

The Risks and Rewards of Battery Recycling

a joint presentation by Battery Solutions and Call2Recycle, Inc

Michigan Recycling Coalition Conference
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Paul Hernley, PhD

**Battery
Solutions**

Tim Warren

call2recycle[®]





Call2Recycle and Battery Solutions Overview



Battery Solutions and Call2Recycle are two of the largest and most experienced battery recyclers in North America



Battery Solutions is a for profit corporation providing collection, sorting and processing operations for large and small format batteries of all types



Call2Recycle, Inc. is a 501c4 non-profit product stewardship organization, funded by the battery industry and consumer electronics industries, providing collection and recycling services for rechargeable and single use batteries up to 11 lb. per battery



Both Battery Solutions and Call2Recycle serve local government recycling programs as well as businesses, retailers, and public agencies



Battery Solutions and Call2Recycle have a joint business venture whereby Battery Solutions sorts and processes the majority of the consumer batteries collected through the Call2Recycle program by its customers



Battery Macroeconomics

Marketplace Growth of Consumer Batteries

- 3 billion batteries sold annually in the US (USEPA)
- 80% single use (primary) 20% are rechargeable
- Rechargeable batteries are regulated as a Universal Waste
- Lithium-ion is rapidly replacing NiCd, and to a lesser extent, NiMH, SSLA for consumer cordless electronics
- Larger, more powerful Li-Ion batteries are becoming more common (40V- 60V) with higher watt hour ratings
- Both rechargeable and single-use batteries are recyclable:
 - Rechargeable recoverable metals: lead, cadmium, nickel, lithium, copper, cobalt, iron/steel
 - Single Use: zinc, manganese, steel, lithium, copper

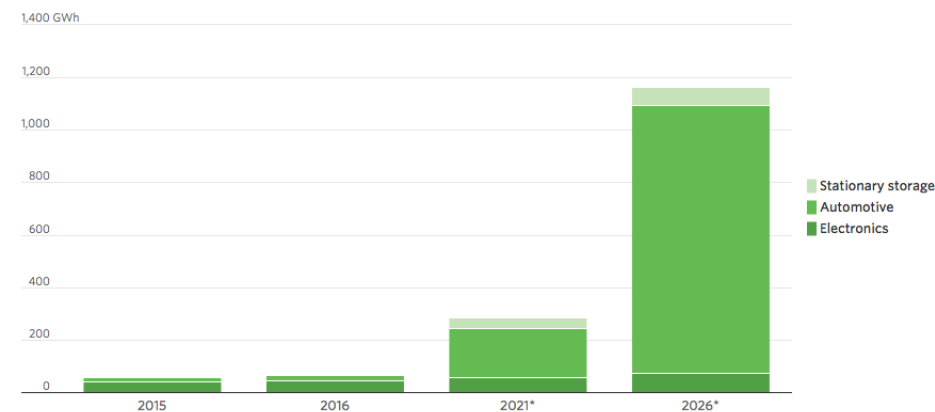
THE WALL STREET JOURNAL.

Batteries Are Taking Over the World

The battery industry is surging. But picking investment winners will be exceedingly hard

Charging Ahead

Projected lithium-ion battery demand by sector



*Projections
Source: Berenberg

THE WALL STREET JOURNAL

By [Stephen Wilmot](#)

Updated Nov. 29, 2017 3:22 a.m. ET

107 COMMENTS



Types of Consumer Batteries



Alkaline/Zinc Carbon



Nickel Metal Hydride (NiMH)



Nickel Cadmium (NiCd)



Lithium-ion (Li-ion)



