Lithium-Ion Battery Response Training

Introductions

NASTTPO 2026, Billings, MT., April 30, 2026

Lithium-Ion Battery Response Training

Introductions

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Introductions

- Considerations to keep in mind
  - Li-ion Batteries are in our life – our intent is not to vilify batteries, but we do need to talk about bad situations to enhance preparedness
  - This training is meant to inform, but not direct
  - Not everything is known about LIB response
  - Future information may change how these incidents are approached
  - Regulations may be Unrealistic (Lack Practicality /Feasibility) and need updates to help address some challenges
  - EPA has a National Task Force for LIBs
    - Response guidance document
    - Continuing training
    - Continuing research

Liability


UNITED STATES
EPA
EMERGENCY
RESPONSE
ENVIRONMENTAL PROTECTION AGENCY

Liability

EPCRA (Emergency Planning and Community Right-to-Know Act) Liability:

- **Purpose:** Reporting
- **Type:**

Strict: The EPA and courts have determined that EPCRA imposes strict liability for reporting violations, meaning the government does not have to prove that a company intended to violate the law to impose penalties.

Civil Enforcement: Section 326 of EPCRA allows for citizen suites against facility owners or operators who fail to comply with reporting requirements.

Reporting Requirements: Strict liability applies to violations of emergency notification (Section 304) and chemical inventory reporting (Section 311/312).

Department of Transportation Liability:

- **Purpose:** DOT PHMSA Incidents specific to training, labeling, and packaging failures
- **Type:** :

Strict: Liable regardless of negligence.

Civil Penalties: Per 49 U.S.C. § 5122, the DOT can impose significant fines for non-compliance, particularly in safety-sensitive areas.

Responsible Parties: Liability applies to “hazmat employers” and employees, including shippers, carriers, and those who certify, pack, or label hazardous materials.

Incident Reporting Liability: Failure to report incidents via DOT Form 5800.1 within 30 days is a significant violation.

Cleanup Liability: Carriers are responsible for safety and cleanup of leaking packages.

Liability

RCRA (Resource Conservation and Recovery Act) Liability:

- **Purpose:** Prevention
- **Type:** While RCRA doesn't explicitly state a standard in the statute courts have applied **strict** liability, meaning liability imposed without regard to fault, negligence or intent.
- **Scope:** Covers generators, transporters, and operators of treatment, storage and disposal facilities (TSDFs).
- **Corrective Action:** Owners/operators can b e held liable for cleanup of releases at active facilities

CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act) Liability:

- **Purpose:** Superfund Emergency Response, TCRA time critical removal actions (1 year or less), and Remedial Actions. Authorities are Stafford Act, CERCLA, and OPA.
- **Type:** Cradle to grave:

  Strict: Liable regardless of negligence or intent.

  Joint and Several: A single party can be liable for the entire cost of cleanup; even if they only contributed a small portion.

  Retroactive: Liable for acts committed before the law was passed in 1980.

- **Scope:** Applies to Potentially Responsible Parties (PRPs), including current owners, former owners at time of disposal, generators, and transporters.

Risk and Regulation

Lithium – ion Batteries: dynamic community risk issue with mitigation challenges!

U.S. Fire Administration
Working for a fire-safe America

Home / A-Z Index / Lithium-Ion Batteries / Risks and Response Strategies

In this section

Risks and Response Strategies for Lithium-ion Battery Fires

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Lithium-ion batteries have emerged as the power source of choice for a vast array of modern tools and mobility devices. From toothbrushes to smartphones, construction tools to medical devices, scooters to cars, these rechargeable power sources have transformed the way we power our homes, cities and everything in between.

However, there are risks associated with lithium-ion batteries, and firefighters must be aware of the challenges they present and the measures needed to mitigate these dangers when tackling incidents involving these devices.

Lithium – ion Batteries: dynamic community risk issue with mitigation challenges!

- Risk = Hazard x Exposure
  - Control the variables to reduce risk.
- Define problem(s), the opposite of the problem is the objective.
- Understand the difference between quantitative and qualitative data, analysis, and risk-based decision making.
  - Life Safety, Environment, Property, Commerce

Some Specific Regulations for Lithium-ion Batteries May be Unrealistic (Lack Practicality /Feasibility)

- Federal regulations are described as "circular" in nature, which generally means they create a self-reinforcing, repetitive, or logically looped system where compliance requires referencing other regulations that refer back to the first, or where the policy justification depends on itself rather than external evidence.
- When the regulations were established and currently enforced, do they truly reflect the hazard characteristics of the material?
- Regardless of regulatory efficacy, fires, explosions, toxic releases, and first responder/community exposures are still occurring.
- The fight will continue to come and how will we as LEPCs, ultimately prepare for that fight with an unfair advantage?

