Lithium Battery Safety and Compliance

September 25, 2025

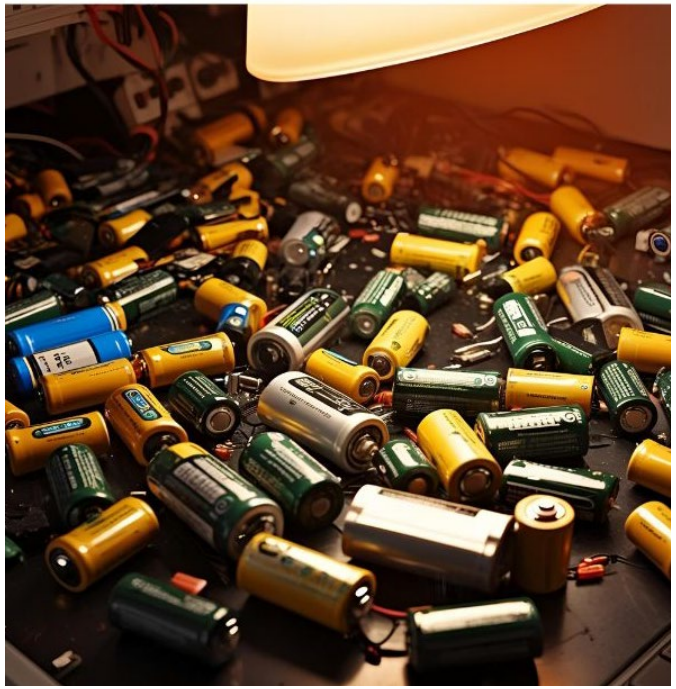
Presenter:

Paul Johnson, Senior Managing Consultant ALL4

Agenda

- Lithium Battery Primer
- General Safety – understanding the hazards
- Real life scenarios
- Prevention Concepts and Requirements
  - Training
  - Packaging
  - Marking
- Storage and Best Practices
- Information Resources
- Q&A

Batteries Are Everywhere!



- Cell phones
- Watches/earphones/rings
- Computers
- Power tools
- Electric vehicles
- Personal mobility devices (scooters, wheelchairs)

- Power supplies/backups (personal and large scale)
- Alarm systems
- Digital cameras

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Lithium batteries come in all shapes and sizes!

Battery Primer

Battery Types

- **Primary batteries** are a single use battery that provides electrical current until the “charge” or stored energy is depleted.
- **Secondary batteries** are rechargeable and may be “reenergized” many times before they begin to lose the ability hold an electrical charge.
- Batteries can be further described by the chemistry present within the cell.

Battery Primer

Lithium Battery Types

- **Primary battery (Metal)** chemistries include Thionyl Chloride, Sulfur Dioxide electrolytes as an example and contain lithium metal or lithium alloys. These are often used in, cameras, military applications and oil exploration.

- **Secondary battery (Ion),** chemistries include lithium Ion or polymer batteries.

It is important to know the chemistry of the batteries you are handing. Information about your batteries may be found in the SDS or manufacturer's literature.

Understanding Lithium-Ion Batteries

- The term “Lithium-Ion Batteries” comprises several sub chemistries.
- Li-ion batteries are constructed from a Lithium metal oxide cathode, lithiated graphite anode and generally have an “LiPF6” electrolyte. These electrolytes contain organic solvents and are generally flammable.
- They are valued for their high energy and low weight. This makes them a favorite for mobile applications.
- Common cathode lithium salts include:
  - lithium cobalt oxide (LiCoO2),
  - lithium manganese oxide (LiMn2O4),
  - lithium nickel manganese cobalt oxide (LiNiMnCoO2),
  - lithium iron phosphate (LiFePO4),
  - lithium nickel cobalt aluminum oxide (LiNiCoAlO2).

Understanding the Hazards

Lithium batteries present both chemical and electrical hazards.

Batteries can be dangerous if not safely packaged and handled when transported.

When ignited or involved in a fire they may be difficult to extinguish. However, water is almost always the best fire-fighting agent.

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Where Are Your Spent Batteries Now?

- How are they being stored?
- What are your employees doing with their batteries?
- What are you family members doing with their batteries?
- Even the smallest of batteries deserve respect and should be properly stored.

General Safety

- Never attempt to re-charge a primary battery.
- Never overcharge a battery.
- Never leave your battery powered device charging unattended for long periods of time.
- Avoiding crushing or puncturing the battery case or cells.
- Never dispose of your batteries in a fire.
- Protect (insulate) the terminals (tape, bag, orientation).
- Never throw batteries into the trash or curbside recycle bin.

Examples of improperly packaged, undeclared batteries and electronics

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March 2022

UNITED STATES COAST GUARD
U.S. Department of Homeland Security

MARINE SAFETY ALERT

Inspections and Compliance Directorate

March 10, 2022
Washington, DC

Safety Alert 01-22

LITHIUM BATTERY FIRE

Burnt lithium batteries in fiberboard boxes.