Lithium Primary

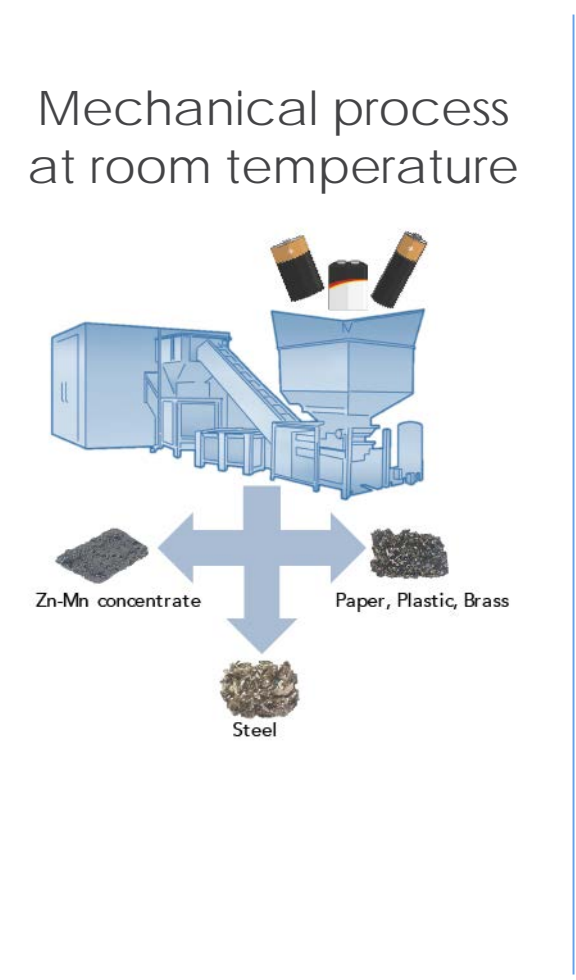


Lead Acid



Alkaline/Zinc Carbon/Zinc Air

Battery Type	Common Use	How it's Recycled	Secondary Commodities
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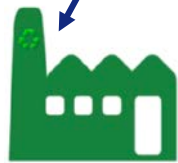
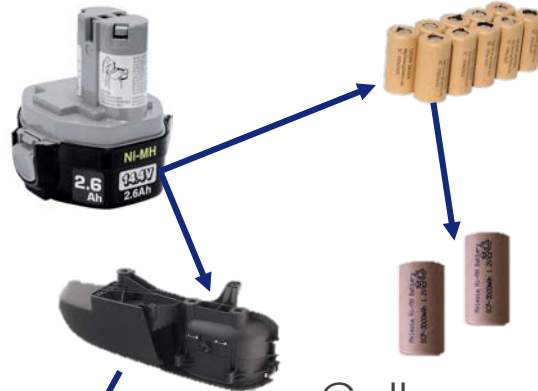


Nickel Metal Hydride (NiMH)

Battery Type	Common Use	How it's Recycled	Secondary Commodities
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Mechanically de-husk the plastic from the battery pack



Plastic is sent for recovery

Cells are sent for nickel recovery through a proprietary thermal process

Secondary Commodities



Nickel is used as raw material in the production of new Ni-based metals used in products such as cookware or major appliances (also aerospace industry and corrosive environments)



Plastic is ground into pellets for future use in plastic products and metal wiring is recovered for manufacturing use



Nickel Cadmium (NiCd)

Battery Type	Common Use	How it's Recycled	Secondary Commodities
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Pyrometallurgy:
 consists of the thermal treatment of minerals and metallurgical ores and concentrates to bring about physical and chemical transformations in the materials to enable recovery of valuable metals.



Iron and nickel is recovered for steel production





Cadmium is extracted and can be reused in new batteries



Lithium-ion

Battery Type	Common Use	How it's Recycled	Secondary Commodities
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Pyrometallurgy (thermal process to separate metals) and/or **hydrometallurgy** (uses an aqueous solution to separate metals) aimed to maximize the recovery of cobalt and other metals: nickel, iron





Lithium Primary

Battery Type	Common Use	How it's Recycled	Secondary Commodities
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Same sizes as alkaline or zinc carbon but lasts 5x longer than alkaline and 10x longer than zinc carbon



How it's Recycled

Batteries are broken down using a shredder or a high-speed hammer mill under inert conditions



The contents are then submerged in caustic (basic not acidic) water

This caustic solution neutralizes the electrolytes, and ferrous and non-ferrous metals are recovered