Lithium – ion Batteries and EPCRA 311-312 Reporting Requirements

An official website of the United States government Here's how you know

EPA United States Environmental Protection Agency

Search EPA.gov

Environmental Topics | Laws & Regulations | Report a Violation | About EPA

Home / Emergency Planning and Community Right-to-Know Act (EPCRA)

Emergency Planning and Community Right-to-Know Act (EPCRA)

- About EPCRA
- Emergency Planning
- Emergency Release Notifications
- Hazardous Chemical Inventory Reporting

Lithium - Ion Batteries and EPCRA 311-312 Reporting Requirements

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Lithium - Ion Batteries and EPCRA 311-312 Reporting Requirements

When are lithium - ion batteries subject to the EPCRA Sections 311 and 312 Hazardous Chemical Inventory Reporting requirements?

The reporting requirements of EPCRA sections 311 and 312, *Hazardous Chemical Inventory Reporting*, [40 CFR part 370] apply to owners and operators of facilities that are required to prepare or have a Safety Data Sheet (SDS) [formerly known as Material Safety Data Sheet (MSDS)] for any hazardous chemical as defined under the Occupational Safety and Health Administration's (OSHA) Hazardous Communication Standards (HCS) [29 CFR 1910.1200(c)], except those hazardous chemicals that are exempt from reporting under the OSHA HCS [29 CFR 1910.1200(b)(6)] or the EPCRA section 311(e).

Exemptions that may apply to lithium-ion batteries include the Consumer Product Exemption [40 CFR 370.13(c)(1)] and the Resource Conservation and Recovery Act (RCRA) exemption [29 CFR 1910.1200(b)(6)(i)]. These exemptions are explained further below.

For more information on the EPCRA Hazardous Chemical Inventory Reporting requirements, please visit our webpage.

Title 40 / Chapter I / Subchapter J / Part 370 Previous / Next / Top

Table of Contents

Details

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Display Options

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Go to Date

Compare Dates

Subpart B—Who Must Comply

§ 370.10 Who must comply with the hazardous chemical reporting requirements of this part?

(a) You must comply with the reporting requirements of this part if the Occupational Safety and Health Administration's (OSHA) Hazard Communication Standard (HCS) require your facility to prepare or have available a Material Safety Data Sheet (MSDS) (or Safety Data Sheet (SDS)) for a hazardous chemical and if either of the following conditions is met:

(1) A hazardous chemical that is an Extremely Hazardous Substance (EHS) is present at your facility at any one time in an amount equal to or greater than 500 pounds (227 kg—approximately 55 gallons) or the Threshold Planning Quantity (TPQ), whichever is lower. EHSs and their TPQs are listed in Appendices A and B of 40 CFR part 355.

(2) A hazardous chemical that is not an EHS is present at your facility at any one time in an amount equal to or greater than the threshold level for that hazardous chemical. Threshold levels for such hazardous chemicals are:

(i) For any hazardous chemical that does not meet the criteria in paragraph (a)(2)(ii) or (iii) of this section, the threshold level is 10,000 pounds (or 4,540 kg).