On August 19, 2021, a container illegally loaded with discarded lithium batteries caught fire while enroute to the Port of Virginia. The container was being transported on a chassis from Raleigh, NC, intended for a maritime voyage to a port in China via a foreign-flagged container ship. The batteries caught fire on the highway resulting in loss of the cargo, and significant damage to the shipping container. Upon initial investigation, the responding fire department determined that the heat produced from the fire burned hot enough to create a hole through the metal container's structure. In addition, the bill of lading listed "computer parts," not lithium batteries. This is a situation that made responding to the fire more challenging and could have been potentially catastrophic had the container caught fire after being loaded aboard the container ship.

Further investigation by the Department of Transportation (DOT) and Pipeline and Hazardous Materials Safety Administration (PHMSA) determined that the shipper failed to properly placard, label, mark and package the lithium batteries, class 9, UN 3480 and 3481, and identified the cause of fire to be residual charge/full circuit, which led to a thermal increase.

The Coast Guard seeks to increase awareness of these hazards, and **strongly recommends** units and other stakeholders:

- Disseminate this safety alert to all marine safety personnel and stakeholders within their respective port(s).
- Have awareness of the following:
  - IMDG Special provisions 376 and 377, which address additional marking requirements for lithium batteries being transported and that are damaged or defective, or being disposed of or recycled.
- Ensure damaged/defective batteries shall be packaged IAW P911 or LP 906.
- Ensure batteries for disposal or recycling adhere to P908 or LP 904.

March 10, 2022
Washington, DC

Safety Alert 01-22

- Ensure all packaging provisions state: cells and batteries shall be protected against short circuit. Note: Some provide additional direction such as isolating each battery and limits on package contents.
- Utilize PHMSA's Lithium Battery Guide Lithium Battery Guide for Shippers | PHMSA (dot.gov) and the U.S. Environmental Protection Agency's (EPA) guidance on Used Lithium-Ion Batteries | US EPA
- Have awareness of Appendix A to Subpart D of 49CFR107, which contains guidelines for civil penalties to pursue enforcement or recommend follow-on action to DOT PHMSA.

Field personnel should be on alert for these shipments and engage port stakeholders as appropriate to ensure compliance with all applicable standards and safe shipping conditions. In the event local units respond to a container fire ***before*** the container reaches a port or facility, the unit should contact PHMSA and/ or the Federal Motor Carriers Safety Association (FMCSA) local representatives to handle the investigation into the incident.

This safety alert is provided for informational purposes only and does not relieve any domestic or international safety, operational, or material requirements. Developed by Sector Virginia and distributed by the Office of Port and Facility Compliance. Address questions to SMB-COMDT-CGFAC@USCG.MIL, or at (202) 372-1092.

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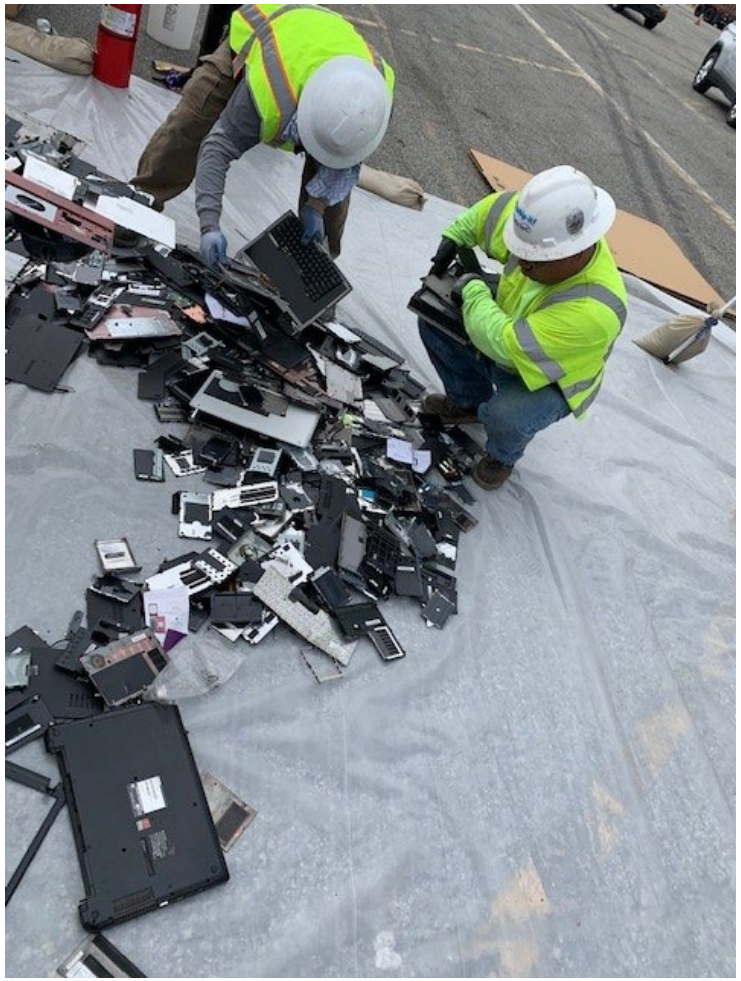
This material had to be de-packed, sorted, identified and repackaged in the field.



