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DEPARTMENT OF TRANSPORTATION

Federal Railroad Administration

Safety Advisory 2026-02: Advanced Chemistry Battery Hazards in Passenger Railcar Operations

AGENCY: Federal Railroad Administration (FRA), U.S. Department of Transportation (DOT).

ACTION: Notice of Safety Advisory.

SUMMARY: FRA is issuing Safety Advisory 2026-02 to alert the passenger rail industry to the severe safety risks associated with advanced chemistry batteries, such as lithium-ion battery (LiB) power sources, carried aboard passenger railcars within electric micromobility vehicles (EMVs). Recent full-scale testing shows that thermal runaway in these battery systems poses rapid and potentially catastrophic thermal, toxicological, and visibility hazards inside passenger railcars. This Safety Advisory recommends specific operational, training, and emergency planning and response mitigations to protect passengers and crew members.

FOR FURTHER INFORMATION CONTACT: Michael Hunter, Staff Director, Passenger Rail Division, Office of Railroad Safety, FRA, 1200 New Jersey Avenue SE, Washington, DC 20590, (202) 579-5508, *Michael.Hunter@dot.gov*.

Disclaimer: This Safety Advisory is considered guidance pursuant to 49 CFR part 5, subpart C. Except when referencing laws, regulations, policies, or orders, the information in this Safety Advisory does not have the force and effect of law and is not binding in any way. This document does not revise or replace any previously issued guidance.

SUPPLEMENTARY INFORMATION:

Background and Electrochemical Failure Mechanisms

Underwriters Laboratories Fire Safety Research Institute (UL FSRI) Test Report[1]

EMVs, which encompass e-bicycles, e-scooters, e-unicycles, and hoverboards, have experienced a surge in popularity for first- and last-mile transit connectivity. The rapid integration of passenger transit with EMV travel has introduced high-energy-density electrochemical storage systems (*i.e.*, the LiB power sources on the EMVs) directly into occupied passenger railcars. While these vehicles provide notable societal benefits, their power systems represent a unique hazard in enclosed transport environments. The primary safety vulnerability stems from the potential for one of the high-energy-density electrochemical storage systems, such as a LiB pack, to undergo thermal runaway, an uncontrolled, self-sustaining exothermic reaction that occurs when internal heat generation exceeds the battery's ability to dissipate that heat.

LiB failures are typically initiated by three distinct abuse modes:

- **Electrical Abuse:** Overcharging, over-discharging, or experiencing internal or external electrical short-circuits.
- **Thermal Abuse:** Exposure to high temperatures, environmental overheating, or external fire exposure.
- **Mechanical Abuse:** Physical damage, structural crushing, shock or impact, or localized penetration of individual battery cells.

To quantify these hazards, researchers at the UL FSRI conducted full-scale experiments inside an 85-foot, 72-passenger railcar to evaluate the dangers of EMV battery fires. They triggered thermal runaway (an uncontrollable, self-heating battery failure) in four common EMVs (a standing e-scooter, an e-bicycle, and two seated e-scooters) placed in standard passenger storage locations to measure heat, smoke, and toxic gas buildup.

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[1] FRA does not discuss the UL FSRI test report in its entirety in this Safety Advisory. For more information, visit *https://doi.org/10.60752/102376.32136697*.

UL FSRI Findings

The UL FSRI report uncovered two main immediate threats to passengers: (1) extreme heat experienced within 10 feet of the device; and (2) toxic asphyxiant gases filling the passenger car. The UL FSRI report explained that when the devices were forced into thermal runaway, the failing batteries suddenly vented flammable gas that ignited into a fireball with little to no warning. Extreme heat within 10 feet (3 meters) created life-threatening conditions for nearby passengers in 20 to 60 seconds. Also, hot smoke traveled end-to-end through the 85-foot railcar in just 19 to 34 seconds. Complete loss of visibility occurred across the car between 1 minute 48 seconds and 4 minutes 6 seconds, which can severely hinder passenger and crew egress speeds. In addition to loss of visibility, the researchers found that dangerous asphyxiant gases accumulated quickly. Based on fractional effective dose, a standard fire safety engineering calculation used to estimate human incapacitation, the air throughout the entire railcar became toxic to breathe in 3 minutes 37 seconds to 7 minutes 8 seconds.

The test report demonstrates that failing LiBs create severe, life-threatening conditions very quickly. Occupants (passengers and crew members) within 10 feet of a failing LiB that enters thermal runaway are exposed to both threats immediately (toxic gas and extreme heat) that can overcome an individual within 20 to 60 seconds. But what is more concerning is that the majority of occupants are exposed to toxic asphyxiant gas without immediately recognizing the threat. Those located away from the immediate proximity of a LiB entering thermal runaway will be exposed to those gases and incapacitated quickly.