Secondary Commodities



Lithium carbonate used to make lithium ingot metal and foil for new batteries



Scrap metal



Lead-Acid

Battery Type	Common Use	How it's Recycled	Secondary Commodities
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Batteries are opened by a hammer-mill and fall into a vat

Plastic pieces are scooped out and cleaned

Lead sinks and is recovered by smelting

Sulfuric acid is treated and converted into sodium sulfate

Lead, used in the production of new batteries

Sodium sulfate, a white power using in laundry detergent, glass and textile manufacturing

Plastic pellets used to manufacture battery cases

2 Battery Collection

- Small volume users served via ground carrier shipping using UN rated and certified storage and shipping containers:
 - Call2Recycle has two sizes of boxes (20-30 lbs. and 40-60 lbs.) with a fire resistant box liner
 - Battery Solutions has three sizes of pails (55 lbs., 35 lbs. and 10 lbs. as well as collection tubes)
- Large volume users are served with bulk shipping programs using freight carriers



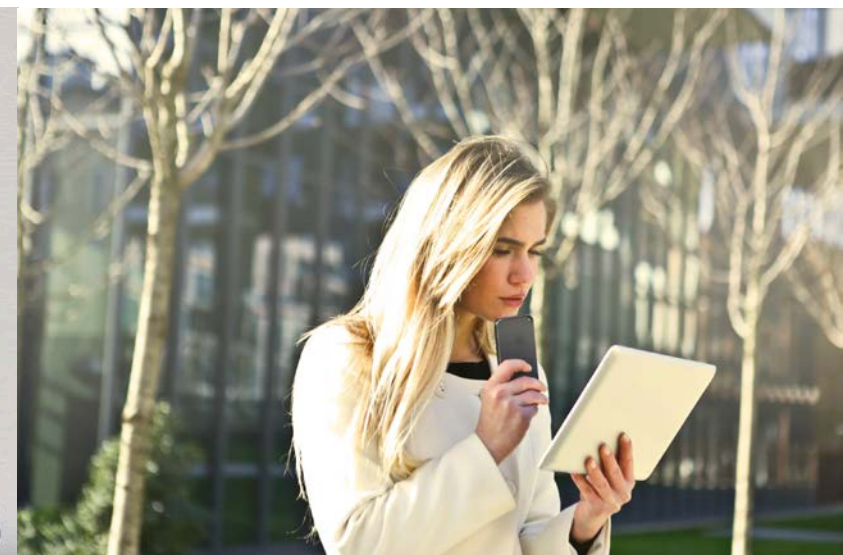


Nationwide Collections



2 Batteries: What's changing and Why?

- Landslide move by consumers to products that are mobile/cordless
- American's obsession with smart phones, iPads, tablets etc. for instant access to information and communication
- Batteries for these devices are lighter, smaller, contain more energy/power, charge faster and hold longer charges



2 Changing Battery Chemistries = Changing Impacts

- Decline of **NiCd**: Lessening of toxicity impacts
- Popularity of **Li-ion**: Fewer environmental, more safety impacts
- Battery fires are in the news and becoming a recognized issue for some consumer products (CPSC recalls)
- Battery safety and fire issues are increasing for waste transport, processing and disposal and even battery recycling



2 Why are Safety Incidents Increasing?

- As more mobile products using batteries (e.g. toys, tools, electronics) are sold, batteries are **flooding the market**
- Battery chemistries can be **hard to identify** making it difficult to know which are hazardous and require special handling
- As the **power** of batteries increases and sizes shrink (energy density), damaged or defective batteries release more energy
- Sales of **counterfeit batteries**, which are more likely to cause safety incidents, are increasing
- The **design of products**, affixing a more powerful battery into a smaller product, creates a premium on design and, in some cases, increases risks
- Batteries are being damaged in processing of waste streams
- Heat from short-circuited lithium-based batteries cause fires





Terminal Protection is a MUST

- US DOT requires the following batteries terminals be protected from short circuit before transit:
 - Lithium primary batteries
 - Lithium-ion batteries with exposed terminals
 - Lead-acid batteries
 - Any battery over 9 volts
- Use clear tape or clear bags



See U.S. DOT 49 CFR 173 for more information



Identifying Damaged Lithium Based Batteries

Watch for lithium-based batteries that show signs of damage such as swelling, smoking, leaking or overheating



Do NOT put damaged lithium-based batteries in a collection box or drum for recycling with other batteries. Immediately put them in an absorbent, non-flammable material (vermiculite) in a cool, dry area.

