Lithium-ion Batteries: Shipping & Emergency Response

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Why Lithium Batteries?

- High energy densities
- Potential short circuiting leading to thermal runaway
- Flammable electrolyte, off-gassing
- Past recycling-related, landfill incidents
  - 245 at waste facilities between 2013-2020 (EPA)
- Expected exponential increases volumes

Today's Agenda

- **Part I**: Lithium Battery Incidents
- **Part II**: DOT/PHMSA Lithium Battery Shipping Regulations
- **Part III**: Emergency Response & Other Resources

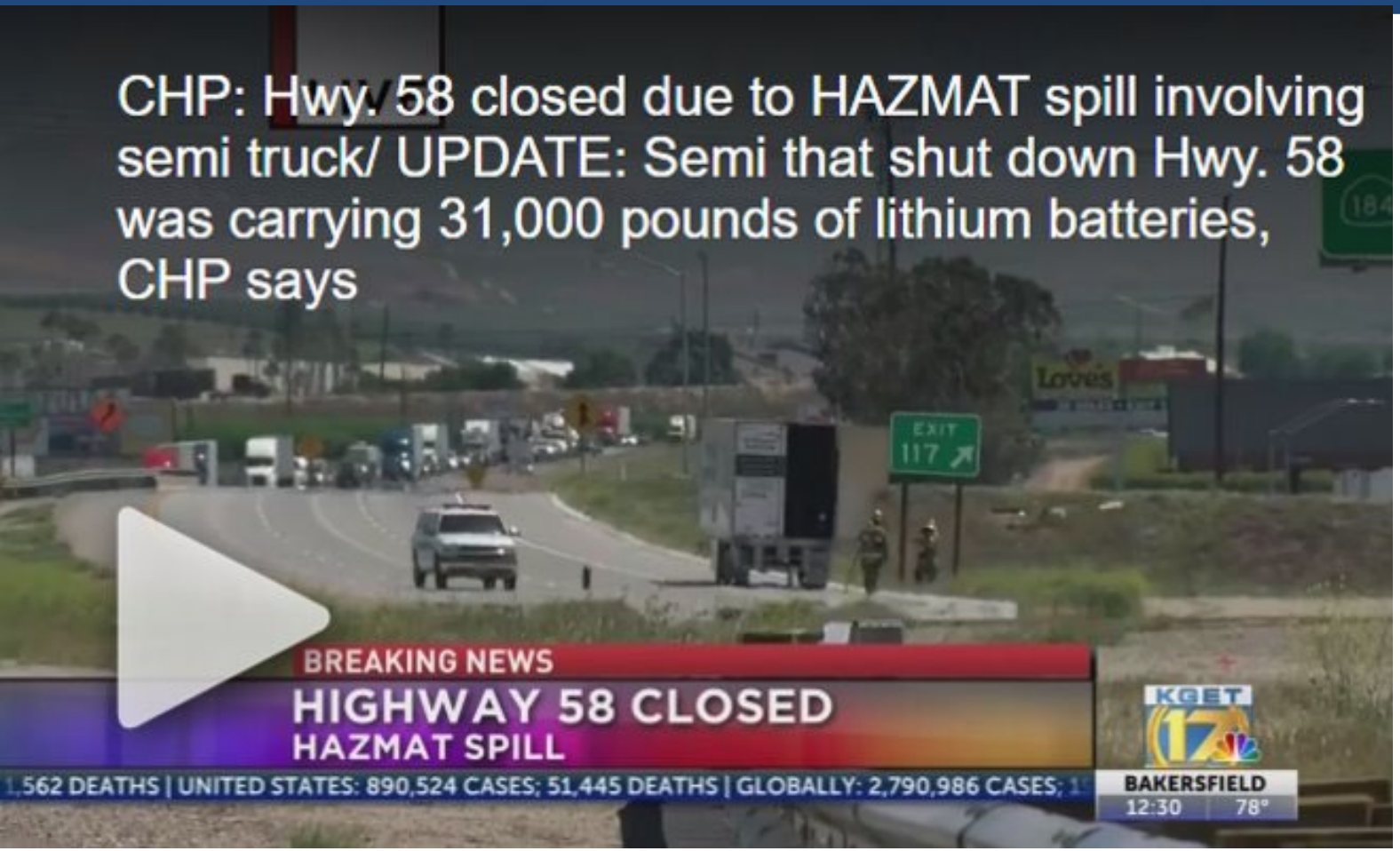
Part I:
Lithium Battery Incidents

Houston TX – April 23, 2017

Shipping container exploded while in transportation by rail.

No warning or indication that lithium batteries were involved.