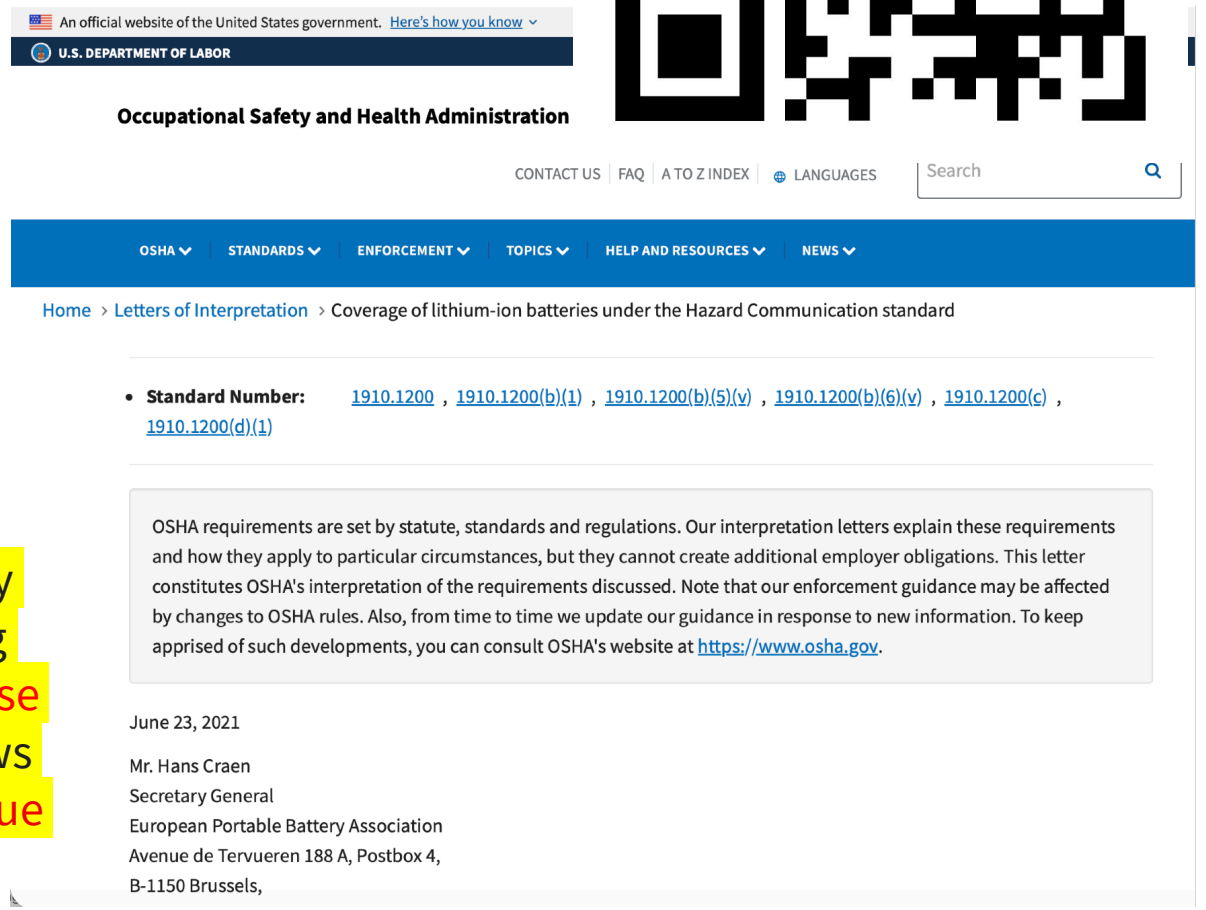
Lithium – ion Batteries and EPCRA 311-312 Reporting Requirements and OSHA Letter

Are lithium-ion batteries considered to be "articles" under the OSHA HCS and for EPCRA Sections 311 and 312 Inventory Reporting Requirements?

No. OSHA has determined that lithium-ion batteries are not considered to be "articles" and are subject to the OSHA HCS regulations. Lithium-ion batteries are not considered to be articles because although they are sealed, they have the potential to leak, spill, or break during normal conditions of use and in foreseeable emergencies causing exposure to chemicals.

Source: OSHA Letter of Interpretation - Coverage of lithium-ion batteries under the Hazard Communication standard.

The information shows that while lithium cell or battery technology is complex, potential cell or battery failure during use and handling can present a fire (physical) hazard, which has caused or could cause workers to be exposed to burns. Additionally, the information shows that toxic air contaminants (e.g., lithium, cobalt) can be released due to chemical leakage or venting when the battery is damaged or catches fire, potentially exposing workers to a health hazard.



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U.S. DEPARTMENT OF LABOR

Occupational Safety and Health Administration

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Home › Letters of Interpretation › Coverage of lithium-ion batteries under the Hazard Communication standard

- **Standard Number:** 1910.1200 , 1910.1200(b)(1) , 1910.1200(b)(5)(v) , 1910.1200(b)(6)(v) , 1910.1200(c) , 1910.1200(d)(1)

OSHA requirements are set by statute, standards and regulations. Our interpretation letters explain these requirements and how they apply to particular circumstances, but they cannot create additional employer obligations. This letter constitutes OSHA's interpretation of the requirements discussed. Note that our enforcement guidance may be affected by changes to OSHA rules. Also, from time to time we update our guidance in response to new information. To keep apprised of such developments, you can consult OSHA's website at https://www.osha.gov.