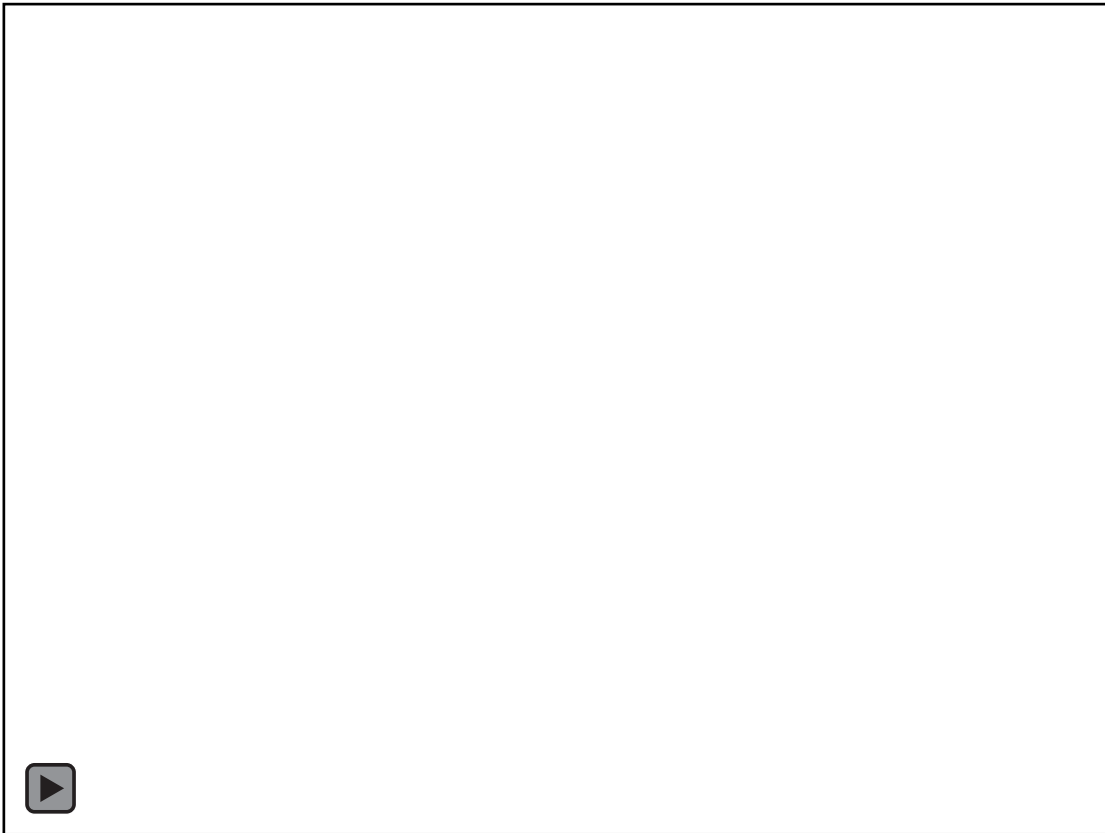
The U.S. DOT requires special packaging for shipping defective, damaged or recalled (DDR) lithium-based batteries, see U.S. DOT 49 CFR 173.185(f)



Lithium-ion Thermal Runaway in Recycling

Ecomaine fire shows why putting lithium-ion batteries in trash is a really bad idea

When damaged, the rechargeable batteries in computers, mobile phones and power tools can ignite with a result that could be catastrophic.

