Rechargeable Battery Management Challenges In Wisconsin
Trying Something Different...

WASTE AND MATERIALS MANAGEMENT STUDY GROUP
All Rechargeable Batteries: Emphasis on Lithium
Lithium Batteries and Personal Electronic Devices...
They Are Not Going Away
Ignition Sources
## Thermal Runaway Temperatures

<table>
<thead>
<tr>
<th>Specific Chemistry</th>
<th>Thermal Runaway (Temp.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>lithium nickel manganese cobalt oxide</td>
<td>410 F</td>
</tr>
<tr>
<td>lithium cobalt oxide</td>
<td>302 F</td>
</tr>
<tr>
<td>lithium manganese oxide</td>
<td>482 F</td>
</tr>
<tr>
<td>lithium iron phosphate</td>
<td>518 F</td>
</tr>
<tr>
<td>lithium nickel cobalt aluminum oxide</td>
<td>302 F</td>
</tr>
</tbody>
</table>

*Data compiled from www.batteryuniversity.com*

Ignition temperature of paper: 421 F – 481 F.

## Hi-Tech Matches

Match ➔ Kindling ➔ Logs

Is Equivalent Too

Lithium Ion Battery ➔ Paper/Dust Electrolyte ➔ Plastics/Residues
Regulation vs. Education
Waste Industry Educational Efforts

Contrasts with State Statute
Studies Do Not Provide Complete Picture
Possibly the broadest, most thorough analysis to date. But not without flaw.

**Approach:** Scoured the internet for news stories regarding damage to waste facilities due to lithium-ion batteries.

- interviewed locations
- categorized the impacts of the incidents
  * Injury
  * Service Disrupted
  * Monetary Impacts
  * Emergency Response

An Analysis of Lithium-ion Battery Fires in Waste Management and Recycling
Problems start occurring.....
As soon as the battery is discarded.

<table>
<thead>
<tr>
<th>Facilities Affected:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landfills</td>
</tr>
<tr>
<td>Waste Transfer Stations</td>
</tr>
<tr>
<td>MRFs</td>
</tr>
<tr>
<td>Recycling Transfer Stations</td>
</tr>
<tr>
<td>Route Truck</td>
</tr>
<tr>
<td>Scrap Yards</td>
</tr>
<tr>
<td>Electronic Recyclers</td>
</tr>
<tr>
<td>Waste Incinerators</td>
</tr>
<tr>
<td>Waste to Energy Plants</td>
</tr>
<tr>
<td>Battery Recyclers</td>
</tr>
<tr>
<td>Pharmaceutical Drop Off</td>
</tr>
<tr>
<td>Library: Battery Drop Box</td>
</tr>
</tbody>
</table>
## Pacific Northwest Landfill

**June 2017 - December 2020**

<table>
<thead>
<tr>
<th>Likely or Definite</th>
<th>Definite</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell phone battery:</td>
<td>17</td>
</tr>
<tr>
<td>Hoverboard size</td>
<td></td>
</tr>
<tr>
<td>remote control</td>
<td></td>
</tr>
<tr>
<td>battery: 1</td>
<td></td>
</tr>
<tr>
<td>Laptop battery:</td>
<td>6</td>
</tr>
<tr>
<td>Remote control</td>
<td></td>
</tr>
<tr>
<td>airplane battery:</td>
<td>1</td>
</tr>
<tr>
<td>Tablet battery:</td>
<td>6</td>
</tr>
<tr>
<td>Watch battery:</td>
<td>1</td>
</tr>
<tr>
<td>DVD player battery:</td>
<td>1</td>
</tr>
<tr>
<td>Unknown LIBs:</td>
<td>91</td>
</tr>
<tr>
<td><strong>Fire Count</strong></td>
<td><strong>124</strong></td>
</tr>
</tbody>
</table>

### Details and Impacts:

One landfill consulted for this report noticed an increasing number of LIBs causing fires, so a supervisor began keeping a record of each LIB-caused fire. Over roughly three years, the facility experienced 124 fires known to be caused by LIBs from a variety of devices. Most were extinguished by staff, but a few fires required assistance from firefighters. A representative from the facility indicated that this number of fires is not abnormal for landfills (landfill supervisor, personal communication, 2021).