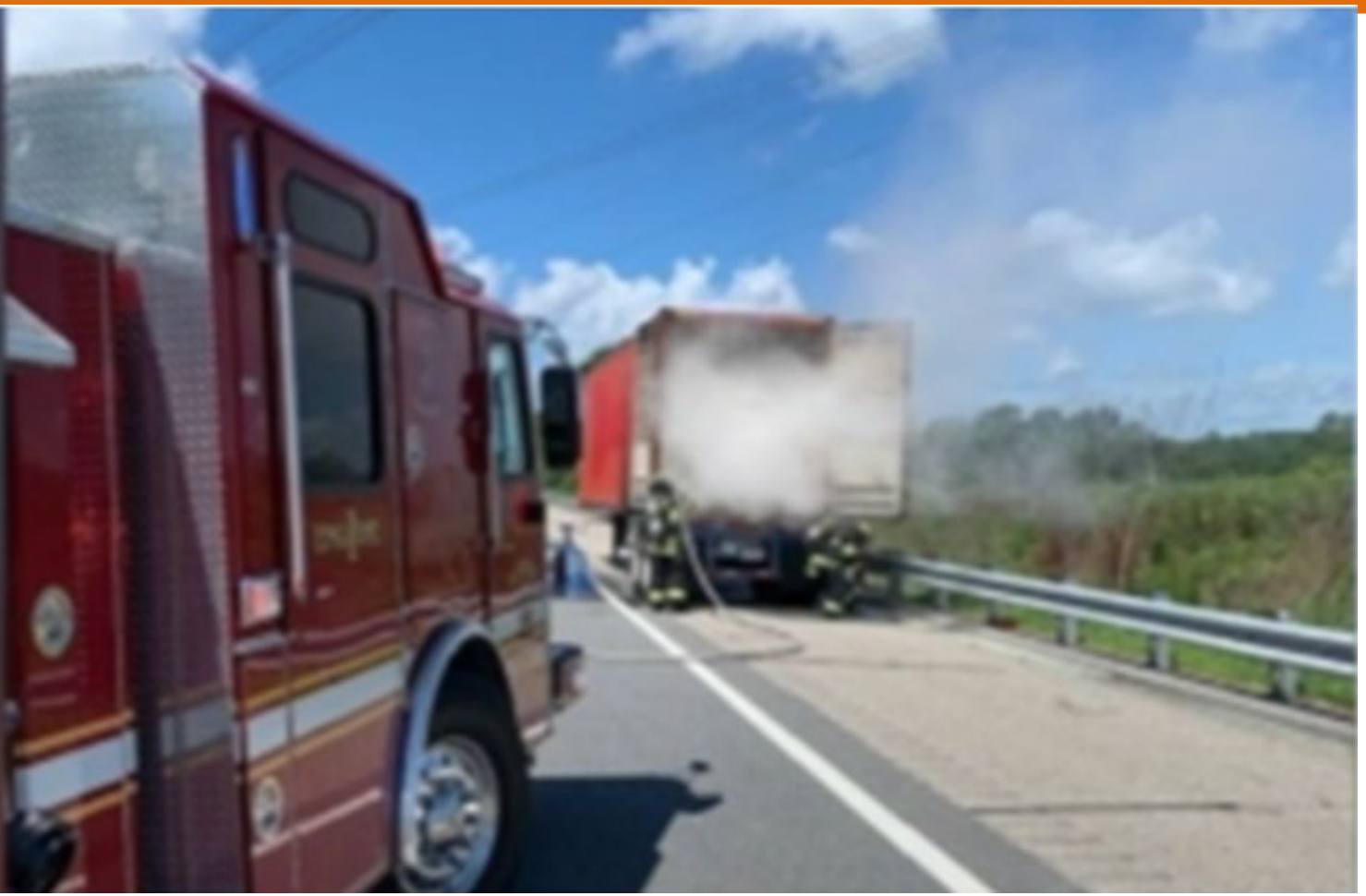
Bakersfield, CA – April 27, 2020



One Shipment

Two incidents

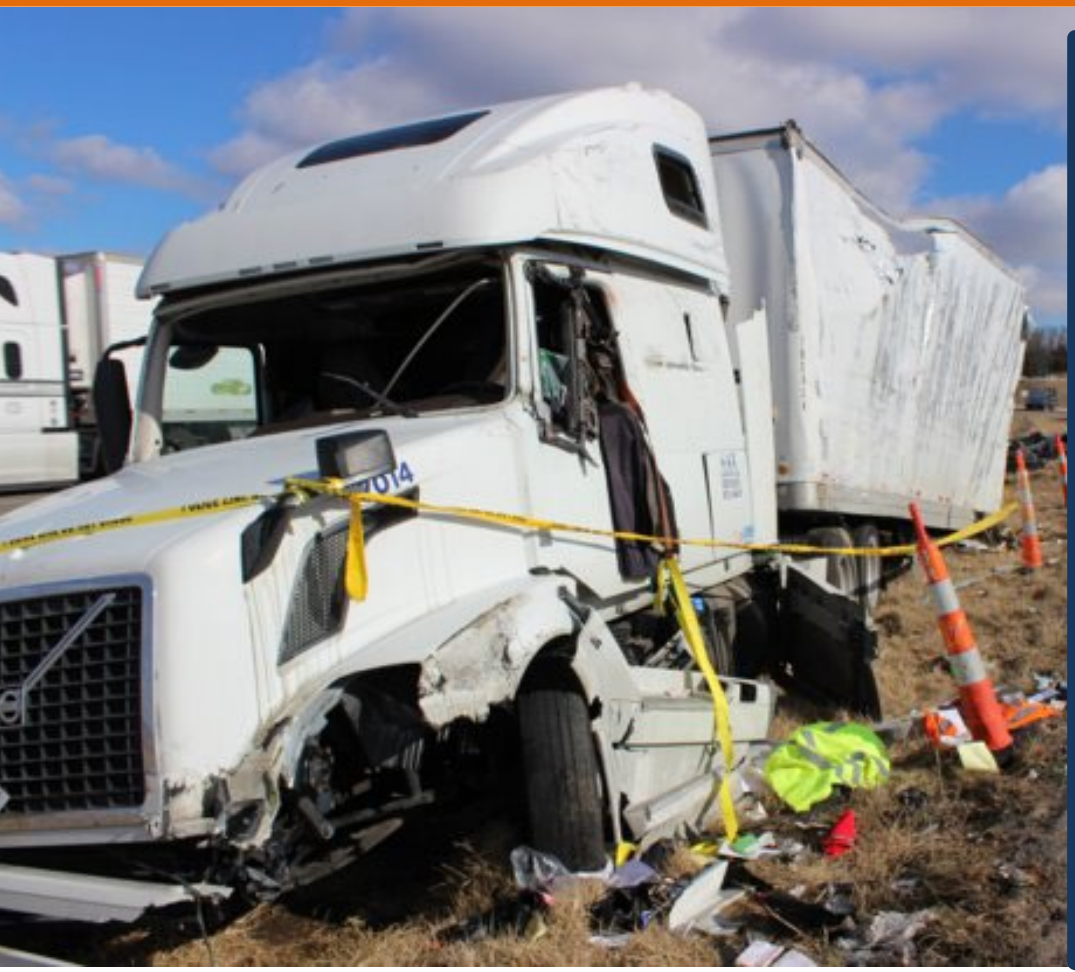
Suffolk, VA – August 19, 2021



Ground shipment headed to a port

Suffolk, VA – August 19, 2021

Rolla, MO – January 27, 2022



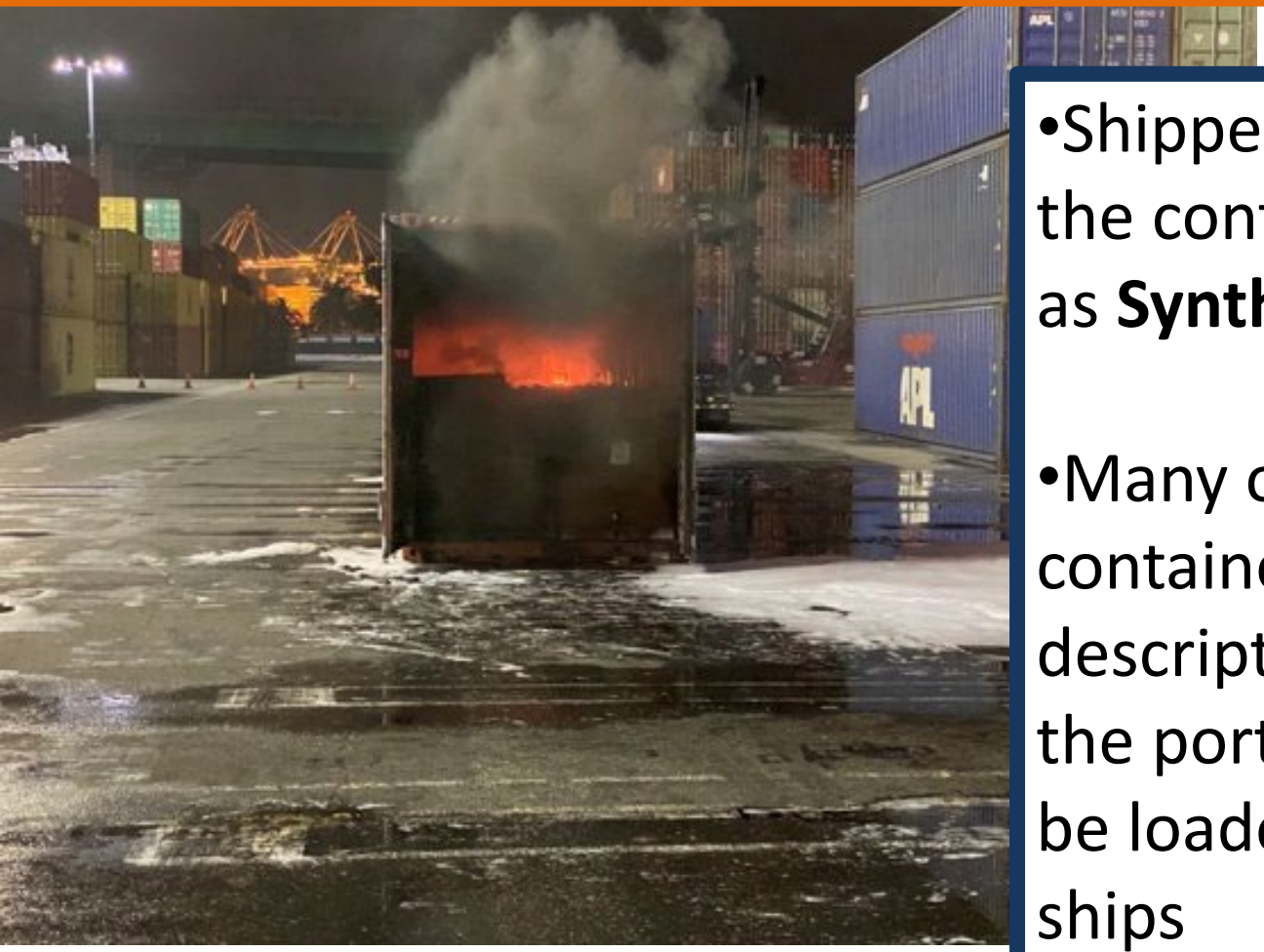
A trailer load of new Chevy Bolt batteries got involved in a traffic accident on its way to Oklahoma. Packaging may have played a role in keeping this incident becoming much worse than it was.

Rolla, MO – January 27, 2022

San Antonio, TX – February 10, 2022

Use of black shrink-wrap made it difficult to see damage that impacted the cellphones/batteries in the packages.