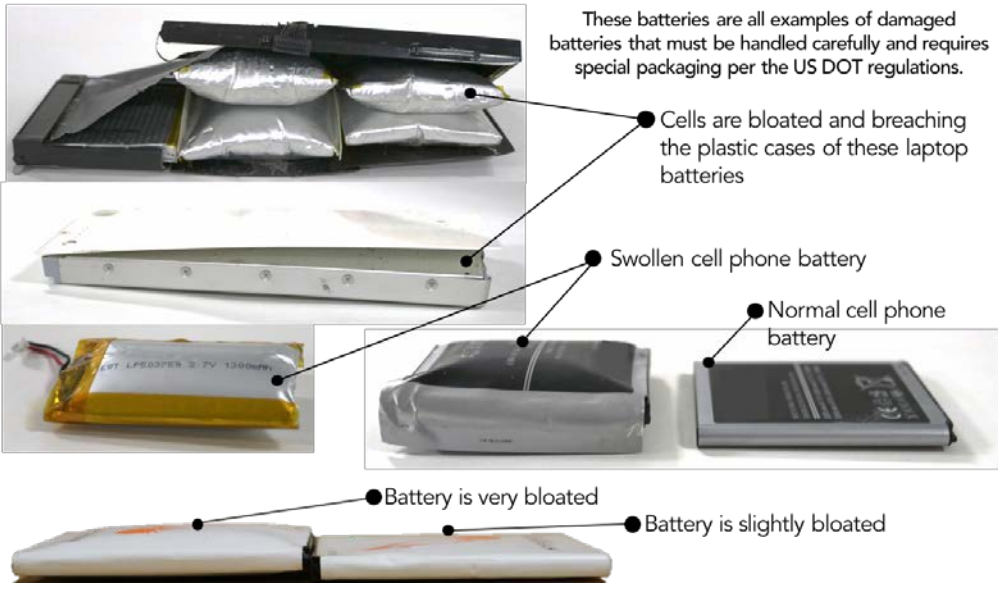


Keys to Li-ion safety in recycling:

- Vigilance in screening for non-conforming material
- Quickly remove hot/flaming batteries from collections
 - Conventional firefighting techniques are generally ineffective (water can prevent spread)
 - Cathode and anode produce O₂ at elevated temperatures
 - Focus on separation and containment
 - Large event: spread out batteries over a non-combustible area (preferably outside)
 - Small event: if possible, smother in fire-proof container
 - Combustion products are harmful, minimize exposure



Lithium-ion Safe Shipping



- Battery Solutions offers DDR recycling options from 4.4lb. through HEV/EV battery options
- Call2Recycle offers DDR recycling kits that hold up to 4.4lb.
- US DOT Special Permits
 - Call2Recycle: DOT-SP 16563
 - Battery Solutions: DOT-SP 20584
- Educational materials
 - Videos on safe handling





Lithium-ion Technology



Battery Solutions and University of Michigan Research Engagement

SofM / UofM

- State of Michigan (SofM) grant
- Conducting lithium-ion research on thermal runaway events
- Goal: create an internal Li-ion safety strategy and establish BSL as a Li-ion thought leader

UofM - Dearborn

- CT scan research project on state of health for lithium-ion
- Goal: find the most efficient avenue to reuse and repurposing

UofM Battery Lab

- Leveraging information and resources of the Battery Lab
- Goal: act as an extension of our engineering department

UofM Capstone

- Two projects:
 - Discover the state of health (SOH) using X-ray, ultrasound, etc.
 - Build a statistical model of SOH based on battery origination

UofM SCIP

- Market intelligence research project to assess the variety of 18650 cells
- Goal: develop the aftermarket audience for reuse and repurpose