FRA Regulations

Fire Safety

Under 49 CFR 238.103, railroads are required to execute a written fire safety analysis (FSA) utilizing a formal safety methodology, such as MIL-STD-882, to identify

inherent design hazards, evaluate emergency egress and ventilation systems, assess overheat protection, and determine the necessity of automatic fire suppression and smoke detection systems.[2] Further, railroads must adopt and strictly adhere to written procedures for the inspection, testing, and maintenance of all onboard fire safety systems and equipment to maintain continuous compliance.[3]

When a passenger railroad permits transportation of EMVs powered by LiB onboard passenger equipment, it introduces high-energy combustible fuel loads and severe thermal runaway ignition sources into the passenger car environment.[4] Because LiB failures can trigger rapid self-sustaining thermal reactions, intense heat generation, and toxic gas release that exceed baseline interior material flammability assumptions, accommodating these devices alters the overall risk profile and available ignition sources.[5] Under § 238.103(c) and (d), the railroad must conduct or update its FSA to re-evaluate whether existing mitigations remain sufficient to ensure safe passenger evacuation during a battery-initiated fire.[6] If the FSA indicates that the risk of personal injury from onboard LiB hazards is non-negligible or unacceptable within that operating environment, the railroad is required under § 238.103(c)(2) and (d)(1)(ii) to implement effective remedial safety measures, such as establishing fire-isolated containment areas, prohibiting onboard battery charging, enforcing capacity thresholds, or instituting operational restrictions, to mitigate the fire risk to an acceptable level.

Passenger Train Emergency Preparedness

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[2] § 238.103(c).

[3] § 238.103(e).

[4] § 238.103(c)(1).

[5] § 238.103(d)(5).

[6] § 238.103(c)(3) and (c)(6).

Under 49 CFR part 239, FRA prescribes minimum safety standards requiring passenger railroads and host railroads to adopt, implement, and comply with a written passenger train emergency preparedness plan (PTEPP) designed to reduce the magnitude and severity of casualties during emergency situations.[7] To manage effectively the unique hazards associated with onboard EMVs, passenger railroads should leverage their required PTEPP as a flexible, proactive tool. By voluntarily integrating micromobility risk mitigation procedures, such as designated stowage locations, LiB fire hazard training for onboard personnel, and tailored emergency response protocols, into their written plans, railroads can enhance overall system safety and operational readiness.[8]

Recommended Actions

Considering the above discussion, FRA recommends that railroads providing passenger rail service:

1. **Review Safety Research:** Review the UL FSRI report, "Recommendations to Improve Passenger Railcar Safety During Electric Micromobility Vehicle Fires" *available at https://doi.org/10.60752/102376.32136697*.

2. **Update FSAs:** Update their FSA under 49 CFR 238.103 to account for the increased on-board fire load if the railroad permits EMVs containing a LiB power source. Railroads should also implement mitigations developed as part of updating the FSA that reduce the level of risk to acceptable levels. For example, railroads could install non-combustible liners in designated storage locations to help mitigate the spread of fire to adjacent material.

3. **Prohibit Seat and Underseat Storage:** Prohibit storage of these devices at seat or underseat locations where devices are in proximity to interior materials that may

[7] §§ 239.1, 239.3, 239.101(a).

[8] § 239.1(b).

contribute to the spread and severity of any potential onboard fire and where devices cannot be easily monitored by train crews or passengers for signs of overheating.

4. **Update Emergency Plans and Conduct Training:** Update written PTEPPs under 49 CFR part 239 with specific procedures for dealing with devices that appear to be overheating or have entered thermal runaway, especially while trains are operating in tunnels or on elevated structures. Those procedures should include instructions to crew members and other onboard employees to prioritize emergency egress of passengers away from the threat over attempting to extinguish or otherwise fight the thermal event. Once updated, conduct training for employees.

5. **Prohibit LiB-Powered Devices in End Cars:** Prohibit lithium-ion powered devices in the forward- or rear-most cars as a localized fire or thermal runaway event in these end cars could severely impede or entirely block critical egress vestibules and end-frame doors.

6. **Prohibit Onboard Battery Charging:** Prohibit the charging of these devices during passenger operations to eliminate a potential thermal runaway ignition source.

FRA encourages the railroad industry to take actions consistent with the preceding recommendations, and to take all actions that help ensure the safety of the Nation's railroad employees and the public. Nothing in this Safety Advisory alters any existing regulatory requirements, operating rules, or obligations under Federal law. FRA may modify this Safety Advisory 2026-02, issue additional safety advisories, or take other appropriate actions it deems necessary to ensure the highest level of safety on the Nation's railroads, including pursuing enforcement or other corrective measures under its rail safety authority.

Issued under authority delegated in 49 CFR 1.89.

John Karl Alexy,
Associate Administrator for Railroad Safety and Chief Safety Officer

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