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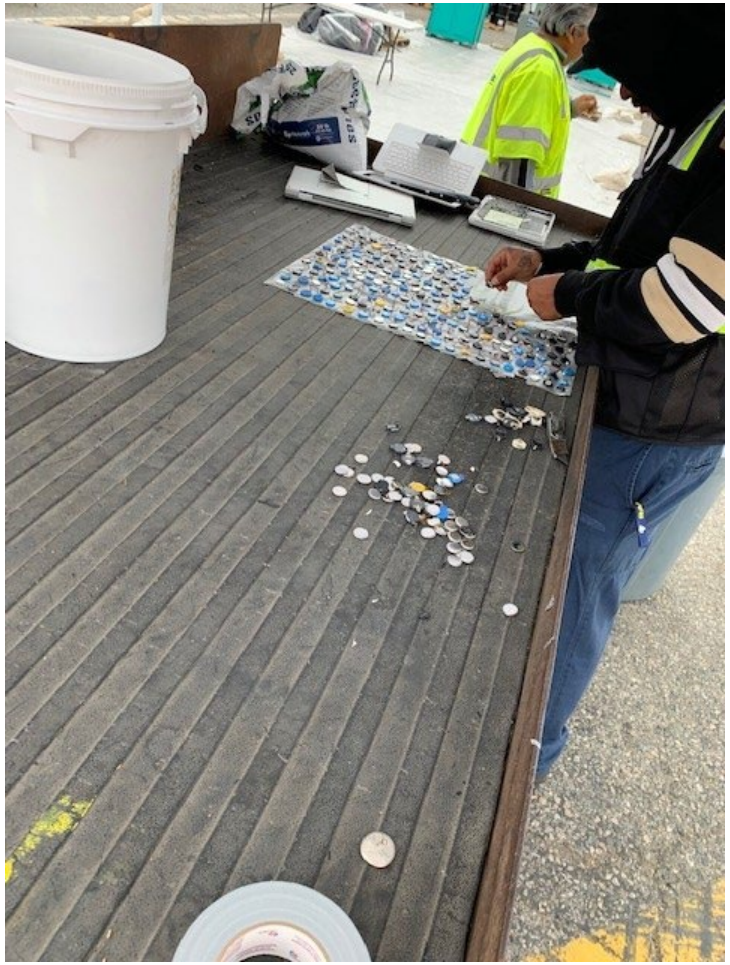
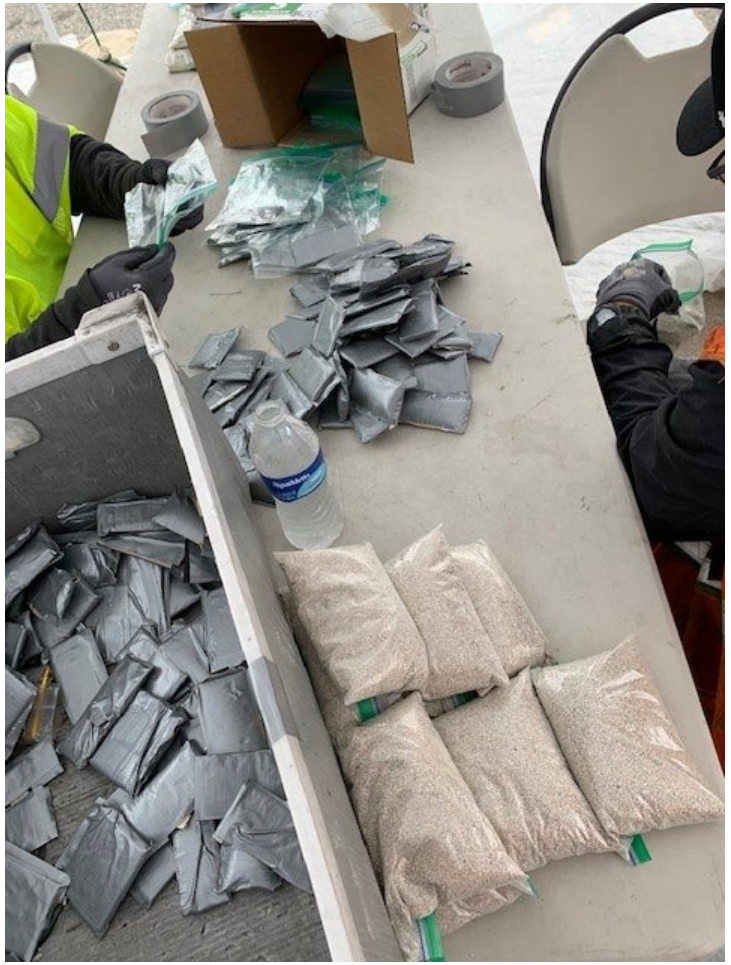
Insulation of coin cell batteries and packaging of DDR batteries.





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The proper preparation of batteries for transportation is a difficult task in the field. Care must be taken when handling, insulating and packaging the batteries for transportation.

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April 2009

U.S. Department of Transportation

1200 New Jersey Avenue, SE
Washington, D.C. 20590

Pipeline and Hazardous Materials Safety Administration

April 3, 2009

To: All battery recyclers and battery collection points and related associations.