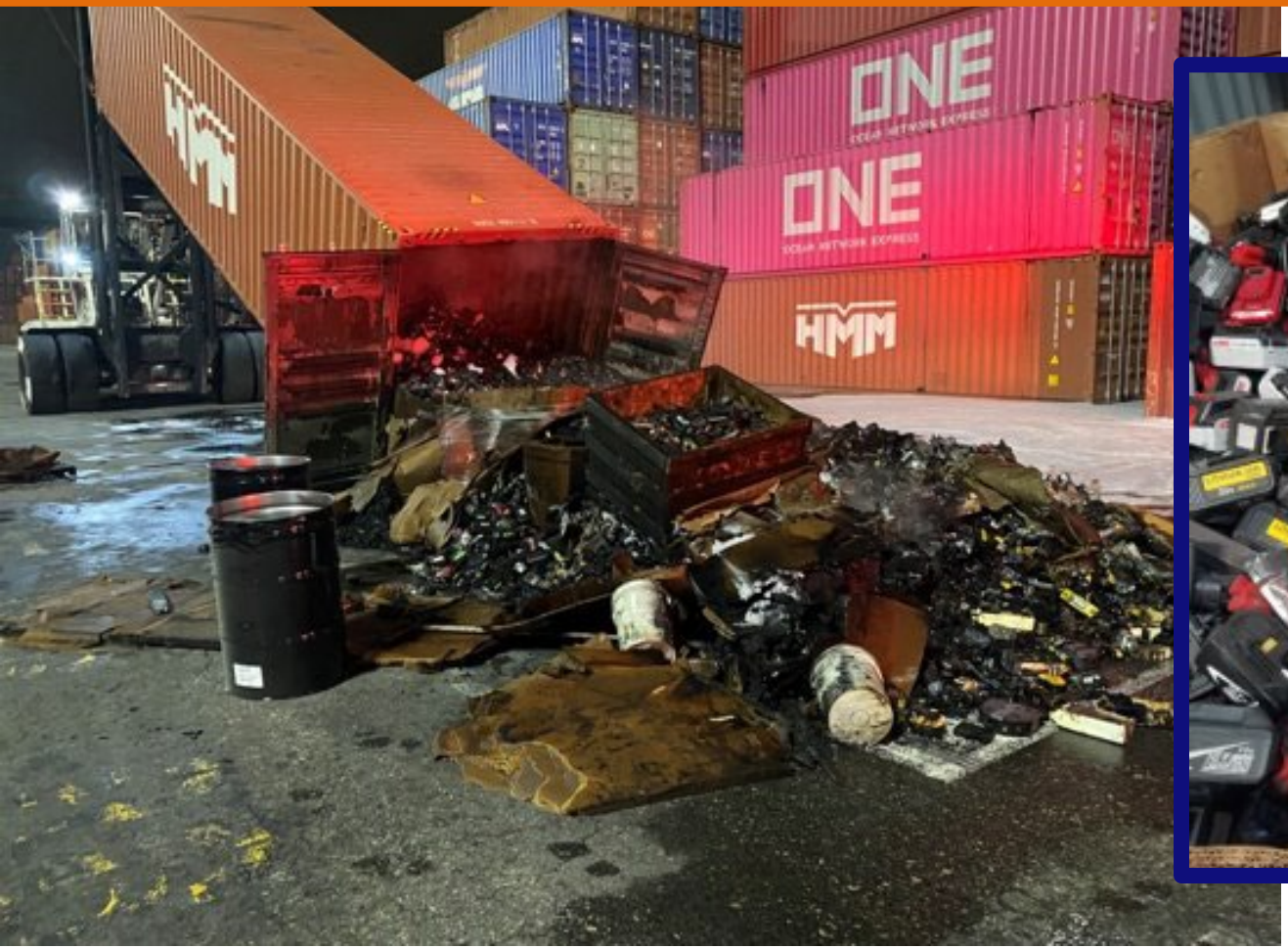
Port – L.A. Long Beach – March 4, 2022



- Shipper described the contents as **Synthetic Resins N.O.S.**

- Many other containers with the same description were found in the port waiting to be loaded and onboard ships

Port – L.A. Long Beach – March 4, 2022

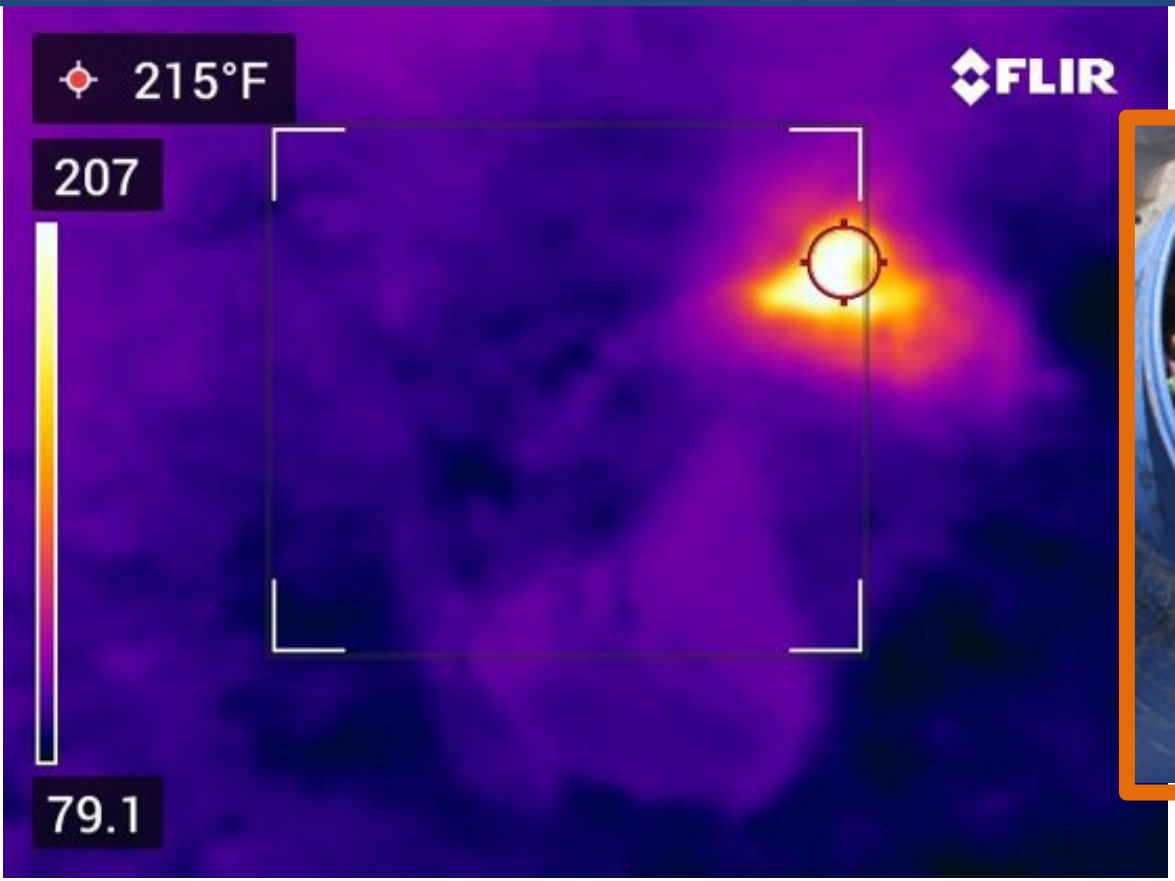


Port – L.A. Long Beach – March 4, 2022

Container of undeclared li batteries involved associated with the previous container contains laptop batteries.

International Import Shipment
Madison, IL – August 10, 2022

International Import Shipment
Madison, IL – August 10, 2022



Hurricanes – September 28, 2022

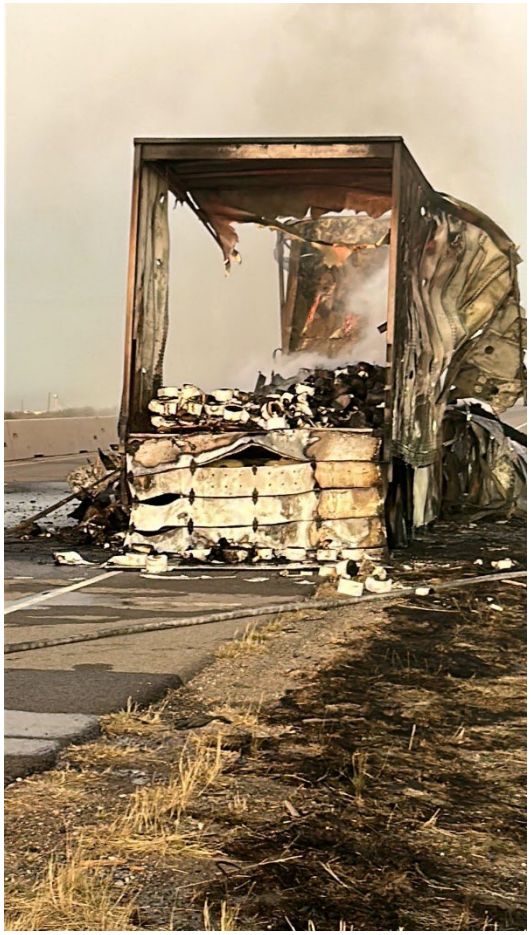
Hundreds of EV's and thousands of devices exposed to sea water and other forces associated with hurricanes.

