GUIDE FOR ESTABLISHING LITHIUM-ION BATTERY MANAGEMENT PRACTICES AT MATERIALS RECOVERY FACILITIES

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INTRODUCTION

As the number of annual fire incidents at waste and recycling facilities continues to rise, one of the main reasons highlighted is the increase in the popularity of lithium-ion batteries (LIBs) as they become cheaper commercially.[1] LIBs are found in everyday items such as scooters, hoverboards, e-bikes, remote controls, solar lighting, lawn mowers, phones, tablets, toothbrushes, vapes, power tools, and hearing aids, among other products. There is a lack of awareness and education between consumers and battery recycling.[2] Labeling is not standardized and can be very confusing. Consequently, batteries are more commonly found in municipal waste and are frequently improperly disposed of in recycling bins. LIBs may unknowingly catch fire and sometimes explode, causing injuries to workers and equipment and potentially destroying an entire facility.[3]

To lower the risk of potential fires caused by LIBs, this guide has been written to assist materials recovery facilities (MRFs) in developing management practices to properly manage LIBs when spotted, to take precaution in case of a fire, and to manage a fire if one does break out. Guidelines to help better educate consumers also are provided.

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>
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CONTRACTUAL LANGUAGE

Issues and points to consider with developing contracts between interested parties:

1. **Clear language that batteries, especially LIBs, are not accepted in a residential waste or recycling bin, or from trucks delivered to the facility.**

2. **Responsibility and ownership for LIBs found during the unloading of trucks (i.e., MRF, municipality, truck operator) and the protocols for proper management and removal.**

3. **A material classification system (i.e., household hazardous waste, hazardous, damaged) for LIBs found in inbound recyclables.**

4. **Responsibilities for the removal and proper re-routing/processing of LIBs found in inbound recyclables, as well as information on who will bear the cost.**

5. **Roles and responsibilities for a curbside education program, notification of safe receiving sites, and guidance on the separate handling or exclusion of LIBs including associated costs.**

National PSA

www.batterysafetynow.org

Website including information on appropriate battery box drop off and other e-waste receiving locations.

When batteries are found or improperly packaged on the curb.

Public engagement - identify specific groups like businesses to target with social media campaigns, schools with educational workshops, feature efforts with press releases, local news segments, and attend community events with educational booths and giveaways.

6. **Language requiring a monthly report on battery types (single use vs rechargeable), quantities found (tons or pounds), other relevant metrics, and associated costs for identifying, segregating, and handling of improperly disposed LIBs.**

INBOUND MATERIAL CONTROL

When developing operational procedures and controls, companies and facilities should consider the following principles:

At earliest detection, establish a program for identification of LIBs for drivers, so they are sensitized while unloading full trucks and when on routes (if not automated).

Develop metrics to raise awareness and identify potential trends such as periodic battery counts (found batteries per hour).

Manage batteries between sorting and proper storage. For example, consider placing batteries in 5-gallon containers containing cushioning material or thermal management material.

Employers should make a selection of personal protective equipment available to employees who handle LIBs such as chemical and heat-resistant gloves, safety glasses, and face shields.

Establish dedicated temporary short-term and long-term storage options for batteries—include signage, barriers and painted identification of areas (demarcations).

Develop a LIB safety management system and training program for material inspection upon arrival at the MRF including battery type identification, safe removal practices, personal protective equipment selection and usage, and proper storage.Typically, this program would include:

- *Training for employees who are engaged in the inspection and acceptance of inbound materials on how to identify and properly handle batteries.*
- *Availability of safe removal supplies (i.e., storage, terminal tape).*
- *Scheduling and rotation of battery management in regular toolbox safety meetings.*

Develop a written list of materials that are prohibited at the facility and materials that will be accepted but require special handling procedures. Ensure language is consistent with contracts (see Contractual Language on page two) and includes consequences for what happens when prohibited materials are brought to the facility.

LITHIUM-ION BATTERY RECOVERY LOCATIONS

Based on industry experience, LIBs are most often recovered at MRFs from the following locations:

- Tip Floor
- Manual Sorting (i.e., pre-sort, quality sorts, aluminum and glass sorts)
- Magnet
- Baling
- Battery Detection

LITHIUM-ION BATTERY IDENTIFICATION: SOFT-SIDED BATTERY

Certain batteries produce their own oxygen.

Photo courtesy of Call2Recycle, Inc.

LITHIUM PRIMARY

(button, cylindrical)

Chemistries: Li-MnO2 (CR), lithium iron sulfide.

Uses: AA/AAA, medical devices, security, backup power, watches, hearing aids, calculators, non-consumer uses.

Sizes: Including but not limited to 9v, AA, AAA, C, D, coin/button cell.