Based on recent investigations conducted by the U.S. Department of Transportation (DOT), Pipeline and Hazardous Materials Safety Administration (PHMSA), and based on recent incidents, this letter is generated to convey our findings and our ongoing effort to improve compliance and transportation safety. PHMSA has noted an ongoing trend of serious safety problems and non-compliance regarding the classification, packaging, marking, labeling, documentation, and transportation of spent batteries in commerce. PHMSA has great concern over the lack of compliance with and understanding of the transportation requirements for batteries. PHMSA recognizes the breadth and scope of the battery recycling and disposal industries. However, due to several incidents resulting in serious consequences, PHMSA pledges its efforts to reduce this risk by enforcing the safety standards and increasing awareness. In order to magnify its safety and compliance efforts, PHMSA feels this letter will help increase the awareness and provide a means of contact for the prescribed safety requirements to the appropriate battery recycling and disposal transportation streams.

PHMSA is concerned that many persons who ship batteries for recycling or disposal do not appreciate the hazards posed by batteries during transportation. PHMSA has documented numerous shipments that were not in compliance with requirements in the Hazardous Materials Regulations (HMR, 49 CFR Parts 171-180).

Common violations and safety problems noted during these investigations include:

(Primary lithium batteries with unprotected terminals)

1. Large numbers of used batteries, of many different types, are collected in large containers that do not adequately prevent damage to the batteries or prevent their release during transportation.
2. Outer packages are not marked and labeled as required to indicate that they contain batteries; the shipments are not described as

hipping documents.

revent a short circuit, such as ***separating the e in a separate plastic "baggie" or taping the***

have directly led to a November 2006 incident in ible lead acid batteries caused a fire that completely he batteries.

dditional parcel carrier delivery truck fires. These ly 2008. Both of these incidents involved batteries

truck fire in Jackson, MI)

f the requirements that apply to ground shipments of These requirements also apply to shipments of batteries from battery manufacturers, equipment manufacturers, distributors and retail sales outlets. While additional requirements apply to air shipment of batteries PHMSA is not aware of used batteries being shipped by air.

Battery Recycling Advisory Letter 2

quirements in the HMR because they have two types or other materials contained in the battery, and he battery.

d for transportation in a manner that prevents short attery or ieved by nclosed

ing the other e package d shifting

lithium-

rials, and § 173.185. n" sized ed by s in § 8 and 189.

(Individually packaged batteries to prevent short circuits)

ries containing electrolyte acid or alkaline battery azardous materials, and are subject to requirements ows for reduced requirements when the batteries nselves (*i.e.*, no other hazardous materials on the

are "Division 4.3" dangerous when wet hazardous e requirements in § 173.189.

tassium hydroxide solid are class 8 corrosive ubject to requirements in 49 C.F.R. § 173.213.

mmon household type alkaline batteries. kel cadmium (NiCad), nickel metal hydride es. These "dry" batteries unless specifically e Hazardous Material Table (HMT) are not subject in conformance with § 172.102 Special Provision ey are to be securely packaged to prevent the d protect against short circuits. Insulating the urely packaging the batteries is an effective means

Battery Recycling Advisory Letter 3

ry 14, 2009, PHMSA published a Final Rule in the Federal Register under HM-215J and HM-224D titled "Revision to Requirements for the Transportation es and Battery-Powered Devices; and Harmonization with the United Nations ndations, International Maritime Dangerous Goods Code, and International ation Organization's Technical Instructions".

specified in §§ 171.14, 171.25, 172.102,172.448, and 178.703 as amended, e with the amendments adopted in this final rule will be required beginning , 2010, with a voluntary compliance date of January 1, 2009.

rule:

equires reporting of incidents involving batteries and battery-powered devices at result in a fire, violent rupture, explosion, or dangerous evolution of heat. mediate notice is limited to air transport of batteries and battery-powered vices.

larifies the requirement that batteries and battery-powered devices and vehicles offered for transportation and transported in a manner that prevents short-rcuiting, the potential of a dangerous evolution of heat, damage to terminals, d, in the case of transportation by aircraft, unintentional activation.

cludes several examples of packaging methods that meet the requirement to be cked in a manner that prevents short circuits.

November 2006 truck fire in Galesburg, IL.)

DOT encourages and supports the safe recycling and disposal of used batteries. However, we take an aggressive approach to swiftly investigate and enforce the safety requirements in the HMR for complaints and transportation incidents such as the parcel carrier delivery truck battery incident in November 2006.

ecycling Advisory Letter 4

Persons who violate the HMR may be subject to significant civil penalties and criminal fines and imprisonment. The maximum penalties depend on several factors, including the nature and circumstances, extent and gravity, and severity of the consequences of the violation, but can range up to $100,000 for a civil penalty and $500,000 and ten years in jail for a criminal penalty. In a recent enforcement case, PHMSA assessed a total civil penalty of $360,000 for multiple violations of the HMR relating to the improper shipment of used batteries for recycling or disposal.

More detailed information on the requirements in the HMR governing the shipment of batteries and additional guidance are available on DOT's Hazmat Safety web site: http://www.phmsa.dot.gov/hazmat. The HMR are also accessible through our website, and you can obtain answers to specific questions from the Hazardous Materials Information Center at 1-800-467-4922 (in Washington, DC, call 202-366-4488).

