differences can affect the way a battery behaves when damaged, overheated, overcharged or otherwise subject to abnormal conditions.

Figure 1: Shows the inside of a lithium-ion battery..

[1] https://fleetworld.co.uk/most-ice-drivers-score-just-two-out-of-10-for-ev-knowledge/
[2] https://en.wikipedia.org/wiki/Lithium-ion_battery_components

4. Typical hazards and general controls

This chapter gives an overview of the risks associated with li-ion batteries and general considerations for the control of risks. The specific risks and controls associated with specific cargo and operational types are covered in more detail in separate chapters later in this guidance. More detailed information on thermal runaway and fire risks is covered in the next chapter.

Lithium-ion batteries are classified as hazardous materials for transportation because of the risk of fire or explosion. The specific risks and hazard associated with EVs and cargos containing lithium-ion batteries should be fully considered through a management of change process before a new cargo is introduced or existing cargo volumes are increased.

The principal concern associated with lithium-ion batteries is the potential for fire and, in some circumstances, explosion[3]. Batteries can also present electrical, chemical and mechanical hazards. The hazards relating to li-ion batteries are NOT the same as ICE vehicles or other lead-acid batteries and therefore should not be treated the same in risk assessments etc.

Whilst the instances of fires in EVs are rare, there are activities or events which increase the risk:

- Damage to the battery or battery pack, including damage arising from collisions, handling or impact.
- Overcharging or discharging outside the manufacturer's recommended limits.
- Manufacturing defects or faults.
- Exposure to excessive heat or cold (above 35 degrees or below zero degrees).
- Modification of the battery pack or addition of non-approved batteries or components.
- A nearby fire or other heat source.
- Electrical faults or short circuits.

Thermal propagation

Lithium-ion batteries can experience a phenomenon known as **thermal runaway[4].** This occurs when heat generated within a cell triggers further heat-producing reactions, leading to rapid temperature rise. This means that combustion may continue without an external ignition source or a continuing supply of oxygen. Thermal runaway and fire risks associated with Li-ion batteries is explored in more detail in the next chapter.

[3] https://www.sciencedirect.com/science/article/abs/pii/S2352152X25031603
[4] https://www.sciencedirect.com/science/article/pii/S2666386426000172

Where batteries or EVs are stored or parked close together, heat from one incident may cause adjacent batteries to overheat or enter thermal runaway. This can occur even where the initial fire did not originate in a battery. Ports should therefore consider both the likelihood of an initiating event and the potential for fire or thermal propagation to surrounding assets.

Battery degradation and other risks

Li-ion batteries can degrade over time, losing their capacity to hold a charge as they age. This degradation can be accelerated by frequent fast charging or exposure to high temperatures. Battery age, condition, maintenance history and available battery-management information may therefore be relevant to risk assessment. Overcharging or discharging lithium-ion batteries beyond their recommended limits can cause damage to the battery's cells.

A specific but unusual risk that ports may experience with li-ion plant and equipment is that they do not make much noise when operating. This can mean that people are unaware that an EV is approaching or that li-ion plant and equipment is operating near-by, increasing the risk of collision.

Information, instruction and training

It is best practice for all port workers involved in operations which may come in to contact with lithium-ion batteries should be trained on their specific risks including:

- Early identification of potential thermal runaway – especially those associated with the vapour cloud.
- Specific EV fire emergency and evacuation procedures.
- Warning signs of battery failure.
- Correct charging procedures for EVs.
- Risks related to battery damage in the event of an accident.
- Inspection procedures for an EV involved in a collision to determine possible battery damage.
- Quarantine or isolation procedures.

Training should reflect the specific batteries, vehicles, equipment and procedures used at the port. Specialist maintenance or firefighting activities should only be undertaken by people who are competent and appropriately trained.

Early detection and isolation

When a li-ion battery has gone into thermal runaway it can be very difficult to contain and includes the release of noxious gases. Therefore, early detection of problems is essential. Monitoring options include thermal imaging, temperature monitoring, battery-management information and gas detection. The practicality, reliability, coverage and limitations of any technology should be assessed rather than assuming that a particular system will detect every developing battery failure.

Where a risk of thermal runaway is identified but **before any visible sign of a vapour cloud or fire is detected**, the EV or li-ion battery should be isolated where possible and a fire break established.

Ports should identify suitable arrangements for isolating damaged or potentially overheating batteries and vehicles. A quarantine area should be selected with consideration of surrounding assets, buildings, people, access, emergency response, drainage, prevailing wind and the potential movement of vapour.

Recovery arrangements should be planned in advance. Moving a damaged battery or vehicle can create additional risk, and the method of movement should be selected according to the condition of the asset and the capabilities of the people and equipment available. Ports with large numbers of EV cars may consider using a transporter to move an at-risk vehicle rather than putting a driver in the vehicle itself.

Fires from lithium-ion batteries carry a high probability of reignition as fires can leave *stranded electrical energy*[5]. A gust of wind or other movement can then cause reignition days, weeks, months or even years after the initial fire.

[5] https://www.sciencedirect.com/science/article/abs/pii/S0378775322012162

5. Fire risk overview

Thermal runaway

Thermal runaway is a rapid, self-accelerating chemical reaction inside a lithium-ion battery cell that occurs when it becomes overheated or damaged. Once the cell reaches a critical temperature, internal materials begin to break down and release heat faster than it can be dissipated, causing temperatures to rise further and potentially ignite the flammable vapour cloud released in the process.

