USCG: Lithium-Ion battery system installations

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The United States Coastguard (USCG) has published Safety Alert 14-25 relating to Lithium-Ion (Li-Ion) battery system Installations. The alert was published following a recent Li-Ion battery fire on a passenger vessel.

What happened?

An integrated Li-ion battery bank recently caught fire onboard an inspected passenger vessel when loosely crimped lugs overheated. While no one was injured and the vessel sustained minimal damage, the event highlights safety hazards unique to Li-ion batteries.

The USCG recommended that integrated (installations used for propulsion and electrical power) Li-ion battery systems should undergo engineering plan review, be fitted with supporting safety systems, be tested and inspected at installation and periodically afterward, and be properly maintained by competent mariners, regardless of the battery bank size or end consumer.

Some safety considerations unique to Lithium-Ion batteries

- **Energy Density:** Li-ion batteries are used on vessels because their high energy densities allow for longer voyages and full electrification. However, high energy density increases risk because if a fire occurs, it will burn hotter and longer.
- **Thermal Runaway:** Upon internal failure or short circuit, Li-Ion batteries may release high-temperature flammable gases that can catch fire or explode. The

heat output of a fire can increase the rate of off-gassing, and those off-gasses in turn increase the size of the fire in an uncontrolled chain reaction.

- **Fire Suppression Resistance:** A thermal runaway fire is very difficult to suppress once it has begun to propagate to other battery modules. Instead, fire management strategies focus on early detection, fire containment, and heat absorption with a water-based suppression system.

- **Toxic gases given off:** In thermal runaway, Li-ion batteries release varied toxic gases, many in excess of their “Immediately Dangerous to Life or Health” thresholds, placing passengers and crew in potential danger. Further, the composition of off-gasses varies dramatically across different Li-ion battery chemistries and manufacturer makes and models.

- **Battery Management:** Li-ion batteries will often have a battery management system to prevent degradation from overcharging, undercharging, or over-cycling. Propulsion, electrical loads, topping loads, and recharging cycles are managed by complex integration systems, which are key in mitigating the increased risks of Li-ion battery systems.

Lessons to learn

- Li-Ion Battery Identification: Packaged Li-ion batteries often visually resemble traditional lead acid batteries, regardless of type, so the best way to identify them is by reading the nameplate specifications. Li-ion batteries can be identified in a variety of ways depending on electrode, electrolyte, and separator materials. Some common types in maritime use are:
  - Lithium Iron Phosphate (LFP).
  - Lithium Nickel Manganese Cobalt Oxide (NMC).
  - Lithium Cobalt Oxide (LCO).
  - Lithium Nickel Cobalt Aluminium Oxide (NCA).
  - Lithium Titanate (LTO).
  - New chemistries continue to emerge as technology advances.
- Material Condition: Batteries should be visually inspected for signs of deterioration, such as bulging cells or corroded electrical connections. Documentation on the completion of required maintenance should be maintained.
- Operational and Maintenance Procedures: Crew members responsible for battery operation and maintenance should be well-trained in the manufacturer’s guidelines and operational procedures and familiar with the functioning of the battery management system. They should also know how to respond to abnormal battery conditions or fires. Safety drills for Li-ion battery fires should be performed, and Li-ion battery system arrangements and risks should be taken into account when conducting other drills.

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