Sincerely,

forcement

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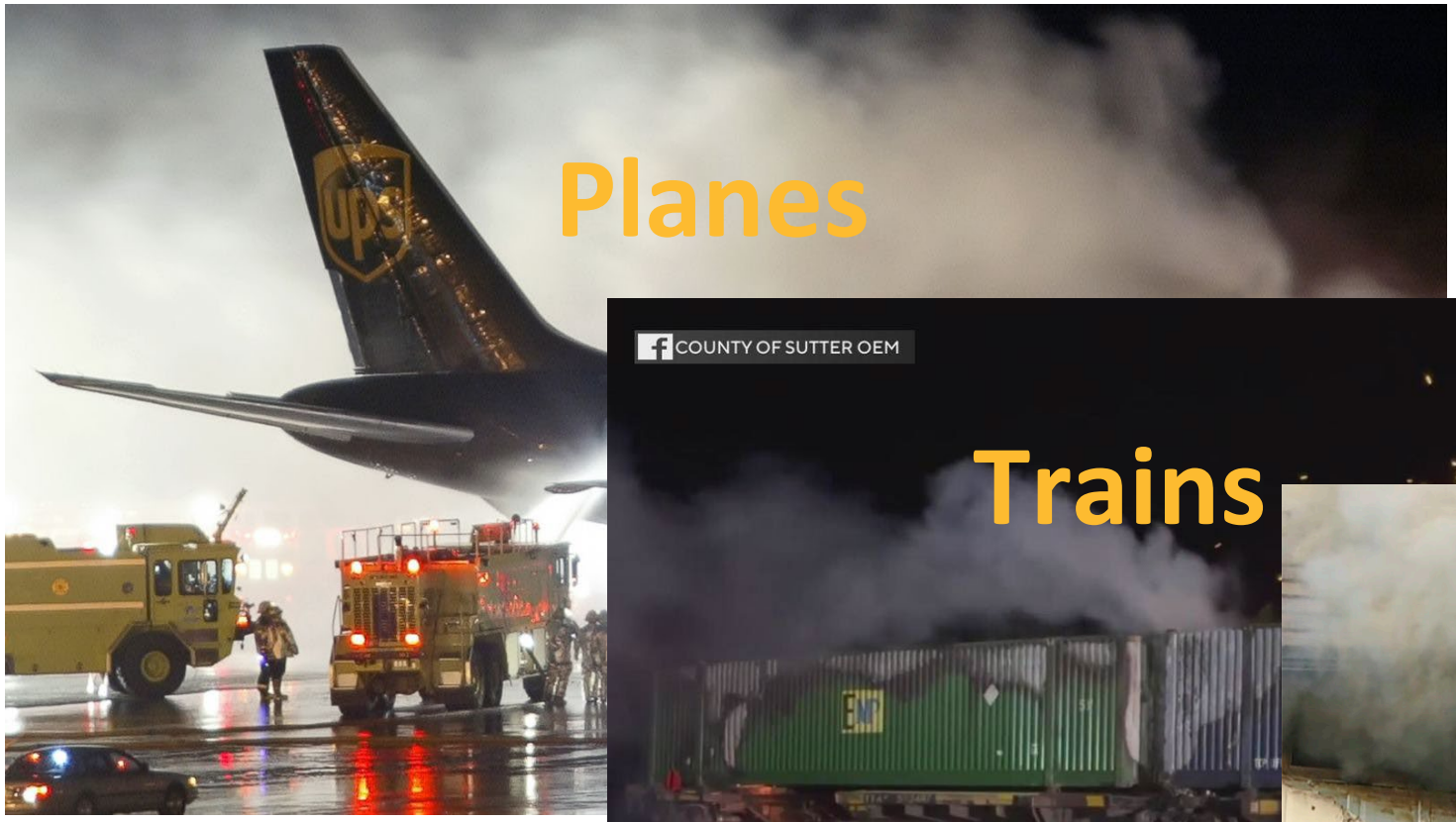

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Increases in Incidents

News 6 WKMG · 7d

'It scares the daylights out of me:' Florida's top firefighter fears more lithium-ion battery fires

> Batteries = > Incidents

- Employee injuries
- Property damage
- Environmental harm
- Harm to reputation
- Public/community scrutiny

AMNY on MSN · 2d

Lithium-ion battery explodes in Brooklyn apartment, destroying asylum-seeker's ...

yahoo!news · 15h

Lithium-ion battery fires are a growing public safety concern – here's how to reduce the risk

In June 2023, a fire started at this e-bike shop in New York City and spread to upper...

Prevention Concepts and Requirements

- Training
- Packaging
- Storage
- Inspections
- Monitoring
- Prevention
- Planning

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Training

- General Safety
  - Fire safety – evacuation routes
  - Hazardous Material Handling – first aid
- OSHA
  - Hazard Communication
  - PPE
  - Electrical safety
- DOT
  - Hazmat Employee
  - Function specific training
  - Security awareness

Training

A hazmat employee is a person who is employed by a hazmat employer and who directly affects hazardous materials transportation.