June 23, 2021

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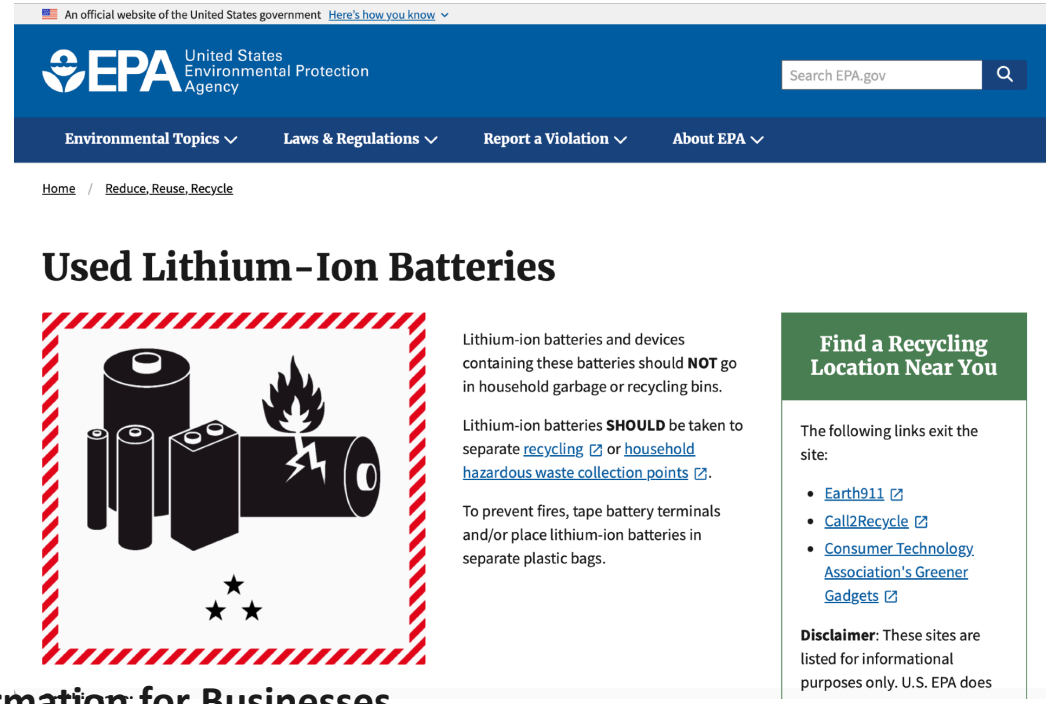
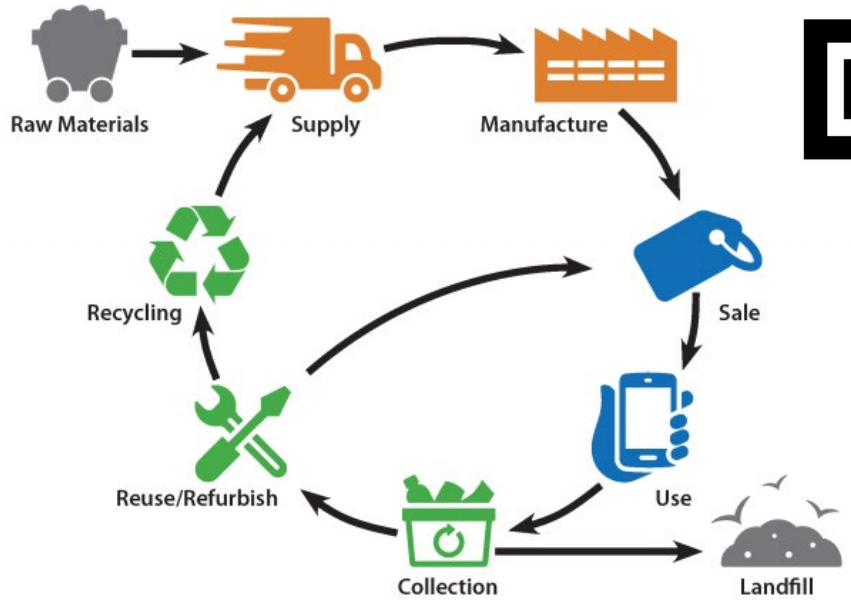
Lithium – ion Batteries and EPCRA 311-312 Reporting Requirements and Used

Lithium-Ion Batteries





Information for Businesses

Most lithium-ion batteries on the market are likely to meet the definition of hazardous waste under the Resource Conservation and Recovery Act (RCRA). Most lithium-ion batteries when discarded would likely be considered ignitable and reactive hazardous wastes (carrying the waste codes D001 and D003, respectively). Persons who generate wastes that are defined as hazardous under RCRA are referred to as "hazardous waste generators." These regulations do not apply to households because under RCRA, hazardous wastes discarded by households are generally exempt from hazardous waste regulations. In contrast, commercial establishments **are responsible** for determining whether any waste they produce is hazardous waste, including Li-ion batteries at their end of life.

Lithium – ion Batteries and EPCRA 311-312 Reporting Requirements *and Used Lithium-Ion Batteries*

Lithium - Ion Batteries and EPCRA 311-312 Reporting Requirements

Are recycled batteries exempt from the EPCRA Sections 311 and 312 Hazardous Chemical Inventory Reporting requirements under the RCRA hazardous waste exemption?

No. Once materials and batteries have completed the recycling or reclamation processes, the new materials and products are no longer covered under the RCRA regulations, and are therefore not eligible for the EPCRA hazardous waste exemption.