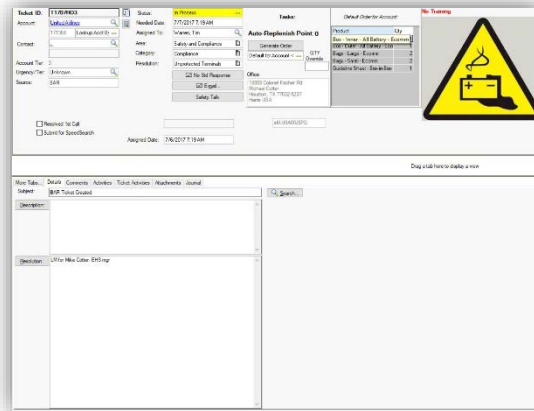


Safeguarding Your Facility

- Expect to see lithium batteries at your MRF, transfer station, landfill, etc. and develop a management plan
- Isolation kit advisable for compromised/damaged lithium ion batteries (DDR Kit) available from both Battery Solutions and Call2Recycle
- Educate consumers to use battery drop off site and collection events for safe recycling and refrain from disposing lithium based batteries in the trash
- **Train staff: Access our safety training PP at www.call2recycle.org/safety-training**
- Promote Call2Recycle's zip code based Collection Site Locator (<http://www.call2recycle.org/locator/>) to your residents
- Battery Solutions' online hazardous material training for customers (coming soon!)
- View Battery Solutions' video and educational materials on safe handling: <https://www.batterysolutions.com/resources/lithium-ion-safety/>

Charge Up Safety™: Consumer Education

- Flame retardant box
- Terminal protection guidelines
- Box Anomaly Reports (BAR)



Battery Solutions Damaged, Defective or Recalled (DDR) Lithium-ion Battery: Required Packaging



Minimum Terminal Protection Guidelines SHIPPING IN CALL2RECYCLE BOXES

Below are the minimum requirements for preparing household batteries for shipment. When in doubt of the battery type, Call2Recycle® recommends the battery be individually bagged or taped.

BATTERY TYPE / CHEMISTRY	TERMINAL PROTECTION REQUIRED?
Rechargeable Nickel Cadmium (Ni-Cd) Nickel Metal Hydride (Ni-MH) Nickel Zinc (Ni-Zn)	9V or Less = NO (drop in the box) Greater than 9V = YES (Terminal protection REQUIRED)
Primary (Select sites only) Alkaline & Carbon Zinc	12V or Less = NO (drop in the box) Greater than 12V = YES (Terminal protection REQUIRED)
Rechargeable Small Sealed Lead Acid (SSLA/Pb) Lithium Ion (Li-Ion)	1 DAMAGED BATTERIES: Special U.S. DOT special packaging (not included boxes) are required for transport. Contact Call2Recycle at 877.753.1267 for assistance. All = YES (Terminal protection REQUIRED)
Primary (Select sites only) Lithium Button/Coin Cell	2 Call2Recycle boxes should be shipped when full (80 lbs) or within one year of the collection of the first battery. 3 Show the Call2Recycle collection box in a red, dry place not where it is a water vapor area. All = YES (Terminal protection REQUIRED)

Charge Up Safety!
call2recycle.org/safety

Avoid the spark!
Batteries are fluids that leak. Metal surfaces or other batteries can spark, causing a fire or explosion.

Protect terminals before shipping
Bag or Tape Each Battery!

Place each battery into a clear plastic bag

- Use DOT-approved special bags
- Protective bags
- Recyclable bags
- Clear tape

If no bags are available, tape the positive (+) terminal with a non-conductive tape

- Clear packing tape
- Electrical tape
- Lead tape

Do NOT use: No conductive tape, No scotch tape, No silver tape, No copper tape, No aluminum tape

Drop in the box

Battery Solutions Damaged, Defective and Recalled Battery Recycling Kits

Corporate Office: 5900 Brighton Pines Court, Howell, MI 48843, 800.852.8127
 West Coast Office: 618 E. Auto Center Drive, Suite 111, Mesa, AZ 85204, customerservice@batterysolutions.com

iRecycle Kit DDR Small
Small metal can fits multiple cell phone, laptop and tablet batteries
Maximum weight: 4.4 pounds
Dimensions: 10" Height, 6" Diameter
Price: \$79.95 (includes round trip shipping)

iRecycle Kit DDR Large
5 gallon steel drums fits multiple cell phone, laptop, tablet and larger batteries
Maximum weight: 35 pounds
Dimensions: 12" Height, 11" Diameter
Price: \$329.95 (includes round trip shipping)