Members of the public or untrained employees often initiate the management of discarded lithium batteries

- E-waste Handlers
- Retain vendors
- Automotive scrap yards
- The public
- MRF's

When untrained personnel or members of the public prepare batteries for transportation or recycling without proper training and knowledge of the basic safety risks, the results may be catastrophic.

Lithium-Ion Battery Packaging

- All Lithium batteries must be protected from short circuit and movement during transportation.
- Specific markings unique to lithium battery packages are required by regulations.
- Specific packagings unique to the type and size of the batteries are required when being offered for transportation.
- Batteries being shipped for recycling or disposal have unique packaging requirements.
- Damaged batteries have unique packaging requirements.

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Lithium Cells and Batteries Shipped for Disposal or Recycling

CFR 49 173.185 (d)

- A lithium cell or battery, including a lithium cell or battery contained in equipment, that is transported by motor vehicle to a permitted storage facility or disposal site, or for purposes of recycling, is excepted* from the testing and record keeping requirements of 172.185 (a) and the specification packaging requirements of 173.185 (b)(3), **when packed in a strong outer packaging (SOP) conforming to the requirements of § 173.24 and 173.24a.**

- Strong outer packaging means the **outermost enclosure that provides protection against the unintentional release of its contents.** It is a packaging that is sturdy, durable, and constructed so that it will retain its contents under normal conditions of transportation.

Damaged and Defective (DDR) Lithium Batteries

173.185 (f)

- Batteries must be **individually** packaged in non-metallic inner packaging that completely encloses the battery
- Inner packaging surrounded by non-combustible, non-conductive, and absorbent cushioning material
- Single inner packaging must be placed in performance-oriented packaging at the Packing Group I performance level I
- If you are using a package with a special permit, you MUST follow the packaging manufacturer's instructions EXACTLY, including the use of any specific packaging components specified (e.g., cushioning, tape)

Damaged and Defective (DDR) Lithium Batteries

"Lithium cells or batteries that have been damaged or identified by the manufacturer as being defective for safety reasons, that have the potential of producing a dangerous evolution of heat, fire, or short circuit (e.g., those being returned to the manufacturer for safety reasons)" are **FULLY REGULATED**.

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Markings and Labels

49 173.185 CFR 172.447

LITHIUM METAL BATTERIES FORBIDDEN FOR TRANSPORT ABROAD PASSENGER AIRCRAFT

LITHIUM-ION BATTERIES FORBIDDEN FOR TRANSPORT ABROAD AIRCRAFT AND VESSEL

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Markings and Labels

Markings contain specific information about the origins, safety information and content of a package. Without proper markings first, responders may be hindered in their efforts

Labels communicate the specific hazards of the content of a hazardous materials package. Without class 9 labels specific to lithium batteries, shipments may not be properly classified or stowed.

Storage Concepts

- Limit fuel density
- Bunkers
- Metal Storage containers
- Segregate by distance
- Isolate/insulate connectors
- Deluge systems
- Smoke and heat sensors

Inspections

- An effective inspection program.
  - Clear objectives
  - Comprehensive list of inspection points
  - Trained Inspector
  - Standard Procedures
  - Use of technology
  - Clear reporting and documentations

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Monitoring

- Detection systems
  - Smoke detectors
  - Heat sensors
  - Surveillance systems

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Prevention

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What if things go wrong?

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Planning

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Planning

- Emergency Response and Preparedness
  - Contingency Plans
  - Business Emergency Plans
  - Evacuation Routes
- Response Teams
  - Emergency Coordinator
  - Training
  - Practice Drills
- Response Contractors
  - Interview and Contract