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See [Industry Experience 2](#) for more detailed information. The landfill supervisor who provided data for this facility requested that the facility remain anonymous, given negative public perceptions regarding landfill fires. We believe that the public benefit of including the detailed data this landfill provided justifies withholding the name of the landfill.
Compliance with Regulations
Universal Waste Rules

- **Universal Waste Batteries: NR673**
  - Compatible with waste
  - Rigid Container
  - Labeled as “Universal Waste - Batteries”, “Used Batteries”, or “Waste Batteries”
  - Accumulation Start Date
  - Removed from site within 1 year
  - Employee Training Requirements
DOT Hazardous Material Regulations (HMR)

• 49 CFR 173.21 – Forbidden materials and packages
  • “Unless otherwise provided in this subchapter, the offering for transportation or transportation of the following is forbidden:”

• 49 CFR 173.21(c)
  • Electrical devices, such as batteries and battery-powered devices which are likely to create sparks or generate a dangerous evolution of heat, unless packaged in a manner which precludes such an occurrence.

This is important when preparing lithium ion and lithium metal batteries for transport but applies to all rechargeable batteries.
Used Batteries Destined for Recycling

Preparation Requirements

- Terminals of rechargeable batteries and alkaline batteries greater than 9 volts need to be covered (to prevent 1 - dangerous evolution of heat; 2 - short circuits; and 3 - damage to terminals) – 172.102(c)(1)(130)(b)

Hazardous Material Proper Shipping Name

- Batteries sorted by chemistry (check for proper shipping name 172.101)
  - Batteries, dry, sealed, NOS (alkaline),
  - Batteries, dry, sealed, NOS (NiCd or NiMH)
  - UN3480 Lithium ion batteries, 9
  - UN3490 Lithium metal, 9
  - damaged*

<table>
<thead>
<tr>
<th>§ 172.101 Purpose and use of hazardous materials table.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symbols</td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td>Batteries, dry, sealed, n.o.s.</td>
</tr>
<tr>
<td>Lithium ion batteries including lithium ion polymer batteries</td>
</tr>
<tr>
<td>Lithium metal batteries including lithium alloy batteries</td>
</tr>
</tbody>
</table>
Used Batteries Destined for Recycling

Special Lithium Battery Markings

**Lithium Cells and Batteries** – 49 CFR 173.185
- Exceptions for recycled batteries - 173.185(d) refers to 173.185(c)
- Battery Size limitations for highway
  - Lithium metal: up to 25 grams of lithium
  - Lithium Ion: up to 60 Wh per cell or up to 300 Wh per battery
- Packaging
  - Any sturdy packaging with cover that withstands 1.2-meter drop test
- Markings
  - (see markings to the right)
- Package Weight Restrictions
  - Not to exceed 66 lbs. gross weight

**Gross Weight Not to Exceed 66 pounds**
**DOT HazMat Employee Training!**

3 General Categories:
1) General Awareness
2) Function Specific
3) Safety/Security

**Training Frequency**
- Initial employment
- Every 3 years thereafter

**DOT Training Brochure**

**Regulation (Cornell Law School)**

**UW System Info**

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**Lithium Ion Batteries**

*(Preparing Lithium Ion Packaging)*

1. **Universal Waste - Used Batteries** Label
   - Regulatory Citing: 49 CFR 172.2
   - Must include:
     - The words "Universal Waste: Used Batteries"
     - An Accumulation Start Date

2. **Non-Hazardous Waste Label**
   - Regulatory Citing: 49 CFR 172.2
   - Must include:
     - Shipper Name
     - Shipper Address
     - Contents: Use the following shipping name:
       UN3480 Waste Lithium Ion Batteries, S, II

3. **Lithium Battery Label**
   - Regulatory Citing: 49 CFR 172.3
   - Must include:
     - The proper size, colors, symbol, & hazard class

4. **Lithium Battery & Cell Marking**
   - Regulatory Citing: 49 CFR 173.185(c)(3)
   - Must include:
     - Appropriate UN number (UN3480)
     - Telephone number for additional information

5. **Air/Vessel Forbidden**
   - Regulatory Citing: 49 CFR 173.185(c)(1)(iv)
   - Must include:
     - Required Verbiage: "LITHIUM BATTERIES - FORBIDDEN FOR TRANSPORT ABOARD AIRCRAFT AND VESSEL"

6. **HMR Internal Drum Number**
   - Regulatory Citing: NA
   - Must include:
     - Drum number

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**Gross Weight not to Exceed 66 pounds**
Lithium Ion Batteries