Markings: It may be marked “lithium” or “lithium cells;" it may be marked as (CR###); it may include a recycling symbol.

LITHIUM-ION BATTERY IDENTIFICATION: SOFT-SIDED BATTERY

Photo courtesy of Call2Recycle, Inc.

LITHIUM-ION

Chemistries: Lithium cobalt oxide (Li-cobalt or LCO), lithium manganese oxide (Li-manganese or LMO), lithium nickel manganese (NMC), lithium iron phosphate (Li-phosphate or LFP), lithium nickel cobalt aluminum oxide (Li-aluminum or NCA), lithium titanate (Li-titanate or LTO).

Uses: Grid storage, electronics, e-bikes, e-cigarettes, hoverboards, power tools, vapes.

Markings: It may be marked "rechargeable;" it may have a battery chemistry name (Lithium ion) or abbreviation (LI-ION, Li-ion, LiPo (lithium polymer)); it may have a button/coin cell (LIR####); it may just have a battery seal or other mark. See below.

REMOVAL

Once identified, frontline employees should inspect and extract any batteries from the inbound material stream.

TIP FLOOR ➤ Secure tip floor and idle all rolling stock while employees remove the battery.

SORTING STATIONS ➤ Idle the conveyor system.

INSPECT ➤ The employee should inspect the battery for damage. If undamaged:

1. The employee should tape the battery terminals and place it in a dedicated temporary storage container.
2. Once placed in the container, the employee should scoop cushioning or thermal management material on top of the battery.

DAMAGED BATTERY PROTOCOL

Damaged batteries should not be stored with other undamaged batteries.

A damaged LIB may appear swollen, corroded, leaking, smoking, signs of previous burning including burn marks, exposed or damanged wires, cracked or opened outer casing, misshapen structure, or have a cherry gum smell.

Thermal runaway can be identified by several indicators including a rise in battery temperature, venting of gas, vapor, or smoke from the battery, or the presence of fire. Fires caused by thermal runaway can produce additional chemical hazards. Batteries that are swelling, smoking, leaking, or overheating should be treated with extreme caution.

Immediately place them in an absorbent, non-flammable material in a cool, dry, well-ventilated area.

Store outdoors away from structures, vehicles, and equipment.

Store in a noncombustible structure.

Recommended storage materials include cushioning material and/or thermal management material.

MATERIAL STORAGE

At the end of each day, batteries should be moved to a long-term storage location from their temporary location.

1. Must be stored in a specific location.

2. Must have a stormwater plan, where required. (See: www.epa.gov/npdes/stormwater)

3. Battery terminals must be protected or isolated to avoid sparks or heat from a residual charge.

4. The positive (raised) terminal must be protected using clear tape. Alternatively, each battery can be placed in its own clear, sealable bag.

5. Batteries that have been individually taped or bagged can be stored in a UN Rated drum (1A) with an anti-static liner or a five-gallon pail with lid.

6. Batteries must be stored in a cool, dry location.

REMOVAL FROM FACILITY

Develop policies which describe safe accumulation mehtods and quantities and indicators for removal.

Please refer to member list for NWRA, ReMA, SWANA and more associations to support your specific battery recycling needs.

Use a LIB recycling service such as Call2Recycle, Inc. or others

FACILITY INSPECTIONS AND MAINTENANCE

Maintain fire suppression following **NFPA Guidelines** for inspections.

Utilize dry fire suppression system especially in cold climates, inspect per NFPA guidelines.

Ensure you have the right **quantity and size of fire extinguishers**.

Continuously monitor for flammable and toxic gases in large storage locations which may include hydrogen fluoride (HF), hydrogen chloride (HCl), hydrogen cyanide (HCN), phosphoryl fluoride (POF3), carbon monoxide (CO), carbon dioxide (CO2), black carbon, and other potentially hazardous chemicals and particulates.

FIRE SUPPRESSION

Hopefully the measures taken above reduce the potential for fires to a minimum. However, in the event of a fire from a LIB, review the following items.

HOUSEKEEPING

Regularly inspect unprocessed and processed material storage (i.e., tip floor, bales, loaded trucks), handling and transfer areas.

Have an action plan and time frame for completion

Conduct routine preventative maintenance of equipment.

Use checklists to maintain a consistent inspection program.

Designate responsible parties.

Be sure that fire extinguishers and suppression systems are adequate and in proper working order.

Access and egress routes must be clearly marked and kept clear at all times.

Follow fire safety and watch requirements during all hot work procedures.

Ensure all fire suppression systems are maintained to National Fire Protection Association standards.

Manage low point drains in dry systems in cold climates.

Ensure fire extinguishers are the proper size and type for the area.