Photos provided by Sanibel Fire Department

Hurricanes – September 28, 2022

Photos provided by Sanibel Fire Department

Monahan, TX – February 23, 2023



Birmingham, AL– March 31, 2023

Dutch Harbor, AK– January 2024

Dutch Harbor, AK– January 2024

Highpoint, WA – July 9, 2024

Highpoint, WA – July 9, 2024

Highpoint, WA – July 9, 2024

San Bernardino, CA – July 26, 2024

Review

- Poor handling in use, collection and storage at end-of-life
- Poor handling and packaging methods in transportation
- Frustrated shipping is occurring because there is no way to see damage outside of clear physical evidence.
- End of life battery handling by industry is inconsistent.

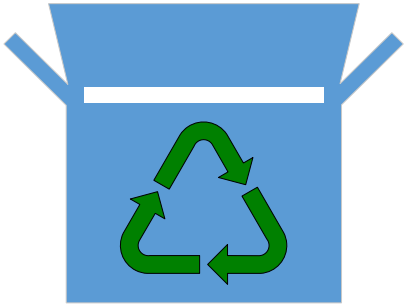
Part II:
DOT/PHMSA Lithium Battery Shipping Regulations

DOT in the Supply Chain

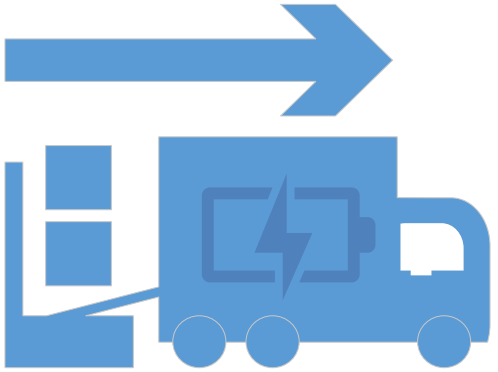
Oversight Over the Transportation Process

Identification and Classification (collection/ sorting)

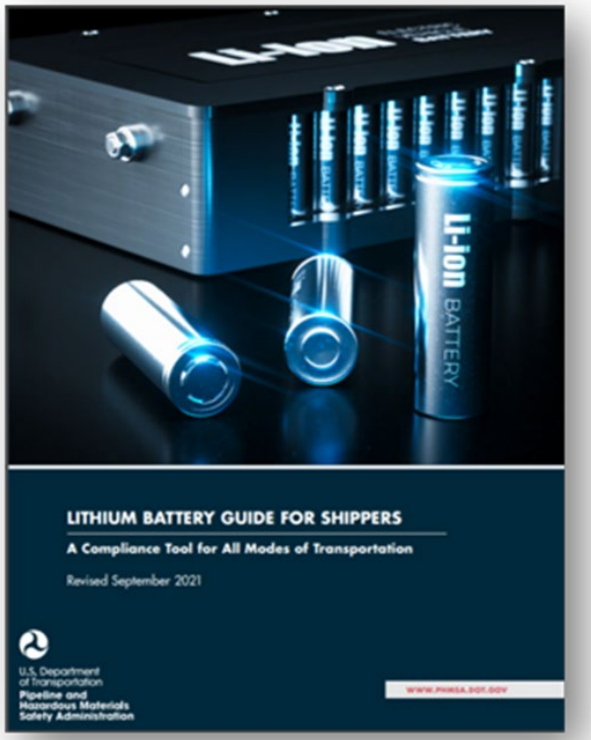
Packaging and Hazard Communication



Movement



Lithium Battery Guide for Shippers



https://www.phmsa.dot.gov/training/hazmat/lithium-battery-guide-shippers

Section 173.185 of the HMR

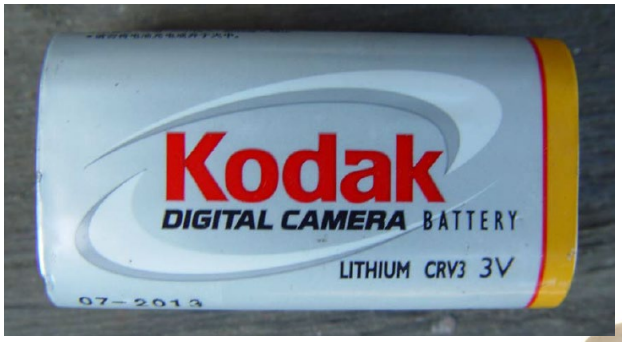
- Code of Federal Regulations Title 49, Section 173.185 addresses requirements for lithium batteries, including the exceptions for recycling lithium batteries:

1. Classification/ UN 38.3 Testing Paragraph (a)	2. Packaging Paragraph (b)	3. "Small" battery exceptions Paragraph (c)
4. Disposal/ Recycling Exceptions Paragraph (d)	5. Damaged, Defective, Recalled (DDR) Requirements Paragraph (f)	

Classification: Type of Lithium Batteries

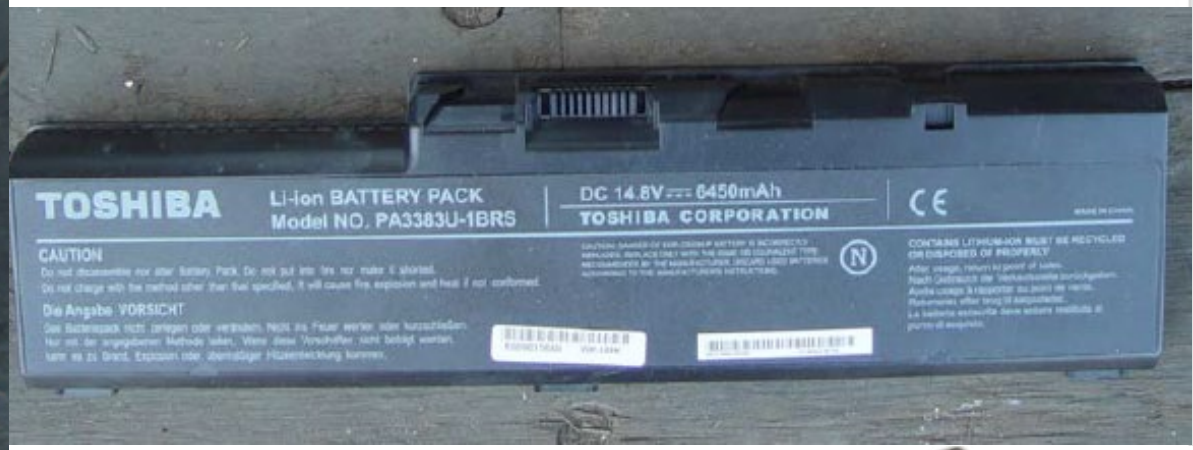
- Lithium Metal (primary)
  - Generally not rechargeable (single-use)
  - Metallic lithium or alloy
  - Size measured in grams
  - Typical configurations : coin cell, cylindrical, and rectangular
  - Examples: watches, thermometers
- Lithium Ion (secondary)
  - Generally rechargeable
  - Lithium compound
  - Size measured in Watt-hours (Wh)
  - Typical configurations: cylindrical, rectangular, and pouch packs
  - Examples: laptops, tablets, cell phones, power tools