Preparing Lithium Ion Batteries

1. Separate Lithium Ion batteries. Look for key word:
   - lithium ion
   - Li-Ion
   - INR, ICR, or similar
   - Battery dimensions: ex. ‘18650’
2. Batteries must be rated < 300 watt-hours*
3. Batteries must be individually bagged; terminals taped; or terminals coated with non-conductive material.
4. Batteries will be placed in a DOT/UN approved plastic twelve gallon pail.
5. Net weight of container and batteries can be no greater than 66 pound.
Should a waste that is considered a DOT hazardous material be allowed to be landfilled?
Isn’t Government Exempt From DOT HMR?

(d) Functions not subject to the requirements of the HMR. The following are examples of activities to which the HMR do not apply: (49 CFR 171.1(d))

(5) Transportation of a hazardous material in a motor vehicle, aircraft, or vessel operated by a Federal, state, or local government employee solely for noncommercial Federal, state, or local government purposes. (49 CFR 171.1(d)(5))

DOT Interpretation letters involving 49 CFR 171.1(d)(5):

Interpretation Letter Reference No. 18-0071:
“...if a government entity (e.g., APHIS) contracts a third party to transport a hazardous material on their behalf, the government exception would no longer apply and government operations would be categorized as transportation for commercial purposes and subject to the HMR.”

Interpretation Letter Reference No. 14-0101:
“...a state agency, such as a state university, that transports hazardous materials for its own use, using its own personnel and vehicles, and is not engaged in transportation in commerce is not subject to the HMR. However, if the university transports hazardous materials using a commercial carrier, such as a contractor or a contract or common carrier, it is subject to the requirements of the HMR.”
Advancements in Battery Technology & Increased Lithium Use
Advancing Lithium Technology

- Surpassing 300 watt*hours
- Less exemption; More Regulation

Devices with Sealed or Built In Lithium Batteries

- Lithium battery not easily removed
- Transportation Complications
- Electronic Recycling Complications
Disposal Options
Battery Disposal Option Issues

- **Specialty Businesses**
  - Problem: Population Centered; Regulatory Awareness

- **Recycling Center or Collection Program**
  - Problem: Properly stored?; Regulatory Awareness

- **Call2Recycle**
  - Problem: Built-in batteries in vaping devices; Accessed through institutions

- **Household Hazardous Waste Programs**
  - Problem: Sporadic availability; Disposal/Recycling expenses are NOT Clean Sweep Grant eligible (batteries, vaping, etc.)
Battery Metals: Scarcity and National Security Issues?
AUSTRALIA AND CHILE IN THE FRONT ROW
Countries with major Lithium production and reserves


source: USGS 2019

production (in 1,000t)

reserves (in 1,000t)
THE 35 MINERALS CRITICAL TO U.S. NATIONAL SECURITY
This draft list of minerals deemed essential to the economic and national security was released Feb 16, 2018

"...our nation's mission is to reduce our vulnerability to disruptions in the supply of critical minerals. Any shortage of these resources constitutes a strategic vulnerability for the security and prosperity of the United States."

—Dr. Tim Petty, Assistant Secretary of the Interior for Water and Science

**Critical Minerals List**

- **HAFNIUM**
  - Nuclear control rods, alloys, ceramics
  - **Net Exporter**
- **HELIUM**
  - MKs, lifting agent, research
  - **Net Import Reliance**

**Example Uses**

- **BERYLLIUM**: 14% alloying agent in aerospace and defense industries
- **MAGNESIUM**: 47% furnace lining for manufacturing steel and ceramics
- **GERMANIUM**: 80% fiber optics, night vision applications
- **LITHIUM**: 80% batteries, 50% used in wear-resistant metals
- **TUNGSTEN**: 50% used in wear-resistant metals

**HELIUM**

The Federal Helium Reserve is the world's only sizable long-term storage facility for crude helium. In recent years, the U.S. has become the world's major source of helium as global demand has risen sharply.

In the summer of 2017, an embargo of products from Qatar caused a temporary shortage of Helium.

**ALUMINUM**

U.S. production of primary aluminum decreased for the fifth consecutive year and is now at its lowest level since 1951.

“The U.S. import reliance [on lithium] is moderate, but increasing foreign consumption in addition to U.S. demand growth has driven a substantial exploration boom”.
Thank You!

Questions?
Trying Something Different...