FACILITY OPERATIONS

The employer should have written plans and training in place to identify and mitigate lithium-ion battery fires safely in conjunction with their emergency action plan and fire prevention plan based on the circumstances, while obtaining the appropriate level of outside assistance.

Consider designating first responders in your emergency action plan and provide them with response level or higher training to respond and implement site-specific procedures for battery incidents. Ensure responders are readily deployable to quickly address areas of concern for battery ignition.

Consider monitoring daily operations for potential hot spots, keeping fire prevention measures in mind at all times.

Areas of concern for ignition of LIB are:

- Waste reception area
- Shredder
- Truck load dumping
- Tipping floor storage
- Feed conveyor and drum
- Paper screens and glass breaker impact points
- Loose storage bins
- Baler
- Bale storage
- Truck storage
- Secondary fires
- Off-gassing

Any point where materials come into contact with machinery or friction can be an area of concern, including being moved by a front-end loader, being loaded onto a conveyor belt, dropping through screens, and dropping to storage.

Have a stormwater program in place, especially for response, where required.

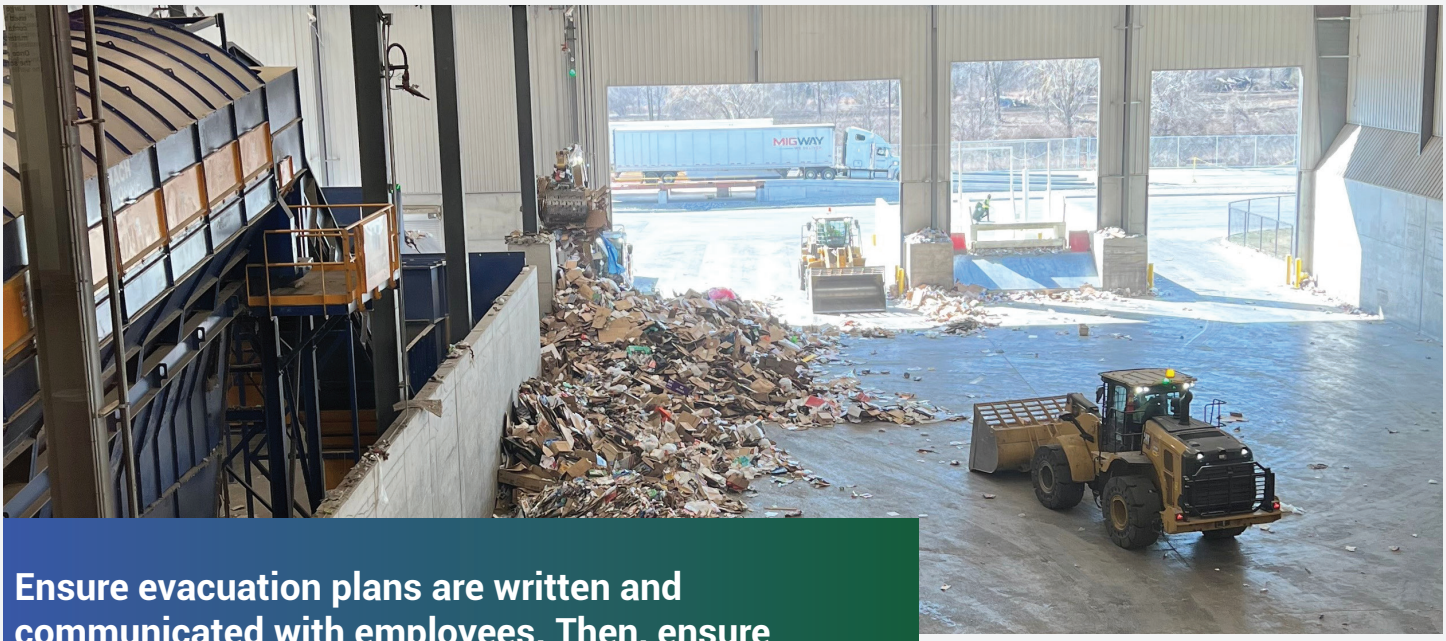
FACILITY OPERATIONS

Develop a “one fire extinguisher” attempt for incipient fires only, call 911, and evacuate.

- 29 CFR 1910.155(c)(26) defines “incipient stage fire” as a fire which is in the initial or beginning stage and which can be controlled or extinguished by portable fire extinguishers, class II standpipe or small hose systems without the need for protective clothing or breathing apparatus.

Train employees in the PASS (pull, aim, squeeze, sweep) fire extinguisher method.

Be aware of the batteries off-gassing and the dangers of smoke inhalation.



Ensure evacuation plans are written and communicated with employees. Then, ensure training is provided to all employees.

Ensure the “meeting point” is clearly communicated and signage is posted at the facility.