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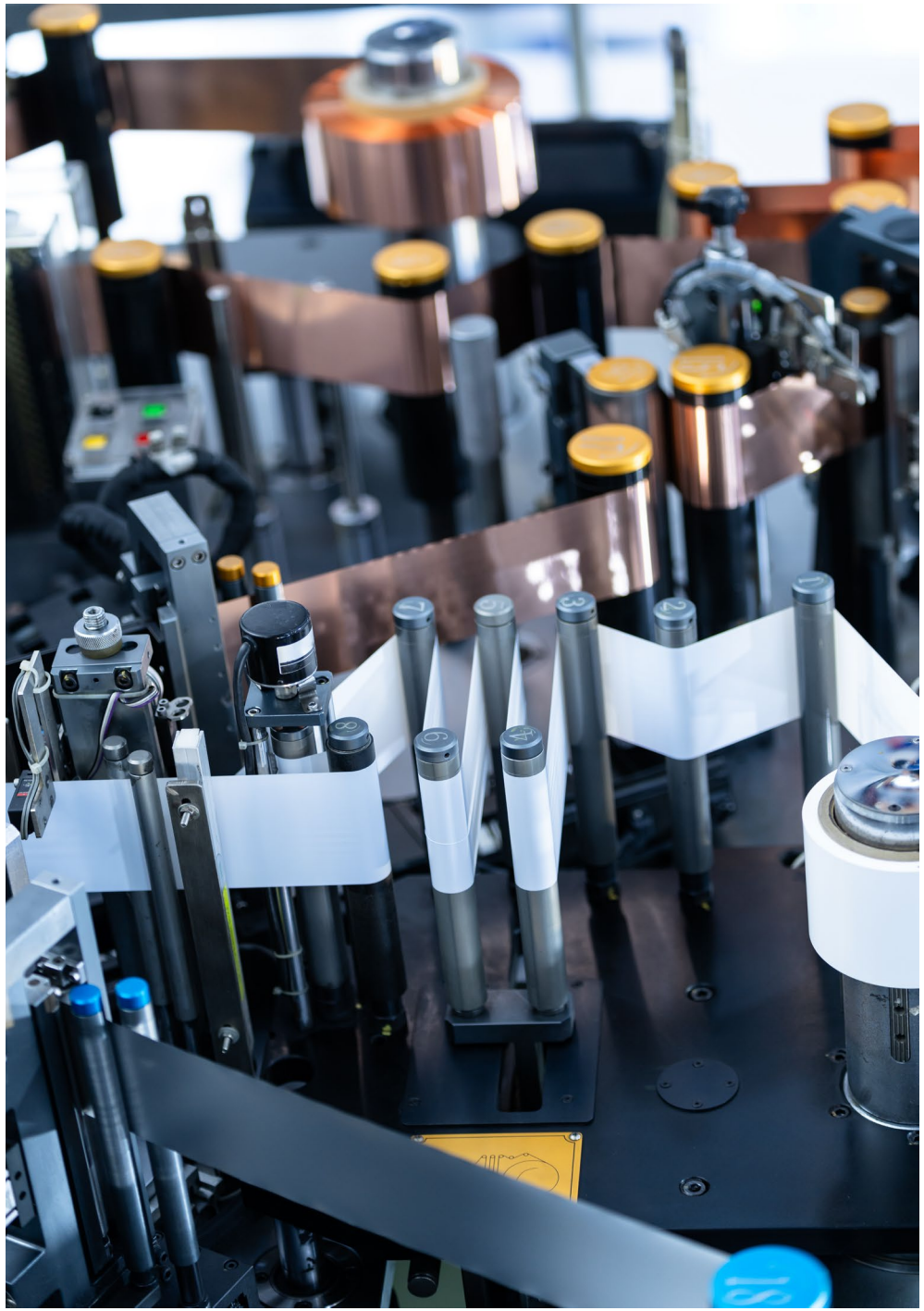
Planning

- Risk Management
  - Contingency Plans
  - BCP
- Modeling
  - OCA
  - Understanding the potential



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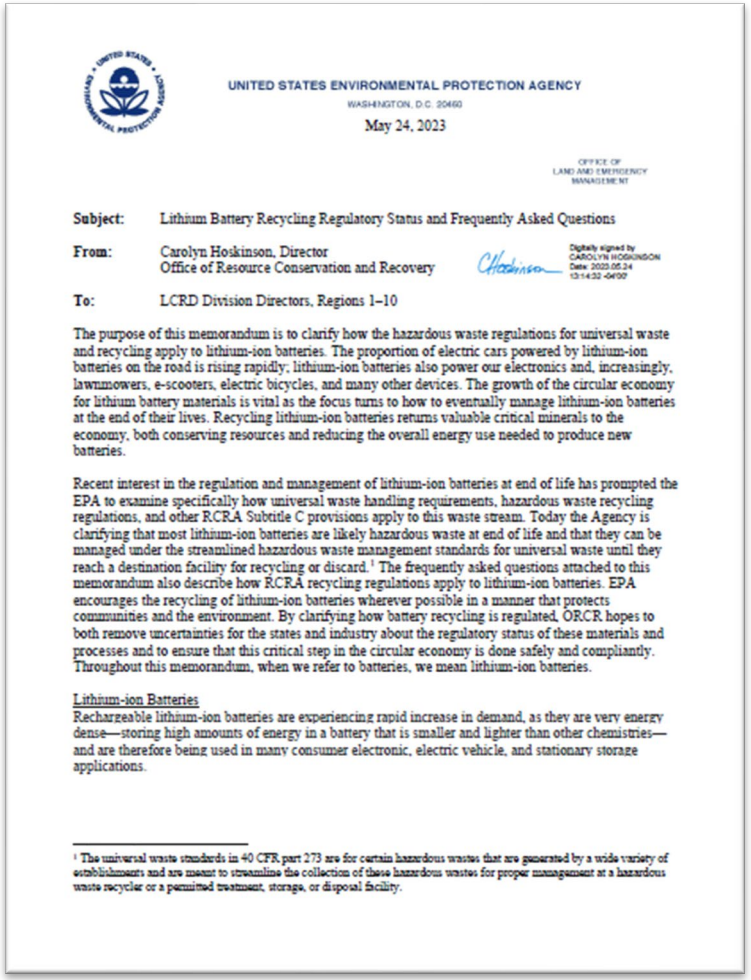
Best Management Practices

- Learn and comply with all federal, state, and local requirements.
- Take every precaution to prevent thermal runaway and fires.
- Insulate and isolate the terminals of the batteries with non-conductive tape, plastic bags, or other separation techniques;
- Mark and label packages and storage areas;
- Preventing damage to batteries;
- Develop written compliance programs;
  - Packaging and storage guidelines
  - Establish approved storage locations
  - Employee training
  - Periodic auditing, visual and thermal inspections of storage areas