Lithium Metal



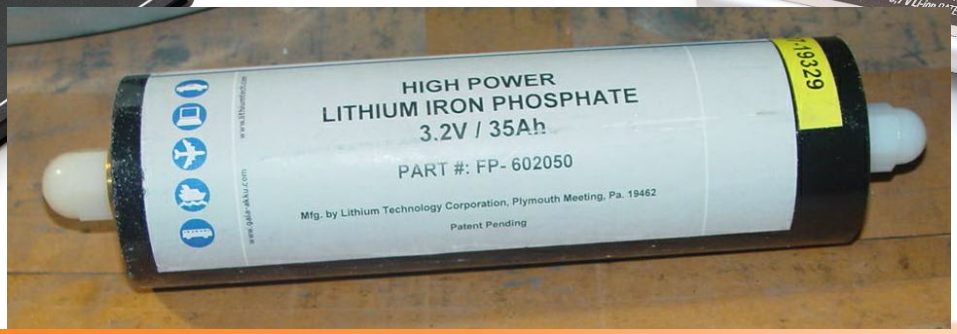
Lithium Ion


MOTOROLA
3.6V LITHIUM ION BATTERY
BATTERIE AU LITHIUM ION 3.6V
BATERIA DE ION-LITIO DE 3.6 Vcc
BATERIA DE IONS DE LITIO DE 3.6V
3.6伏 1450 毫安时锂离子电池
NNTN4655B C6S608CTQCIC.BE
CELL ORIGIN TAIWAN FINISHED IN CHINA
20060711


TOSHIBA
Li-ion BATTERY PACK
Model NO. PA3383U-1BRS
DC 14.8V 6450mAh
TOSHIBA CORPORATION
CAUTION
Die Angabe VORSICHT


LITHIUM ION BATTERY
Li-ion 3.7V 1600mAh
Charge limit voltage: 4.2V
Standard:GB-18287-2000
Production Date: 2009.12
Attention: 1.Do not approach the fire to avoid detonation
2.Do not disassemble the battery secretly
3.Strictly prohibit short circuiting.
4.Please refer to the user handbook when the battery need charging.


3.7V Li-ion BATTERY 3.7V Li-ion BATTERIE 2.96Wh
3.7V Li-ion BATERIA 3.7V Li-ion BATERIA 2.96Wh
361-00044-00
Rechargeable Li-ion Battery
Output: 3.7 V 1150 mAh 4.255 Whr


HIGH POWER
LITHIUM IRON PHOSPHATE
3.2V / 35Ah
PART #: FP- 602050
Mfg. by Lithium Technology Corporation, Plymouth Meeting, Pa. 19462
Patent Pending

Classification: UN ID Numbers

UN3480	• Lithium Ion Batteries
UN3481	• Lithium Ion Batteries Contained in/Packed with Equipment
UN3090	• Lithium Metal Batteries
UN3091	• Lithium Metal Batteries Contained in/Packed with Equipment

Classification: UN ID Numbers

UN3171	• Battery-Powered Vehicle
UN3536	• Lithium batteries installed in cargo transport unit

Classification: Energy Capacity

- The energy capacity of the lithium battery is an important consideration – larger batteries and quantities are subject to increased regulation. Thresholds:

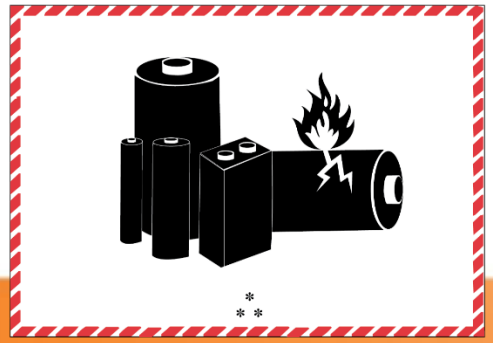
Lithium Ion (Smaller Batteries)	Lithium Metal (Smaller Batteries)
• ≤ 100 Wh • ≤ 300 Wh ground only*	• ≤ 2 g • ≤ 25 g ground only*

* Additional hazard communication is required

Small Battery Exception

- Must meet thresholds
- Excepted from general hazard communication, training, emergency response contact info requirements

- Marking requirements: based on size, mode, whether packed with/contained in equipment



- **Packaging (performance-based)**
  - Prevent short circuits
  - Prevent damage caused by shifting
  - Prevent accidental activation
  - Prevent release of contents
  - Packaging requirements are performance-based

- **Basic configuration**:
  - Inner packaging
  - Cushioning material
  - Strong outer packaging