Assign a responsible individual to conduct head counts and ensure personnel accountability.

EMERGENCY RESPONSE PLANNING

Have a written fire prevention and response plan in place (required by OSHA 29 CFR 1910.39).

Ensure the "meeting point" is clearly communicated and signage is posted at the facility.

Identify the following evacuation types:

- Shelter in place
- Move to another structure onsite
- Onsite outdoor evacuation locations
- Offsite evacuation locations for large events

Consider inviting first responders to your facility for familiarization purposes.

- Introduce responders to facility fire detection and suppression systems
- Tour the facility identifying dangerous equipment or hazardous chemical storage
- Review written response plans
- Ensure to schedule follow-up visits when operations change or for new responders

Utilize an emergency key box (Knox Box) or similar device in place to hold an entry key to the facility.

Educate and train employees on the fire prevention and response plan, and ensure they have proper personal protection equipment, non-flammable gloves (all leather), safety glasses, appropriate cotton long-sleeved shirt, etc.

During the extinguishment of a baler fire, beware the possibility of another flash fire as the baler pushes the material out, flammable cans are crushed, and the heat of the baler acts as the ignition source.

If a battery is observed beginning to react, it can be pulled out using tongs, placed into a lidded metal container containing fire prevention media like sand and then taken to an isolated location.

- Certain batteries produce their own oxygen
- Quantity of batteries

Fire response should conform to the Emergency Response Guidebook.

- Lithium Primary Battery Fire Response – Emergency Response Guide (ERG) 138
- Lithium-Ion Battery Fire Response – Emergency Response Guide (ERG) 147

Evaluate battery detection technology as a potential future capital investment.

WORKFORCE TRAINING

Workers must be trained in a language and at a literacy level they understand.

At a minimum, workers should be trained on site-specific guidance for responding to battery failures, including fires and/or explosions caused by thermal runaway, hazards associated with lithium-ion batteries, use and limitations of required personal protective equipment, and training on the physical and health hazards associated with LIBs.

While there is not a specific OSHA standard for lithium-ion batteries, many of the OSHA general industry standards may apply, as well as the General Duty Clause (Section 5(a)(1) of the Occupational Safety and Health Act of 1970).

Appropriate OSHA training may include, but is not limited to:

- Hazard Communication (29 CFR 1910.1200) training
- Hazardous Waste Operations and Emergency Response (HAZWOPER) (29 CFR 1910.120) training
- Personal Protective Equipment (29 CFR 1910.132)
- Respiratory Protection (29 CFR 1910.134)
- Air Contaminants, (29 CFR 1910.1000)
- Access to employee exposure and medical records (29 CFR 1910.1020).

CUSTOMER AWARENESS MESSAGING

BATTERIES ARE NOT SAFE IN RESIDENTIAL SOLID WASTE OR RECYCLING SYSTEMS NOT DESIGNED TO PROCESS THEM

- Special battery receiving methods and facilities are required to eliminate health and fire threats.
- Help provide guidance and information for the public on places to take all batteries.
- It's hard for consumers to tell the difference between batteries.
- It's hard to enforce lithium-only bans.

CUSTOMER AWARENESS MESSAGING

POWER COMES WITH RESPONSIBILITY

Spent batteries aren't dead and can be dangerous

- Used lithium batteries can often maintain 80 percent-plus of their original charge.
- Other chemistries also cause fires.

Do not removed embedded LIBs

- Lithium polymer batteries, without hard cases, are susceptible to damage.
- If it's hard to get out, leave it alone.

Tape or bag

- The positive (raised) terminal or the charging terminals must be protected either by packing, duct, or electrical tape. Alternatively, the whole battery can be individually placed in a clear, sealed bag.

Batterywise: Curbside is seldom wise

- Most municipal governments lack a battery management plan; however, more local governments are beginning to mitigate safety issues.
- Engage your local officials about improving the safety of the waste stream.
- Find a dedicated collection container, site, or Center in your area.
- *Note: The U.S. and Canadian Special Permit allows for no more than 4.4 pounds (2 kilograms) of lithium cells and batteries to be contained in a single package. However, a single cell or battery may be shipped within one package provided the cell or battery has a mass of 5 kilograms or less.*

EXTENDED PRODUCER RESPONSIBILITY (EPR)

Public policy has a role in increasing options for Li-ion collection and recycling. Extended Producer Responsibility (EPR) for batteries and grant programs for expanded battery collection are policy tools. Battery EPR creates a framework for the producers and sellers of batteries to establish a collection program. For additional information on EPR, view the technical policies and guidelines.

SWANA: https://swana.org/advocacy/technical-management-policies
NWRA: https://tinyurl.com/nzdnx7j3
ReMA: https://tinyurl.com/4u5kchht

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