Lithium – ion Batteries and EPCRA 311-312 Reporting Requirements *and Used Lithium-Ion Batteries*

Lithium - Ion Batteries and EPCRA 311-312 Reporting Requirements

Can states require that lithium-ion batteries be reported as Hazardous Chemicals, if reporting isn't a federal requirement?

Yes. States, tribes, and territories can have more stringent applicability and reporting requirements for lithium-ion batteries.

"States were always given the flexibility to implement the EPCRA program as necessary to meet the goals of EPCRA, which is to prepare for and respond to releases of EHSs and to provide the public with information on potential chemical risks in their communities. This flexibility includes adding more chemicals, setting lower reporting thresholds and creating a reporting form or format that includes more information than is required by the Federal reporting requirements." (75 FR 39854; July 13, 2010).

Facilities should contact their state for the specific requirements for that state.

Last updated on February 20, 2026

Lithium-Ion Battery Response Training

Battery Basics and Hazards

Total Incidents by Category

Total incidents reported for each category

CONSUMER PRODUCTS

2,178 total injuries

199 total fatalities

ELECTRIC VEHICLES (>20MPH)

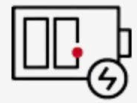
192 total injuries

103 total fatalities

MICRO-MOBILITY DEVICES (<20MPH)

1,982 total injuries

340 total fatalities



ENERGY STORAGE SYSTEMS

65 total injuries

4 total fatalities

https://www.ul.com/insights/lithium-ion-battery-incident-reporting

Battery Types (Primary)

Non-rechargeable Batteries (Alkaline)

- Stable, no significant energetic releases.
- Consistent energy, long-term power, but loses strength over time.
- Long shelf life.

Non-rechargeable Batteries (Lithium Metal)

- Stable, large energy density.
- Can provide strong energy surges even after a period of low discharge
- Lithium metal found inside is **extremely water reactive**

Battery Types (Secondary)

Lead Acid Batteries

- Stable, low energy density
- Contains lead and sulfuric acid
- Risk of explosion due to oxygen and hydrogen generation during charging

Nickel Cadmium (NiCad)/Nickel Metal Hydride (NiMH) Batteries

- Rechargeable and stable
- Suffers from “memory effect”
- Can be smothered (METAL-X, sand, etc.)
- Water application can cause hydrogen gas release

Lithium-Ion Battery Types

18650
18 x 65 mm

2170
21 x 70 mm

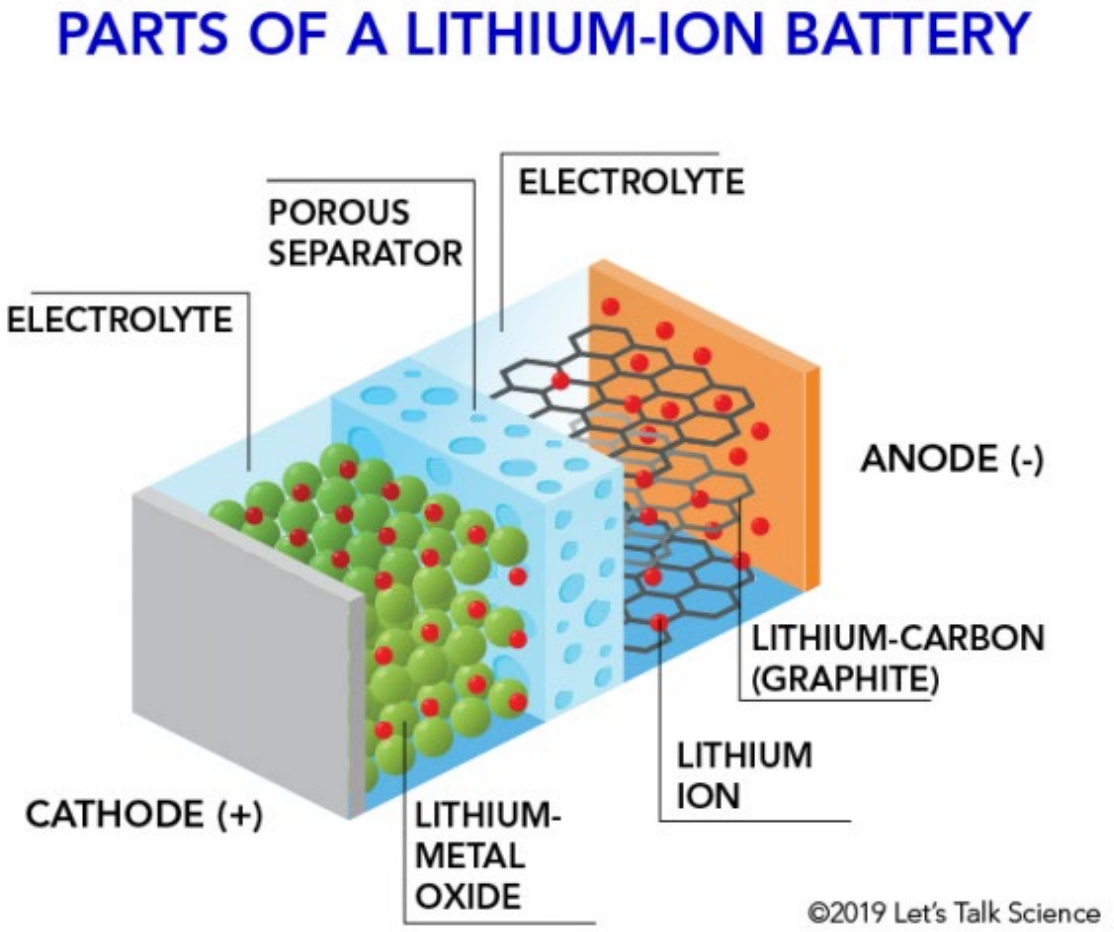
Cylindrical cells (18650) are the most common cell in mobility devices (bikes, scooters, etc.) and are used by electric vehicles with 3,000 to 8,000 cells