Resources and Services are Available



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

May 24, 2023

OFFICE OF
LAND AND EMERGENCY
MANAGEMENT

Subject: Lithium Battery Recycling Regulatory Status and Frequently Asked Questions

From: Carolyn Hoskinson, Director
Office of Resource Conservation and Recovery

Digitally signed by CAROLYN HOSKINSON
Date: 2023.05.24 13:14:32 -04'00'

To: LCRD Division Directors, Regions 1–10

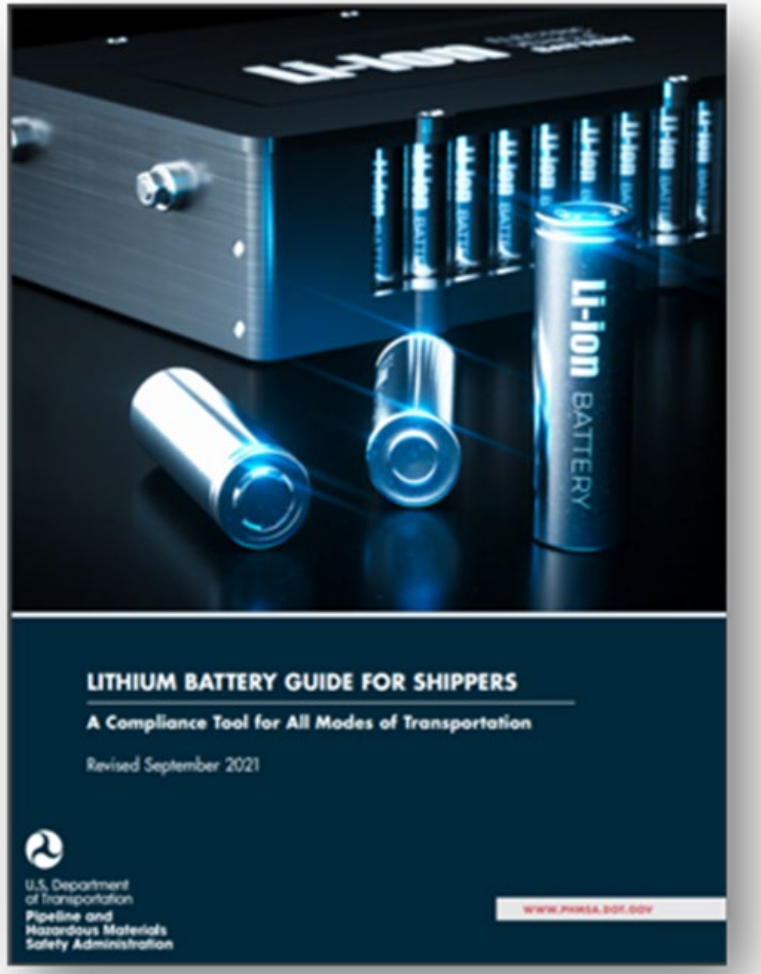
The purpose of this memorandum is to clarify how the hazardous waste regulations for universal waste and recycling apply to lithium-ion batteries. The proportion of electric cars powered by lithium-ion batteries on the road is rising rapidly; lithium-ion batteries also power our electronics and, increasingly, lawnmowers, e-scooters, electric bicycles, and many other devices. The growth of the circular economy for lithium battery materials is vital as the focus turns to how to eventually manage lithium-ion batteries at the end of their lives. Recycling lithium-ion batteries returns valuable critical minerals to the economy, both conserving resources and reducing the overall energy use needed to produce new batteries.

Recent interest in the regulation and management of lithium-ion batteries at end of life has prompted the EPA to examine specifically how universal waste handling requirements, hazardous waste recycling regulations, and other RCRA Subtitle C provisions apply to this waste stream. Today the Agency is clarifying that most lithium-ion batteries are likely hazardous waste at end of life and that they can be managed under the streamlined hazardous waste management standards for universal waste until they reach a destination facility for recycling or discard.[1] The frequently asked questions attached to this memorandum also describe how RCRA recycling regulations apply to lithium-ion batteries. EPA encourages the recycling of lithium-ion batteries wherever possible in a manner that protects communities and the environment. By clarifying how battery recycling is regulated, ORCR hopes to both remove uncertainties for the states and industry about the regulatory status of these materials and processes and to ensure that this critical step in the circular economy is done safely and compliantly. Throughout this memorandum, when we refer to batteries, we mean lithium-ion batteries.

Lithium-ion Batteries

Rechargeable lithium-ion batteries are experiencing rapid increase in demand, as they are very energy dense—storing high amounts of energy in a battery that is smaller and lighter than other chemistries—and are therefore being used in many consumer electronic, electric vehicle, and stationary storage applications.

[1] The universal waste standards in 40 CFR part 273 are for certain hazardous wastes that are generated by a wide variety of establishments and are meant to streamline the collection of these hazardous wastes for proper management at a hazardous waste recycler or a permitted treatment, storage, or disposal facility.



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Questions or Comments?

Contact Information:

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www.all4inc.com