49 CFR § 173.185(b)(1)–(3)/(c)

Inner Packaging

Cushioning Material

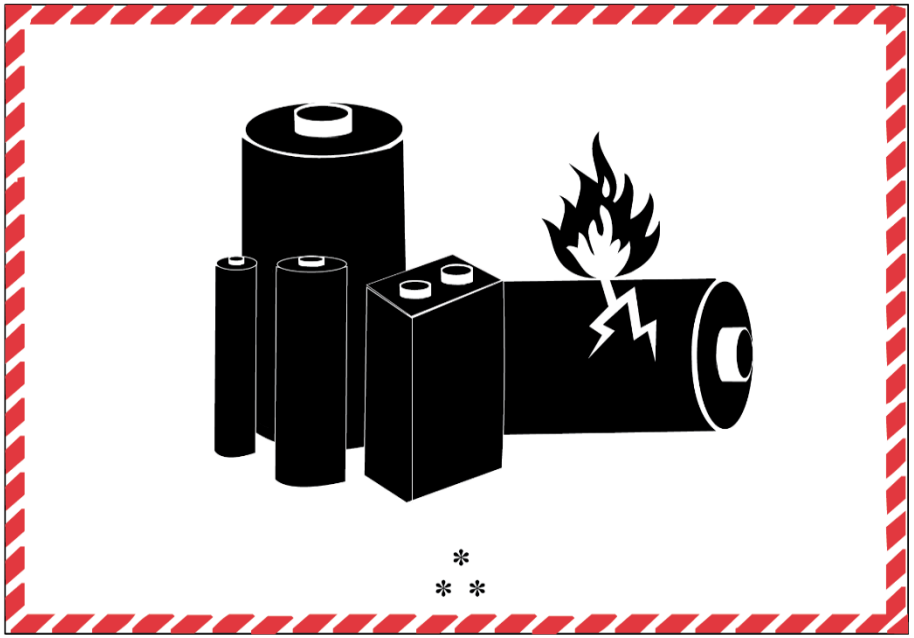
- Non-conductive
- Non-reactive
- Prevent movement

Outer Packaging

- Rigid, strong outer packaging
- Sturdy, durable, retain contents
- Meet 1.2 m drop test

Lithium Battery Handling Mark

- "*" = the applicable UN ID number(s)
- "**" = telephone number for information about the shipment*



120mm width (~4.8 inches)/110mm height (~4.3 inches); May be reduced to 105mm width (~4.1 inches) / 74mm height (~2.9 inches) should the package be too small for the larger mark

*HM-215Q: removing, current mark authorized until Dec. 31, 2026

Larger Batteries and Quantities

Increased Regulation

- Batteries over 300 Wh rating (Lithium Ion) or 25 g (Lithium Metal)
- Packages over 66 lbs gross weight

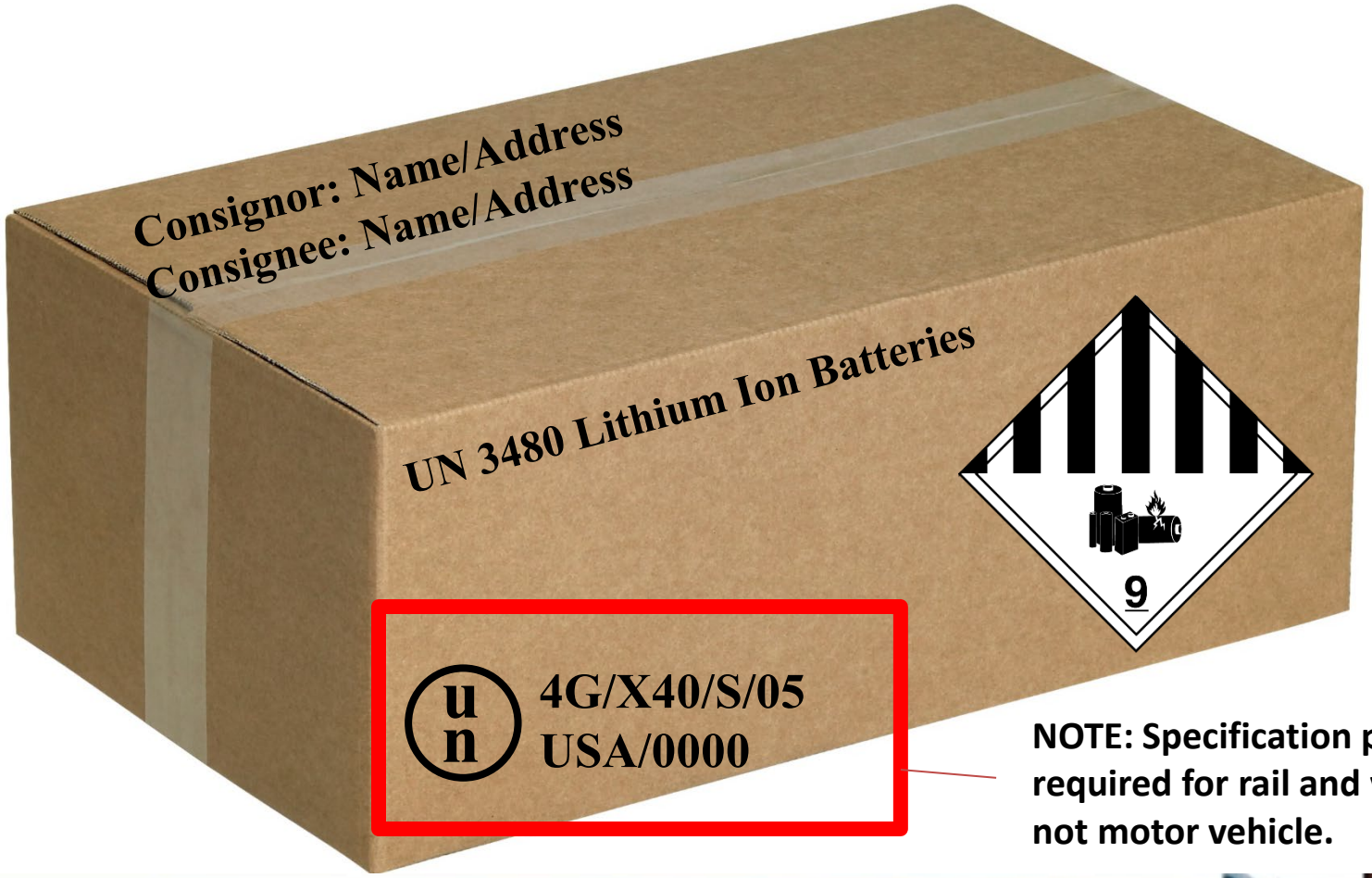
Shipping Papers

Emergency Response Information

Marks

Labels

Larger Batteries and Quantities



NOTE: Specification package required for rail and vessel – not motor vehicle.