iRecycle Kit DDR 400
55 gallon steel drums fits multiple cell phone, laptop, tablet and larger batteries
Maximum weight: 400 pounds
Dimensions: 34" Height, 22.25" Diameter
Price: \$1499.95 (plus shipping)

iRecycle Kit DDR 9/6
Fits 9 cell phone or cell phone batteries or 6 laptop batteries
Dimensions: 13" L x 8" W x 6" H
Price: \$139.95 (includes round trip shipping)

iRecycle Kit DDR 1
Fits one cell phone or cell phone battery
Dimensions: 5" L x 6" W x 6" H
Price: \$79.95 (includes round trip shipping)

cause the electrolyte inside the battery to raise its vapor pressure. This is called thermal runaway and is difficult to stop once it starts. These fires can reach temperatures of 900 degrees.

For DDR Lithium-ion Batteries

Batteries must be packaged individually using a special kit for safe transport per the U.S. DOT 49 CFR 173.185(f) regulations. It is recommended to package and ship immediately, as they are a fire hazard.

For more information, order and to learn more, visit: batterysolutions.com/store

Arizona | www.batterysolutions.com | 800-852-8127

Charge Up Safety™: Consumer Education

- Safety videos
- Safety portal
- Consumer outreach events

**NBD 2018
FEB. 18th**

Help Lead the Charge On NATIONAL BATTERY DAY

Take action now:

- ✓ Gather and individually bag used batteries for safe transport
- ✓ Visit our website to locate a convenient drop-off site
- ✓ Talk about battery recycling with friends and family

For more information:
Visit call2recycle.org/nationalbatterysday
877-723-1297 • call2recycle.org

call2recycle
Leading the charge for recycling™

Battery Safety University
Battery Prep 101

call2recycle
Leading the charge for recycling™

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SAFETY

Safety is a core tenet of the Call2Recycle® program and is reflected in every aspect of our daily operations. We are committed to the safety of the employees, collection sites, transporters, industry stewards, sorters and processors involved in the used battery collection and recycling process. As the premier North American battery recycling program, Call2Recycle is continually improving its safety policies and best practices to ensure we protect both people and the environment.

We invite you to join us and **Charge Up Safety** in your recycling efforts! This safety portal shares our best practices and resources on how to improve recycling safety, whether you are a large business, municipality, retailer, community center or consumer. Test your knowledge with our safety training lesson. Find out why damaged batteries require special packaging. Download our collection site guidelines. Get ready to charge up the safety of your recycling!

Collections & Shipping

Learn about the essential aspects of handling, collecting and shipping used household batteries, whether you are shipping in boxes or bulk.

[LEARN MORE](#)

Safety Training

Test your safety knowledge, including how to bag and tape batteries, what containers are acceptable and what mistakes to avoid in preparing batteries for shipping.

[LEARN MORE](#)

Damaged, Defective & Recalled Batteries

Find out what to do with your damaged, defective or recalled batteries, which require special packaging requirements.

[LEARN MORE](#)

FAQs & Resources

Charge up your recycling safety by reading common safety questions and visiting links to other safety resources.

[LEARN MORE](#)

Battery Solutions: Damaged, Defective, and Recalled (DDR) Battery Module

2018

Hazardous Materials Regulations
49 CFR Parts 100 - 180

- DOT SP 20584
- DOT SP 16532
- DOT SP 20331
- DOT SP 16011

Department of Transportation
UNITED STATES OF AMERICA

Lithium-ion Battery Safety

You've seen the news about exploding lithium-ion batteries, here's what you need to know and how to safely recycle damaged, defective or recalled (DDR) lithium-ion batteries. If you have a bloated lithium-ion battery for recycling, visit our store to purchase a special kit equipped to handle these batteries.

Why do lithium-ion batteries explode?

In this video, we guide you through the potential dangers of lithium-ion batteries and why they explode, how to safely transport damaged lithium-ion batteries for recycling, and how to safely handle non-damaged lithium and lithium-ion batteries.