Prismatic Cell

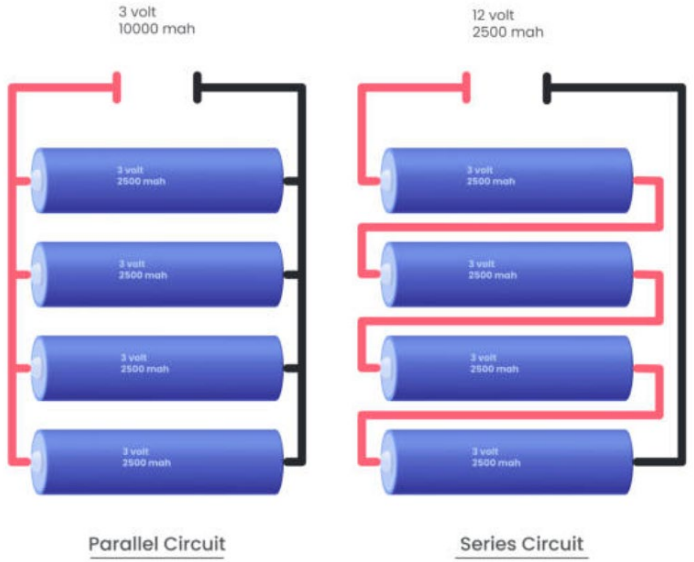
Pouch Cell

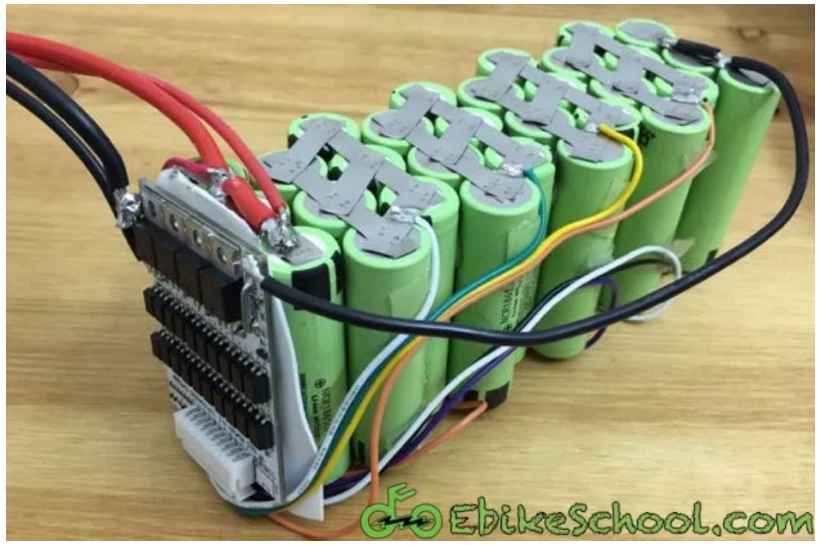
Prismatic and Pouch Cells are found in industrial and consumer electronics, respectively; both are used in electric and hybrid vehicles

Lithium-Ion Battery (LIB) Construction



Battery Configurations





The most common configuration for Electric Vehicle (EV) batteries is a series-parallel hybrid.

Series Connection: Increases the battery pack's voltage, which is vital for providing the necessary power to drive the vehicle.

Parallel Connection: Increases the battery pack's capacity, essential for storing the energy required to achieve the desired range.