Electric Vehicle or Electric Storage Batteries

Alternative packaging

- Batteries that weigh over 12 kg (26.5 lbs)
- Must have strong, impact-resistant outer casing

Not permitted for passenger aircraft (Cargo Aircraft requires Approval by AA)

May be packed:

- In "strong outer packagings"
- In protective enclosures (e.g., crates)
- On pallets

49 CFR § 173.185(b)(5)
or
49 CFR § 173.185(d)

End-of-Life Lithium Batteries

49 CFR § 173.185(f)

Shipped for Disposal or Recycling

- By highway *only*
- Excepted from
  - UN 38.3 testing requirements,
  - UN specification packaging requirements (when in strong outer packaging).
- Eligible for the "smaller" cells and batteries exceptions, provided they meet size, packaging, and hazard communication conditions in § 173.185(c).
- All other requirements of the HMR apply

49 CFR § 173.185(d)

Damaged, Defective, Recalled (DDR)

- "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)"

Change in classification: **FULLY REGULATED**

49 CFR 173.185(f)

Identifying DDR

- Batteries to Look For:
  - Defective
  - Leaked or vented
  - Sustained physical or mechanical damage
  - Cannot be diagnosed (i.e., cannot say for sure they are not damaged)
- Consider:
  - Acute hazards (e.g., gas, fire, electrolyte leaking)
  - Known misuse of the battery
  - Signs of physical damage (swelling, corrosion, discoloration)
  - Damage to safety features, components, or short circuit protection

Source: 21st Revised Edition of the UN Model Regulations 3.3.1, Special Provision 376

Packaging DDR

- Batteries must be **individually** packaged as follows:
  - 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.**

DDR Hazard Communication

- Requires the same hazard communication as a larger, fully-regulated lithium battery (e.g., marks, labels, shipping paper)

- "Damaged/defective lithium ion battery" and/or "Damaged/defective lithium metal battery" as appropriate.

49 CFR 173.185(f)(4)

What are Special Permits?

- DOT special permits (SPs) are an extension of the regulations and offer alternative provisions
  - Not otherwise authorized
  - "Equivalent level of safety"
- There are three types of SPs:

Manufacture, mark, and sell (MMS) packaging	Offer	Emergency

Example DDR Kits

Disclaimer: images are examples of DOT Special Permit packaging and not an endorsement of any particular product or company

Pictured L-R: DOT-SP 20549, DOT-SP 20432, DOT-SP 20910

Part IV:
Emergency Response & Other Resources

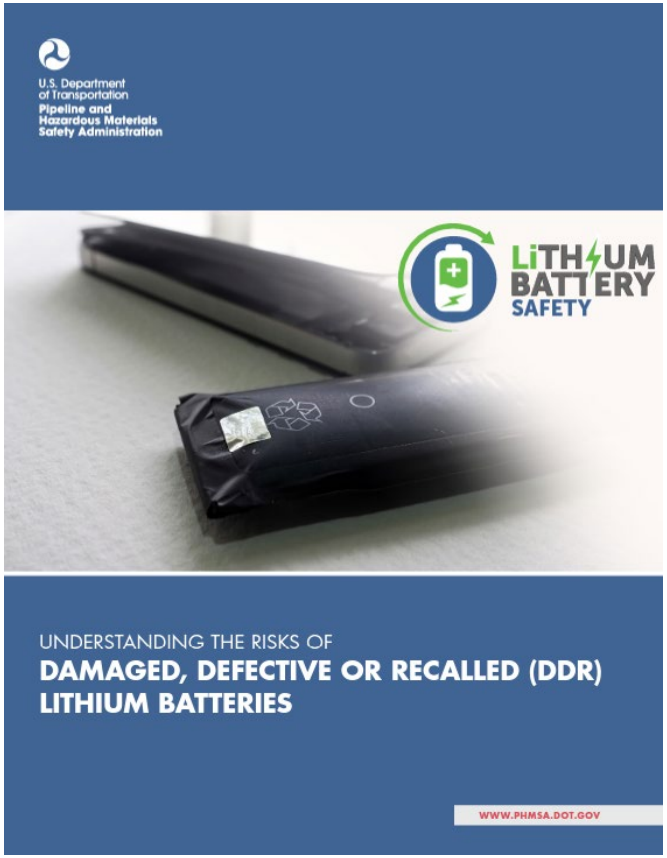
Emergency Response Guidebook (ERG) 2024

Key additions in 2024:

- Updated Guide 147 with latest recommendations for lithium battery fire response
- New “Considerations for Lithium Battery and Electric Vehicle (EV) Fires”

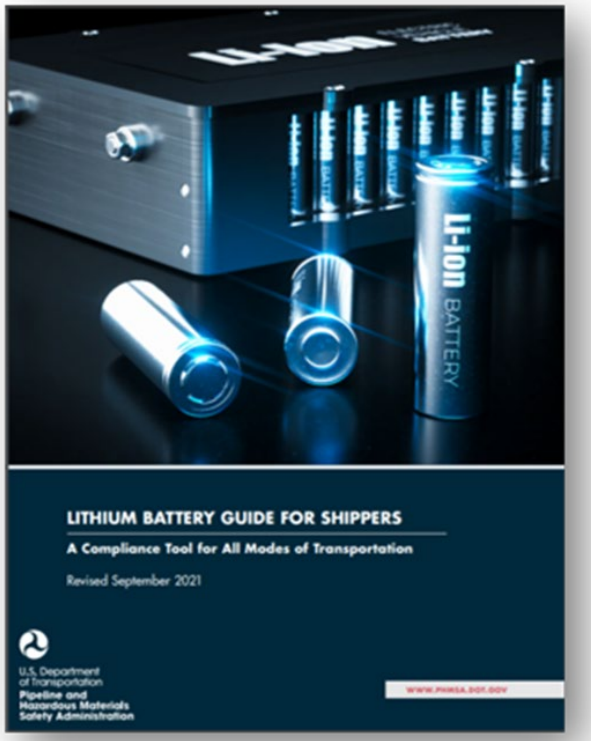
https://www.phmsa.dot.gov/training/hazmat/erg/emergency-response-guidebook-erg

Understanding the Risks of Damaged, Defective, or Recalled (DDR) Lithium Batteries



https://www.phmsa.dot.gov/training/hazmat/understanding-risks-damaged-defective-or-recalled-ddr-lithium-batteries

Lithium Battery Guide for Shippers



https://www.phmsa.dot.gov/training/hazmat/lithium-battery-guide-shippers

Hazardous Matters Newsletter

Introducing "Hazardous Matters"—the quarterly newsletter for PHMSA's Office of Hazardous Materials Safety. As always, it is packed with the latest news, expert tips, and essential insights for the safe handling and shipment of hazardous materials. Stay informed, stay safe!

HM

https://www.phmsa.dot.gov/training/hazmat/phmsas-quarterly-hazmat-newsletter

Contact Info

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- Hazardous Materials Info Center

  1-800-HMR-4922 (1-800-467-4922)

  Email: infocntr@dot.gov