Thermal runaway produces large volumes of vapour cloud, which is a mixture of gases and organic droplets. This can explode within an EV (producing a confined vapour cloud explosion) or vent to the outside of the vehicle. If the vapour cloud ignites immediately, it produces one- to two-meter-long flare-like flames. If ignition is delayed, an unconfined vapour cloud explosion can result. Further, there is increasing evidence that the vapour cloud is very toxic[6].

Lithium-ion battery fires behave differently to other fires. They can:

- Produce much higher peak temperatures.
- Produce jets of flame. See video 1.
- Generate toxic and flammable gases (vapour clouds).
- Resist traditional suppression methods.
- Reignite (day or weeks later).
- Produce explosions from the vapour cloud. See video 2.
- Produce shrapnel from confined vapour cloud explosions. See video 3.
- Develop rapidly See video 4.

Toxic fumes and vapour cloud

Thermal runaway can cause gases within the battery cells to expand and escape, which creates a white or grey vapour cloud. This can have the appearance of smoke or steam but contains toxic, flammable and explosive gases which must be treated as hazardous. Vapour clouds are produced before flames are visible and it can be less than five minutes before an explosion occurs.

Once a li-ion battery has entered thermal runaway, ignition or explosion may occur rapidly. Personnel should therefore keep clear of any vapour cloud and avoid entering areas into which it may spread or accumulate.

[6] https://www.ttclub.com/news-and-resources/news/article/fire-not-the-only-danger-with-lithium-ion-batteries/

The exact chemical make-up of a lithium-ion batteries[7] differs by manufacturer, but a vapour cloud which can result from thermal runaway typically includes:

- Hydrogen (50% - 80%).
- Carbon monoxide (circa. 20%).
- Carbon dioxide.
- Hydrogen fluoride (100's ppm).
- Hydrogen chloride (100's ppm).
- Hydrogen cyanide (100's ppm).
- Small droplets of residual organic solvents used in the electrolyte.
- Small droplets of long-chain organic molecules.
- Ethane, methane and other hydrocarbons (up to 10%).
- Sulphur and nitrogen oxides.
- Up to 100 other trace organic molecules.

The small droplets of organic material give the vapour cloud the appearance of smoke or steam. Thermal runaway is not a combustion process; it is a synthesis hence the mixture of products.

Some of the toxic gases released are heavier than air and spread at low levels as well as drifting upwards. This can mean that it is not possible to duck beneath the cloud as with other fire smoke.

If the gas vents from the vehicle and immediately ignites, it can result in a one- to two-metre-long blowtorch-like flame. Where this gas is confined (for example inside a fire blanket) it can result in a vapour cloud explosion. As the gases include hydrogen, high pressure explosions can occur with little warning and increase the risk of wider damage from shrapnel from confined vapour cloud explosions.

[7] https://en.wikipedia.org/wiki/Lithium-ion_battery

6. Firefighting and containment

Emergency response

Emergency response should follow a hierarchy of controls, prioritising protection of people and preventing escalation. Depending on the circumstances, this may include:

- Raising the alarm and contacting the emergency services where appropriate.
- Establishing an exclusion area based on the actual incident, battery characteristics, environmental conditions and advice from competent emergency responders.
- Isolating nearby people and, where safe and practicable, preventing the incident from spreading to adjacent vehicles, batteries or structures.
- Avoiding unnecessary movement of an affected battery or vehicle.
- Using trained and appropriately equipped personnel only for specialist intervention.
- Managing contaminated firefighting water and preventing pollution.
- Maintaining monitoring and control after the immediate fire has been extinguished because of the potential for reignition.

The evacuation or exclusion distance will depend on the battery, incident, location, confinement, wind, surrounding hazards and emergency-service advice. Ports should pre-plan how exclusion zones can be established and expanded if conditions change.

The batteries quarantine or isolation area should be away from any DSEAR (Dangerous Substances and Explosive Atmospheres Regulations) areas and, where possible, in an area where the vapour cloud is less likely to reach inhabited areas.

Ports should agree with their local fire and rescue service what response arrangements are appropriate for the batteries and operations on the port estate. Ports should ensure that emergency responders understand access arrangements, water supplies, drainage, site constraints, battery locations and any specialist equipment available.

Ports should maintain relationships with local fire and rescue services and other relevant emergency responders. Familiarisation visits and exercises should consider site access, egress, battery locations, charging areas, isolation points, water supplies, drainage, exclusion zones, communication arrangements and the roles of tenants and contractors.

Where a port handles significant quantities of lithium-ion batteries, exercises should test the practical response to a damaged or overheating battery, a developing vapour cloud, a fire involving adjacent assets, contaminated firefighting water and post-incident monitoring.

In the event of thermal runaway or vapour cloud

Where evidence of thermal runaway is detected, it is advisable to treat the fire as an explosion risk and port workers should not attempt any firefighting unless they have been specifically trained in lithium-ion firefighting and fully equipped with protective clothing and full breathing apparatus.