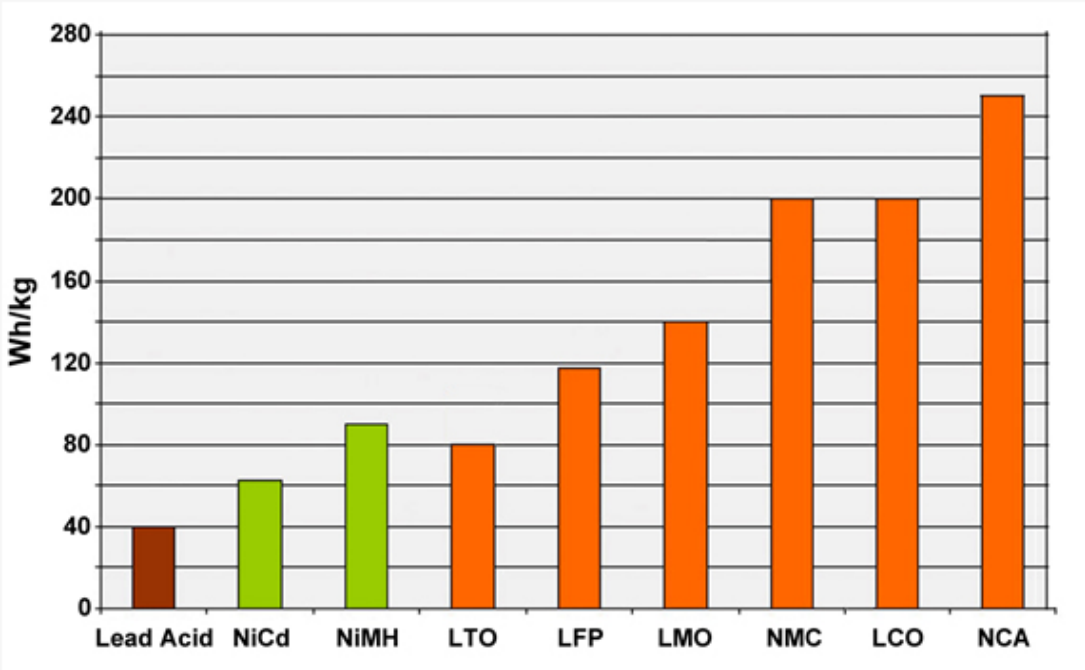
To calculate the gross battery pack size, multiply the total parallel capacity in ampere-hours (Ah) by the battery pack's nominal voltage in volts (V). The result is in watt-hours (Wh).

LIB Chemistries

Acronym	Name	Formula
LCO	Lithium Cobalt Oxide	$LiCoO_2$
NCA	Lithium Nickel Cobalt Aluminum Oxide	$LiNiCoAlO_2$
NMC	Lithium Nickel Manganese Cobalt Oxide	$LiNiMnCoO_2$
LMO	Lithium Manganese Oxide	$LiMn_2O_4$
LFP	Lithium Iron Phosphate	$LiFePO_4$
LTO	Lithium Titanate	Li_2TiO_3

Chemistries cannot always be mixed in recycling

Energy Density by Chemistry



LIB Toxic/Flammable Smoke (Gases & Solids/Liquids)

Flammable and Toxic Smoke:

- Hydrogen (30%-50%)
- Carbon Monoxide
- Carbon Dioxide
- Hydrogen Fluoride
- Hydrogen Chloride
- Hydrogen Cyanide
- Phosphoryl Fluoride
- Organic Solvent Droplets
- Ethane, methane, and other hydrocarbons/**gases**
- Heavy Metal Particulates