Documentation and Reporting

Confirmation of Reclamation (COR)

Upon completing each recycling job, you receive a COR documenting your batteries were recycled per federal, state and local regulations

Reporting

Customizable reports based on your needs providing you with the statistics that mean the most to your business

Record Keeping

Secure storage of all documentation for 3-years

Battery Solutions

Confirmation of Reclamation

Generator: SAMPLE

Generator EPA ID Number: MAK-000-000-000

Date of Receipt: 12/01/2016

Shipping Document Number: K123456

Customer PO/Ref. Number:

Description of Material:
Alkaline 1,234 lbs : Li-Ion 2,123 lbs : Lithium Primary 3,456 lb : NiCad 4,567 lbs : NiMH 5,678 lbs : Small SLA 6,789 lbs : Li-Ion Cellphone 7,890 lb : Li-Ion Laptop/Modem 8,901 lbs

Total Weight: XX lbs

Battery Solutions' EPA ID: AZR-000-504-902

This document confirms that the above described material has been received and is in the process for reclamation. The material is being recycled in compliance with all applicable federal, state and local laws and regulations.

Authorized Signature
Doug Smith
Director, Commercial Sales Support, Battery Solutions
Date: 12/31/2016

5900 Brighton Pines Court
Howell, MI 48843

www.batterysolutions.com
800.852.8127

RECHARGING THE PLANET.
RECYCLING YOUR BATTERIES.

call2recycle

Call2Recycle Certificate of Recycling

Date Issued: 3/22/2015

Name :

Time Period: 03/06/2015 - 03/06/2015

Location :

S : : GA-92154-7247

Certificate Reference #: L16
.....-20458322-R-L16

Page 1 of 2

All materials received with the provided certificate of recycling reference number during the time period above, have been received through the Call2Recycle program at the collection center listed in the receipt report. All waste materials accepted for recycling are received, analyzed and processed in accordance with receiving and processing facility permits and requirements. These waste materials are handled in a manner that adheres to applicable federal, state and local laws, ordinances, regulations and guidelines.

Call2Recycle, operated by Call2Recycle, Inc., which administers contracts for used battery and cellphone collection, transportation, consolidation, and recycling; conducts due diligence environmental audits of facilities and contractors; and manages the program compliance with environmental laws.

Carl E. Smith, CEO & President

Call2Recycle, Inc. 11000 Parkwood Circle, Suite 200 | Atlanta, GA 30339 | USA

Call2Recycle Certificate of Recycling

Certificate Reference #:-00188222-R-L16

Time Period: 03/06/2015 - 03/06/2015

Weight in lb

Site ID	Name	City	State	Zip Code	County	Status							
.....	CA	92154-7247	San Diego County	Active							
Receipt Date	Total Wgt	RECY	LI-Ion	NI-CAD	SLA	ALKALINE	LI-Ion	Other	Facility	Ship Date	Ship To	Transp Mode	Receipt ID
03/06/2015	1,240	0	1,240	0	0	0	0	0	WISDOM	03/06/2015	020458322-R-L16	Call2Recycle	020458322-R-L16
Total	1,240	0	1,240	0	0	0	0	0					
Grand Total													

The Rewards of Battery Recycling



- 501c4 non-profit, funded by the battery industry
- 22 years of battery recycling experience
- North America's oldest and most recognized product stewardship organization
- 144 million lb. of batteries recycled from 14,000 customers
- Partnership with The Home Depot, Lowes, Best Buy for consumer rechargeable batteries
- 86% of US residents within a ten mile radius of an active Call2Recycle drop off site



- 26 years of battery recycling experience
- North America's largest battery recycler, processing 50 million pounds, annually
- Our 25th anniversary marked an estimated 1 billion batteries recycled in that time frame
- Award-winning for spreading the word about the circular economy of battery recycling, at the World Economic Forum





Questions?



Tim Warren

US Regional Account Manager

twarren@call2recycle.org



Paul Hernley

Lead Engineer

phernley@batterysolutions.com