The fire service should be called immediately and informed of the nature of the fire. All port users should be evacuated to at least outside of the risk of fumes and explosion – around 100 meters dependant on wind speed. Windsocks should be located nearby to monitor wind speed and direction of potential vapour clouds.

Ports should develop relationships with their local fire services as a matter of course, and the local service should be informed of potential high-risk areas or activities, such as the prevalence of li-ion batteries within the port estate.

Ports should work with the local fire service to ensure that they are equipped to deal with a lithium-ion fire. Where the local fire service does not have sufficient resources, ports may consider purchasing additional firefighting equipment to be used by the fire service. The local fire service should then be trained on the location and use of this equipment within the port.

It is good practice for ports to undertake regular familiarisation visits and emergency exercises with local fire and rescue services and other emergency responders. These activities should ensure that responding agencies are familiar with the port or terminal layout, access and egress routes, water supplies, firefighting equipment, emergency resources and any operational constraints that may affect an incident response.

Where ports handle significant numbers of electric vehicles, lithium-ion powered equipment or battery energy storage systems, emergency plans and exercises should specifically address the unique challenges presented by lithium-ion battery incidents. These exercises should test response arrangements, communication and coordination between all relevant organisations, ensuring that responders understand the hazards associated with thermal runaway, the prolonged nature of these fires and the measures required to manage them safely.

Where firefighting includes dousing with water, the amount of water required will be far more than when dealing with other fire types. The resulting runoff will also contain hazardous contaminants and should be treated as polluted water. Depending on the duration of the incident, ports may also need to consider measures to collect, retain and, where appropriate, recycle water to maintain effective cooling.

Firefighting equipment

Water may be required to cool an affected battery, extinguish a fire or prevent propagation. The quantity of water required to extinguish a li-ion fire may be significantly greater than for some other types of vehicle or equipment fire. Water used for firefighting may contain hazardous contaminants and should be managed as polluted water. Risk assessments and emergency plans should therefore consider containment capacity, drainage isolation, collection and disposal arrangements.

Ports should ensure that risk assessments and emergency plans consider the practical implications of managing contaminated firefighting water. This should include the maximum volume of runoff that can be safely contained, measures to prevent pollution of drains and surrounding watercourses, any infrastructure required (such as isolation valves or containment systems), arrangements for disposal of contaminated water, and the potential for battery reignition hours, days or even months after the initial incident.

Boundary cooling systems such as water curtains may help reduce heat transfer and fire spread but should not be treated as a substitute for an appropriate firefighting strategy. Windsocks should be used to identify wind direction and speed to determine the direction of travel for any vapour cloud and potential safe distances.

Fire blankets should never be used as a means of extinguishing or cooling a lithium-ion battery fire. A fire blanket will not prevent thermal runaway or thermal propagation and will shift the hazard from fire to explosion by containing the vapour cloud. Their potential role is to reduce the spread of radiant heat or flames to nearby assets, where a suitable industrial blanket has been selected, and its use is supported by the manufacturer's instructions and the port's risk assessment.

Fire blankets should be designated as for industrial use and be tested in accordance with DIN SPEC 91489:2024-1.1. Fire blankets that are large enough to cover a vehicle can be heavy and require at least two people to put in place and should only be deployed by those trained in their use.

There are also a growing range of lithium-ion fire extinguishers available, however, current research suggests that these **should not** be used to extinguish a li-ion fire involving batteries the size of those on electric bicycles or scooters or above[8]. These fires should be tackled by those trained in the use of the specific extinguisher. Ports should assess any product against the battery size, application, evidence of effectiveness, manufacturer's instructions and emergency-service arrangements before relying on it.

Ports are advised to consult with manufacturers, hauliers, shipping companies, research institutes, PSS, and other stakeholders as lithium-ion technology develops and new firefighting equipment and techniques are developed to ensure they are fit for purpose.

[8] https://www.sciencedirect.com/science/article/abs/pii/S0379711222000406

7. Electric vehicles

EVs are one of the most visible applications of lithium-ion batteries in ports and may be encountered as imported or exported vehicles, passenger vehicles, commercial vehicles or port plant.

ICE vehicles on the road still outnumber EV cars by a large margin[9], they have generally travelled significantly more miles and include vehicles of all ages; whereas most EV cars in use are relatively new. This means it is difficult to compare the relative safety of EVs compared to ICE or hybrid vehicles.

Current evidence suggests that EVs are **not more likely**[10] to catch fire than ICE vehicles as they contain fewer combustible materials and the level of dangerous events involving EV cars is lower than ICE vehicles[11]. However, it is currently unclear whether this is because the technology is safer, because the average EV car age is less than the average age of an ICE vehicle on the road, or because there are fewer of them currently in use.

Car fires involving EVs are not classified by the fire services as a distinct type of fire, which limits the availability of reliable data for comparison with fires involving EV or ICE cars.

Ports should ensure that personnel who are required to operate EVs know how to safely start, control and secure the vehicles concerned. Procedures should account for differences between manufacturers and models, including keyless systems, parking controls, charging connections and low-noise operation.

Vehicle condition

Battery damage may arise from a collision, impact with a linkspan or kerb, lifting or handling activity, or an incident that occurred before the vehicle arrived at the port. A vehicle with suspected battery damage should be assessed and, where appropriate, isolated in accordance with the port's damaged-vehicle procedure.

As EV batteries are typically located within the floorpan of the car, there is an increased risk of battery damage during loading and unloading, especially from vessel to linkspan. Batteries may also be damaged in a collision or accident, even a minor incident such as mounting a kerb may damage the battery. Any EV with suspected battery damage should be isolated.

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9 https://www.gov.uk/government/statistics/vehicle-licensing-statistics-2025/vehicle-licensing-statistics-united-kingdom-2025
10 https://www.faraday.ac.uk/wp-content/uploads/2023/07/Faraday_Insights_17_July2023_FINAL.pdf
11 https://energysavingtrust.org.uk/report/are-electric-vehicles-a-fire-risk/

When loading and unloading EVs, check for any damage to the battery or underside of the vehicle. A car may have been involved in a minor accident prior to arrival, unknowingly damaging the battery, or a car may strike the linkspan when entering or exiting the ferry. Many drivers of EVs are not aware of the impact that a minor collision can make to a battery and therefore ports should consider asking passengers to declare any recent impacts.

Charging

As the risk of fire is increased (although still low) during charging, ports should consider the locations of EV charging points. The placement of charging points for electric plant and vehicles should consider:

- Avoiding clustering high-energy assets.
- Separation distances from buildings, fuel, and other vehicles.
- The importance of good ventilation and access for emergency response.
- Avoiding charging stations inside enclosed spaces where heat or smoke accumulation is harder to manage.
- Away from areas classified under DSEAR and other locations where flammable gases, vapours, mists or combustible dusts could create an explosive atmosphere.
- Emergency stop buttons should be located remotely from charging stations and be easily accessible (ie. not contained in locked cabinets etc.) The local fire and rescue service should be fully informed of these locations.
- Storage areas for cables so they are not draped across, or in danger of being run over by vehicles or subject to any other damage.
- Cables should be monitored for wear and tear, and subject to a regular maintenance schedule.

8. Port electric plant and equipment

Alongside EV cars, electric lift trucks, HGVs and other larger port plant are being introduced as equipment is replaced or operations change. The introduction of battery-powered plant should be properly managed in the same structured way as other significant new equipment or technology.

Equipment may initially be supported by a manufacturer's maintenance contract. As equipment ages, ports should ensure that competent personnel and appropriate specialist support remain available for battery maintenance and fault conditions.

Battery powered plant is likely to be quieter in operation than traditional equipment and therefore port workers need to be more aware of when battery powered plant is manoeuvring and operating in the area.

All port workers who use any battery powered plant should understand the risks associated with the equipment, including battery damage, charging, thermal runaway and emergency response. Operators of heavy plant should be made aware of the level of power required to charge the battery and the different risks this presents from to traditional internal combustion engine power. A port electrician may need to supervise the charging of large plant and equipment.

Charging points for plant should be located near to its use but away from cargo, equipment or environments that may increase the consequences of a fire. Battery-powered plant and equipment should not be left charging overnight or without appropriate monitoring for long periods.

Where possible, battery charging levels and battery health should be monitored, mobile apps are often provided by the manufacturer for this purpose.

Figure 2: shows a battery-powered reach stacker and Figure 3: shows a battery-powered forklift truck both of which can be virtually silent in operation.

9. Car carrier operations

Car carrier operations in port and on vessels require cars to be parked very close together which increases the risk of fire spreading. Even where a fire does not start in an electric vehicle, the heat produced from the fire can cause an EV to go into thermal runaway. Therefore, early detection of increasing heat around an EV is vital.

It is best practice to undertake a visual inspection of cars before they are driven, to check for any damage which may affect the battery – particularity underneath the vehicle. Port staff should be specifically trained in the operation and risks involved with EV cars, the warning signs of battery damage, and the means of isolation.

Ports should understand the acceptance criteria, state-of-charge requirements and damaged-vehicle procedures applied by the relevant vehicle manufacturers, carriers and shipping operators. These requirements should be incorporated into port procedures where appropriate.

New EVs are typically transported with a maximum battery charge of 30 per cent and therefore ports may need to consider the placement of charging stations where vehicles are to be driven away from the port rather than placed on car transporters.

Most car carrier vessels are currently not designed with any specific firefighting capacities aimed at EVs. Ports should work with manufacturers and monitor car carrier ship design to understand any modifications which are made as these will inform safety developments in the future. Some manufacturers have battery status monitoring capabilities and have begun to share this information with those involved in the supply chain. Where possible, ports should discuss having access to this information pre-arrival and whilst in port.

The Bristol Port Company have provided an EV car import handling checklist which members may find useful.

10. Ferry operations

Passengers driving EV or hybrid cars should declare this information when entering the port if not before.

Many ports are still loading vehicles by size, weight etc. but this may change as the number of EV cars increased. Ferry operators may have policies about the placement of EVs onboard, where this is absent, it is recommended that EVs are placed on the vessel in places where they have the most ventilation. Some evidence suggests that EVs should not be placed next to each other to avoid the spread of thermal runaway. However, there is also evidence that ICE cars are more likely to suffer fires and any EVs which are situated near a burning car are at risk of heating and going into thermal runaway.

Ports may consider advising drivers to travel with a maximum 30 per cent charge. However, consideration will then have to be given to where cars will be recharged on exit from the vessel. This will also require some drivers to discharge power before travelling and this comes with its own risk.

Where possible, any EV cars with suspected battery damage should be isolated within the port, advising the driver of the potential risks. However, many ports will not have the space required to safely isolate cars sufficiently and careful consideration will need to be given to the passengers of any quarantined cars.

11. Container shipping

Lithium-ion batteries may be transported in containers as part of products, as standalone batteries or as end-of-life batteries. Some of the more common li-ion battery fires involve vapes, mobile phones or laptop batteries, and therefore additional care should be taken where containers are likely to include these. Large scale transportation of end-of-life li-ion batteries is still in its infancy, and ports should keep up to date with changes in risk as numbers being transported increase.

Containers with lithium-ion batteries inside should be classed as dangerous goods and clearly marked as hazardous. Ports should risk assess how to manage mis-declared cargo or mislabelled containers. Ports should work with shipping operators to share any information on potential li-ion battery damages to containers during transit.

Ports should pay particular attention to how containers containing li-ion batteries are loaded and unloaded, as excessive swinging or a hard landing could cause batteries inside to move and sustain damage. Where containers with damaged li-ion batteries or battery parts are identified, they should be quarantined and subject to an inspection before they are moved on.

Where EV cars are being transported in cradles, care should be taken to avoid damaging the car when offloading and checks should be made of any suspected battery damage.

Containers with a large number of small batteries (ie. in personal devices) carry the same risk as a couple of large EV sized batteries. Therefore, additional care should be taken to not cause the batteries to move inside the container which can damage them, or cause them to heat up as they could all go into thermal runaway.

When containers with li-ion batteries are being stacked in the port, attention should be paid to the temperature to ensure the content does not become too hot or too cold, damaging the battery cells.

Where increased heat or potential thermal runaway is identified, containers should be immediately quarantined, taking additional care in moving the affected container to avoid further damage or trailing vapour cloud.

Ports may handle containerised battery energy storage systems in which lithium-ion batteries are installed within a cargo transport unit. These units should be correctly classified, declared, marked and handled in accordance with the applicable dangerous-goods transport requirements.

Members can review the report of the correspondence group on the review of transport provisions for vehicles. This IMO sub-committee amendment was submitted by United States and covers the carriage of li-ion cargoes and containers, proposing an amendment to the IMDG Code and supplements.

12. End-of-life batteries

Small lithium-ion batteries have been in use for many years in items such as mobile phones, laptops, and medical devices (hearing aids, defibrillators, etc.). It is good environmental policy for ports to collect smaller batteries which can then be recycled by an external contracted company. Larger batteries from vehicles and plant are increasingly reaching end of life and may require specialist handling, storage, transport and recycling.

Port should develop policies and procedures for dealing with end-of-life batteries which are regularly reviewed.

Where larger, removeable li-ion batteries reach their end of life they should be treated as hazardous waste and monitored to ensure they are not showing signs of damage or deterioration. They should be collected by a specialist contractor in the same way.

The recycling of large li-ion batteries, such as those in cars, plant and equipment is still in its infancy. Ports dealing with them - particularly where they are showing signs of damage should keep them in an isolated area so far as is reasonably practicable and monitor them for heat and other signs of thermal runaway.

Where the port estate includes recycling facilities which deal with li-ion batteries, a risk assessment and emergency plan should be produced which specifically deals with the issues related to thermal runaway. Figure 4: Shows the remains of a li-ion battery which caused a scrap metal fire in a port.

13. Battery storage systems

Battery Energy Storage Systems (BESS) are increasingly found in ports, either as laydown before installation elsewhere or installed on the port estate but owned and managed by third party contractors. In both cases, ports should update their risks assessments to include the specific needs of these systems.

BESS being temporarily stored on the port estate will not have fire suppression installed and should be monitored for signs of heating. They can be difficult to access for firefighting and best practice is to leave at least three meters space between each container, and at least 15 meters from other cargo, or more for other hazardous materials. Windsocks should be used to monitor wind direction and speed.

Different manufacturers have different designs and carry different risk (such as access for cooling), and ports should work with owners and installers to understand the specific requirements of the units being installed.

Where BESS are installed in the port they will be subject to local planning consent and it is advisable to have an inspection from the fire service before going live. These systems carry the same risks as other li-ion batteries, but the internal systems include a much greater level of monitoring for increases in temperature. Most have inbuilt fire-suppression systems and provide a greater level of feedback on the status of the batteries.

Some of these systems are automated so they can disconnect automatically and shut down as soon as any minor increases in temperature are detected. However, ports should still train staff in early detection and the risks related to thermal runaway and vapour clouds.

The transport of a BESS to or from the port must comply with the requirements laid out in IMDG (International Maritime Dangerous Goods Code) and ADR (The Carriage of Dangerous Goods and Use of Transportable Pressure Regulations). Whilst there are no comparable standards in the UK, the US National Fire Protection Association (NFPA) has developed a standard for the Installation of Stationary Energy Storage Systems which should be used as best practice.

Lithium-ion cells and batteries incorporated into a BESS should have passed the applicable tests in UN Manual of Tests and Criteria, Part III, subsection 38.3. The relevant UN 38.3 test summary should be obtained from the supplier during the planning and procurement stages.

The BESS owner or operator should ensure that the installation is designed, installed, commissioned and operated in accordance with applicable legislation, recognised standards, manufacturers' instructions and any conditions imposed through planning, permitting or approval processes. Ports should obtain appropriate assurance that these requirements are being met and that any proposed changes affecting the approved arrangements are notified, assessed and authorised before implementation.

Units should be monitored for damage before installation and quarantined where necessary. It is recommended to request that the manufacturer is involved with the installation to provide specialist knowledge. Ports should consider the end-of-life arrangements for any units and the expected life cycle.

There have been reports of malicious damage to BESS systems and ports may need to review and amend security measures once units are installed and operating

PD Ports have provided a sample BESS visual inspection checklist and handling framework which members may find useful.

14. Public use of other lithium-ion powered equipment

Where ports have public access (either through the port on public access routes or for embarking and disembarking vessels), there is increasing likelihood of them doing so using electric powered equipment (e.g. e-bikes, e-scooters, powered mobility aids etc.).

Port should consider the risks associated with charging these items and place external fast-charging points in areas where emergency situations can be swiftly identified and that are not close to other high-risk areas.

Where public and staff are able to charge personal vehicles, this should only be permitted in suitable locations and not in front of emergency access areas. Users should be informed about the risks of overcharging and of leaving their devices plugged in for extended periods.

The risk from li-ion batteries significantly increases where the battery has been modified or additional batteries have been added, such as on e-bikes and e-scooters. Ports may wish to consider banning, where possible, modified e-bikes and e-scooters. It should be noted that in 2025, Transport for London banned all non-folding e-bikes due to an increase in fires in stations and on trains. A ban on folding e-bikes is due to come into force by 2027.

Where port users are permitted to use e-bikes and e-scooters around the port, consideration should be made around their use on pedestrian walkaways as they typically move much faster than average walking pace and are quiet. Where they use the road, speed limits and PPE should be enforced. Limited data suggests that e-scooter and hired e-bike users are less likely to wear helmets than traditional bike riders.

15. Shipboard EV fires and places of refuge

Whilst this guidance focuses on EVs and lithium-ion batteries in ports, incidents of shipboard fires have increased concern about the carriage of EVs and li-ion batteries and the landside response to a shopboard EV fire.

Most Ro-Ro and Ro-Pax ships currently in use were not specifically designed for the carriage of EVs although some have been adapted to allow for their specific requirements (such as increased ventilation).

As with any shipboard emergency, the primary concern is the safety of those on board, nearby vessels, responders, and the surrounding population. Whilst the initial response will be managed through the vessel's emergency arrangements, ports may be required to provide assistance and specialist knowledge.

Where a vessel in difficulty may require a place of refuge in UK waters, the decision sits with the Secretary of State's Representative for Maritime Salvage and Intervention (SoSRep). The SoSRep is the UK competent authority for places of refuge and is empowered to make time-critical decisions in the overriding UK public interest.

The SoSRep has noted that shipboard fires involving li-ion batteries are likely to include a toxic vapour cloud, and that the ability for land side fire services to put out an EV fire once thermal runaway has occurred is limited. These concerns are likely to impact when a ship with an EV fire onboard is taken into a port, and when it should be abandoned and left out at sea until the fire has been extinguished.

Ports should work closely with the SoSRep, shipping companies, local authorities and local fire services to ensure that all parties are aware of the procedures for dealing with an EV fire at sea and where possible conduct joint emergency exercises.

Ports should have emergency plans in place which deal with the specific risks associated with li-ion battery fires on board ships. Such incidents can escalate rapidly and may require an immediate and coordinated response from the ship, port and emergency services therefore, preplanning, and fast emergency response and training exercises are vital.

16. Appendix 1: Supporting images

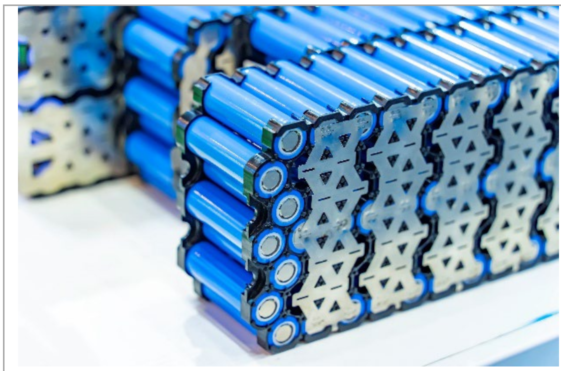

Figure 1: The inside of a lithium-ion battery.
©Shutterstock stock image.

Figure 2: A battery-powered reach stacker.
©Shutterstock stock image.

Figure 3: A battery-powered forklift truck.
©Shutterstock stock image.

Figure 4: The remains of a li-ion battery which caused a scrap metal fire in a port.

17. Appendix 2: External links referred to in this document

Links to information provided by other organisations and referred to in this guidance are provided here for ease of reference. Port Skills and Safety has no control over the content of external websites and the documents referred to may move or no longer be available from those organisations.

Members-only additional resources

The Bristol Port Company EV import handling checklist (Pdf):
https://www.portskillsandsafety.co.uk/wp-content/uploads/2026/09/EV-Import-Handling-Checklist.pdf.

PD Ports Battery Energy Storage System visual inspection check sheet (Pdf):
https://www.portskillsandsafety.co.uk/wp-content/uploads/2026/09/BESS-Visual-Inspection-Check-Sheet.pdf.

PD Ports Battery Energy Storage System handling framework (Pdf):
https://www.portskillsandsafety.co.uk/wp-content/uploads/2026/09/Battery-Energy-Storage-System-BESS-Handling-Framework-PD-Ports.pdf.

PSS Lithium-ion in maritime safety campaign (2025)
www.portskillsandsafety.co.uk/about-us/campaigns/lithium-ion-and-ev-awareness-16-30-october-2024/

Paul Christensen presentation to the PSS EV maritime safety conference (2024)
https://youtu.be/6bAadL7_Iz0

Safety Alert: Lithium-ion Battery Explosion Leads to Fire on Oil Tanker – ICHCA
https://ichca.com/safety-alert-lithium-ion-battery-explosion-leads-to-fire-on-oil-tanker

Report of the Correspondence Group on the Review of Transport Provisions for Vehicles – International Maritime Organisation 2024 (pdf):
https://www.portskillsandsafety.co.uk/wp-content/uploads/2026/09/IMO-Report-of-the-Correspondece-Group-on-Vehicle-Provisions.pdf.

Video resources

Professor Paul Christensen has given permission for Port Skills and Safety to make a number of videos available to members which demonstrate some of the fire risks related to lithium-ion batteries.

Video 1: Shows jets of flames from a vapour cloud explosion:
https://www.youtube.com/watch?v=NndYo_V1kak.

Video 2: Demonstrates the velocity and speed that an overcharged lithium-ion battery fire can begin:
https://www.youtube.com/watch?v=_mK9HJX2NHk.

Video 3: This video shows firefighters tackling an EV car fire and the shrapnel risk:
https://youtu.be/ewzxR8pgx0w.

Video 4: Demonstrates how fast an EV fire can take hold:
https://youtu.be/NndYo_V1kak.

Presentation from Prof. Paul Christensen to the 8th International Tall Building Fire Safety Conference in London Dec 2024:
https://www.youtube.com/watch?v=1FK3CnDGcRc

Electric vehicle battery fire extinguishment (Advanced Fleet Management)
https://www.youtube.com/watch?v=x7KXqN49xkc

Open access resources

Most ICE drivers score just two out of 10 for EV knowledge (article):
https://fleetworld.co.uk/most-ice-drivers-score-just-two-out-of-10-for-ev-knowledge/

Lithium-ion battery components (Wikipedia):
https://en.wikipedia.org/wiki/Lithium-ion_battery_components

Vehicle licensing statistics, United Kingdom: 2025:
www.gov.uk/government/statistics/vehicle-licensing-statistics-2025/vehicle-licensing-statistics-united-kingdom-2025

Improving the safety of Lithium-ion battery cells (article):
www.faraday.ac.uk/wp-content/uploads/2023/07/Faraday_Insights_17_July2023_FINAL.pdf

Are electric vehicles a fire risk? (article):
https://energysavingtrust.org.uk/report/are-electric-vehicles-a-fire-risk/

A comprehensive review of lithium-ion battery safety issues and fault diagnosis strategies throughout the entire lifecycle (academic research paper):
www.sciencedirect.com/science/article/abs/pii/S2352152X25031603

Overview of the current state of research on thermal runaway and thermal propagation testing of lithium-ion batteries (academic research paper):
www.sciencedirect.com/science/article/pii/S2666386426000172

Stranded energy issues and mitigation strategy (academic research paper):
www.sciencedirect.com/science/article/abs/pii/S0378775322012162

Fire not the only danger with lithium-ion batteries (article):
https://www.ttclub.com/news-and-resources/news/article/fire-not-the-only-danger-with-lithium-ion-batteries/

Full-scale experimental study on suppressing lithium-ion battery pack fires from electric vehicles (academic research paper):
https://www.sciencedirect.com/science/article/abs/pii/S0379711222000406

DSEAR (Dangerous Substances and Explosive Atmospheres Regulations):
www.legislation.gov.uk/uksi/2002/2776/contents

European Standards:
www.en-standard.eu/ics-codes/13-environment-health-protection-safety/13-220-protection-against-fire/13-220-10-fire-fighting/

International Maritime Dangerous Goods Code (IMDG):
www.imo.org/en/ourwork/safety/pages/dangerousgoods-default.aspx

The Carriage of Dangerous Goods and Use of Transportable Pressure Regulations (ADR):
www.legislation.gov.uk/uksi/2009/1348/contents

UN Manual of Tests and Criteria:
https://unece.org/transport/dangerous-goods/rev8-files

NFPA 855: Standard for the Installation of Stationary Energy Storage Systems:
https://www.nfpa.org/codes-and-standards/nfpa-855-standard-development/855

TfL announces safety ban of non-folded e-bikes on its transport network (article):
https://tfl.gov.uk/info-for/media/press-releases/2025/march/tfl-announces-safety-ban-of-non-folded-e-bikes-on-its-transport-network

18. Appendix 3: Further information and guidance

These links are provided to enable members to find further information which may be relevant to this guidance. Links are correct at the time of publication but Port Skills and Safety has no control over the content of external websites and the documents referred to may move or no longer be available from those organisations.

UK government interim guidance for covered car parks (2023):
www.gov.uk/government/publications/covered-car-parks-fire-safety-guidance-for-electric-vehicles

HSE Electric and hybrid vehicles:
www.hse.gov.uk/mvr/topics/electric-hybrid.htm

RMP (Risk Management Partners Ltd) EV Safety Guidance:
https://rmpartners.co.uk/ev-safety-guidance/

UK Chamber guidance on carriage of EVs and lithium-ion batteries (2023):
www.ukchamberofshipping.com/news/uk-chamber-issues-guidance-carriage-evs-and-lithium-ion-batteries

Maritime Technology Forum report on the safe carriage of electric vehicles at sea (2025):
www.hilldickinson.com/our-view/articles/maritime-technology-forum-2025-report-on-the-safe-carriage-of-electric-vehicles-at-sea/

MGN 653 Electric vehicles onboard passenger roll-on/roll-off (ro-ro) ferries:
www.gov.uk/government/publications/mgn-653-m-amendment-1-electric-vehicles-onboard-passenger-roll-onroll-off-ro-ro-ferries/

International Chamber of Shipping Sharing information on battery safety (2023):
www.ics-shipping.org/news-item/sharing-information-on-battery-safety/

CHIRP Electric Vehicles on Roll-On and Roll-Off Passenger Ferries (capability and preparedness) (2026):
https://chirp.co.uk/hot-topic/electric-vehicles-on-roll-on-and-roll-off-passenger-ferries/

TT Club De-risking the carriage of lithium-ion batteries:
www.ttclub.com/news-and-resources/news/article/de-risking-the-carriage-of-lithium-ion-batteries/

Brookes Bell, TT Club and UKP&I – Lithium batteries whitepapers (2022):
https://www.brookesbell.com/news-and-knowledge/transport-of-lithium-ion-batteries-a-continuous-threat-158122/

EMSA Safe Transport of Alternative Fuel Vehicles on Ro-Ro Ships (STARRS) study (regulatory review) (2025):
www.emsa.europa.eu/afv/starss.html

SMI webinar: Exploring the risks of carrying ev battery powered vehicles onboard:

https://www.youtube.com/watch?v=F9s9WsKow_I

Gexcon Understand and Mitigate BESS Fire and Explosion Risk (2023):
https://www.gexcon.com/understand-and-mitigate-bess-fire-and-explosion-risk

Zenon The role of software technology in BESS integration:
https://go.copadata.com/bess-whitepaper

Motoring facts:
www.racfoundation.org/motoring-faqs/mobility#:~:text=31%20March%202023%3F-,Q1)%20How%20many%20vehicles%20are%20there%20in%20the%20United%20Kingdom,the%20end%20of%20March%202023.

UK and Electric Cars – EV Market Stats 2024:
https://citaevcharger.co.uk/uk-and-electric-cars-ev-market-stats-2024/#:~:text=With%20over%201%2C000%2C000%20fully%20electric,2024%2C%20underscoring%20their%20increasing%20popularity.

Electric car statistics and projections (article):
https://heycar.com/uk/news/electric-cars-statistics-and-projections

ARUP – fire safety guidance for electric vehicles:
http://covered-car-parks-fire-safety-guidance-for-electric-vehicles/

BESS Failure Incident Database:
https://storagewiki.epri.com/index.php/BESS_Failure_Incident_Database

Experimental Study on Fire Evolution Process of Electric Vehicles in Underground Parking Garages:
https://link.springer.com/epdf/

Fire safety of indoor car parks accommodating electrically powered vehicles:
https://nipv.nl/wp-content/uploads/2023/09/20210715-NIPV-Fire-safety-of-indoor-car-parks-accommodating-electrically-powered-vehicles.pdf

Ship fires and Electric Vehicles – The Evolving Risks of the Energy Transition (article August 2025):
https://www.wfw.com/articles/ship-fires-and-electric-vehicles-the-evolving-risks-of-the-energy-transition/

EV fire risks draw IMO's attention (article April 2026):
www.rivieramm.com/news-content-hub/ev-fire-risks-draw-imos-attention-88377

IMO Sub-Committee on Ship Systems and Equipment (SSE 12) (DNV meeting report):
https://www.dnv.com/news/2026/imo-sub-committee-on-ship-systems-and-equipment-sse-12

LashFire – EU-funded research project aiming at reducing Ro-Ro fire risks:
https://lashfire.eu/

19. Appendix 4: Safety in Ports guidance

SiP000 Guidance framework

SiP001 Port and terminal planning

SiP002 General cargo

SiP003 Container handling

SiP004 Timber handling

SiP005 Mooring operations

SiP006 Transfer of bulk liquids and gases

SiP007 Loading and unloading of dry bulk cargo

SiP008 Storage of dry bulk cargo

SiP009 Lighting

SiP010 StoRo & RoRo operations

SiP011 Sources of occupational health information

SiP012 Ro-Ro passenger and cruise operations

SiP013 Management of non-permanent employees

SiP014 Safe access and egress

SiP015 Confined spaces in ports

SiP016 Emergency planning in ports

SiP017 Guidance on fitness for work and health surveillance

SiP018 Safety induction and training

SiP020 Water safety

SiP021 Access to small craft

SiP022 Biomass