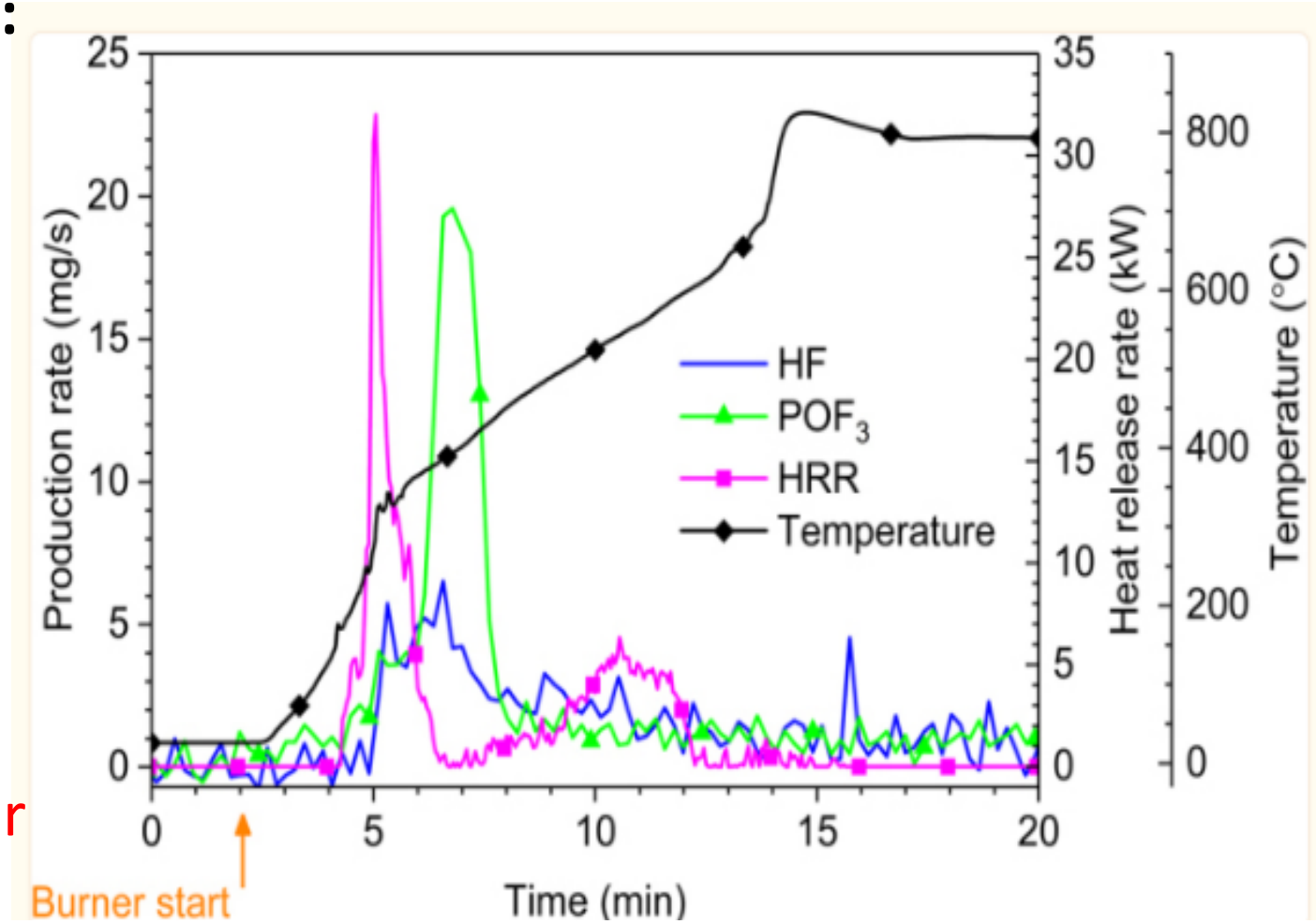


Image Source: Larsson et. al, 2017.

SAN DIEGO LITHIUM-ION BATTERY FIELD STUDY DATA SUMMARY:

AIR MONITORING

Run	Test Media	Air Monitoring Data							
1	4 LiFePO4 100% SOC		O2 %	VOC	CO	LEL %	HCN	HF	Particulate
		Min	20.9	-2.7	-1	0	0	0	0.001
		Max	20.9	0	5	0	0.8	0.58	0.707
2	4 LiFePO4 18500 SOC Unknown		O2 %	VOC	CO	LEL %	HCN	HF	Particulate
		Min	20.9	-2.7	0	0	0	0	0
		Max	20.9	9.8	36	0	1.1	20	10.082
3	8 LiFePO4 18500 "Low SOC"		O2 %	VOC	CO	LEL %	HCN	HF	Particulate
		Min	20.9	-2.1	0	0	0	0	0
		Max	20.9	66.5	171	2	3.9	0.95	7.567
4	8 LiFePO4 18500 100% SOC		O2 %	VOC	CO	LEL %	HCN	HF	Particulate
		Min	20.9	-0.6	3	0	0	0	0
		Max	20.9	36.4	52	0	1.4	20	35.439
5	12 NMC (Nuon) 18650 100% SOC		O2 %	VOC	CO	LEL %	HCN	HF	Particulate
		Min	20.9	-1.8	-2	0	-0.8	0	0
		Max	20.9	1.1	3	0	0	1.62	23.533
6	44 NMC 21700 Zheijang Skateboard 100% SOC		O2 %	VOC	CO	LEL %	HCN	HF	Particulate
		Min	19.4	0	0	0	-0.6	0	0
		Max	20.9	135	2460	6	18.2	1.08	100
7	8 NMC Mollicel ISS 21700 <100% SOC		O2 %	VOC	CO	LEL %	HCN	HF	Particulate
		Min	20.2	0	14	0	1.6	0	0
		Max	20.9	50.5	1190	3	5.8	0	1.439
8	65 NMC KULR Ebike & