

Swapping conventional batteries with Li-ion batteries

This guidance highlights the importance of managing the health and safety risks of lithium-ion (Li-ion) batteries when they are used to replace conventional lead-acid batteries on non-SOLAS commercial vessels not originally designed for them. It also includes guidance about large capacity portable batteries. As Li-ion batteries and the associated technologies are evolving quickly this guidance will be updated as required.

Definitions

Lead Acid batteries: Applies to all rechargeable batteries that have sulphuric acid as the battery electrolyte and lead-based plates. In New Zealand, this includes the following battery types:

- Thin Plate Lead Acid (TPLA)
- Absorbent Glass Mat (AGM) and Gel
- Advanced Lead Carbon (ALC)
- Sealed maintenance free or Valve Regulated lead-acid battery
- Wet lead acid with flooded and vented valves (WLA)

Lithium-ion (Li-ion) batteries: All rechargeable batteries that work by the transfer of lithium-ions between the electrodes. Lithium-ion batteries do not contain metallic (elemental) lithium and include (but are not limited to) the following sub-categories:

- Lithium iron phosphate (LFP)
- Lithium nickel manganese cobalt oxide (NMC)
- Lithium cobalt oxide (LCO)
- Lithium nickel cobalt aluminium oxide (NCA)
- Lithium titanate oxide (LTO)
- Lithium manganese oxide (LMO)

Lithium-ion battery installation: May comprise the following configurations:

- individual cells with an external Battery Management System (BMS) and safety disconnect device(s)
- modules comprise of multiple cells with an internal or external BMS and external safety disconnect device
- one or more “drop-in” replacement modules that have an internal BMS and a safety disconnect device



Background

Although Maritime Rules, such as 40A.38 require approval of certain information by a recognised Design Approver Electrical (DA_E) when a ship undergoes major alteration of its electrical systems, they do not specify what happens when a Li-ion battery pack or bank replaces a Lead-acid battery or battery bank. However, commercial marine operators, surveyors and DA_Es have responsibilities under the Health and Safety at Work Act 2015 (HSWA) to eliminate risks to health and safety so far as is reasonably practicable, and if it is not reasonably practicable to eliminate the risks, to minimise them so far as is reasonably practicable. If Li-ion batteries are not installed correctly, they may put the vessel and persons on board at risk.

These risks include:

- damage to existing onboard equipment, especially the wiring or circuitry caused by a higher current output from the Li-ion battery than the system was designed for
- increases in temperature. Li-ion batteries can overheat which can then lead to fire or explosions. There have been multiple reports overseas and in New Zealand of Li-ion batteries installed on vessels (or installed in equipment on vessels) overheating and catching alight
- physical damage to batteries. Li-ion batteries can be prone to physical damage like puncturing or crushing. This can result in the discharge of gases or electrolytes which can cause severe health problems or explosions
- downstream effects of damage to batteries or poor battery performance. Incorrectly installed Li-ion batteries could damage or result in a loss of power to essential equipment while the vessel is at sea. Radio, navigation, steering, bilge pumps and lighting could be out of action depending on the configuration of the electrical system. This risks harming passengers, crew and the environment, and damaging the vessel.
- passenger safety if Li-ion batteries are installed in passenger egress locations. If sets of Li-ion batteries are fitted incorrectly in these locations, including under stairways, they could create a risk of fire, impeding passenger movement
- portable electronic batteries overheating. There have been numerous reports of fire caused by charging large (for example, electric outboards or electric motors on Seabobs/e-bikes) or multiple smaller Li-ion batteries (such as cellphones). This risk is increased if the devices are left charging unattended or on a soft surface.

Reminders for operators

When replacing lead acid batteries with Li-ion batteries or charging Li-ion batteries in equipment or devices, operators should:

- obtain advice from a recognised Design Approver Electrical (DA_E). For a list of recognised Design Approvers see <https://www.maritimenz.govt.nz/content/commercial/safety/safety-management-systems/recognised-surveyors/recognised-design-approvers.asp>
- follow the advice from the DA_E around the design when they are making changes
- for ships of 24 metres or less in length ensure that the installation of Li-ion batteries complies with AS/NZS 3004.2:2014 'Electrical installations – Marinas and boats – Part 2: Boat installations' or relevant rules of a classification society
- for ships of more than 24 metres in length, ensure that the installation of Li-ion batteries comply with the applicable parts of the IEC 60092 series of standards – Electrical installations in ships or the relevant rules of a classification society.
- have people on the vessel when charging portable Li-ion batteries in devices or equipment
- if people are sleeping onboard do not leave Li-ion batteries charging, including devices like cellphones or equipment like Seabobs
- have a designated area for charging portable Li-ion battery devices or equipment
- amend the Maritime Transport Operator Plan (MTOP) to address these risks.

Advice to DA_ES

Li-ion batteries are voltage and temperature sensitive; make sure any battery design includes the following:

- batteries and the BMS, at a minimum, must satisfy the requirements of AS/NZS 3004.2 or therelevant rules of a classification society if the vessel is 24 metres or less in length. If the vessel is over 24 metres in length ensure that it complies with the applicable parts of the IEC 60092 series of standards – Electrical installations in ships or the relevant rules of a classification society
- follow good practice such as relevant classification society rules or guidance that become available
- batteries are installed in spaces where temperature is lower than the manufacturers safe limits for when they are charging
- batteries and battery systems are located in well ventilated spaces to maintain a safe temperature
- the batteries are located away from passenger egress routes
- battery cabinets, rooms or enclosures are constructed from a structurally fire-rated, non-combustible material to contain a battery thermal event to allow sufficient time to either evacuate the vessel or, if possible, control the thermal event
- information about the battery status including warnings and alarms available to the vessel's operator
- if a data network forms part of the battery management and safety system, ensure the network is only be used for that purpose
- ensure that any data network malfunctions or failures means the battery only fails to a safe level of charge
- alternative sources of power for essential systems are available on the ship
- remind operators to provide a space for safely charging portable batteries that passengers bring on board.

Reminders for Surveyors

Periodic surveyors should be aware of the risks associated with changing from lead acid batteries to Li-ion batteries. Surveyors who see newly installed Li-ion batteries on a commercial vessel when undertaking a periodic survey are reminded to ensure:

- they check the type of batteries that are on board
- if Li-ion batteries are installed, a recognised DA_E has reviewed and advised on the proposed design of the Li-ion batteries and battery management system , including any reconfiguration necessary to accommodate a Li-ion battery pack
- the installation complies with the approved design from the recognised DA_E.

More Information

General health and safety information - Introduction to the Health and Safety at Work Act 2015

<https://www.worksafe.govt.nz/managing-health-and-safety/getting-started/introduction-hswa-special-guide/>

List of recognised design approvers

<https://www.maritimenz.govt.nz/content/commercial/safety/safety-management-systems/recognised-surveyors/recognised-design-approvers.asp>

List of recognised surveyors

<https://www.maritimenz.govt.nz/content/commercial/safety/safety-management-systems/recognised-surveyors/recognised-surveyors.asp>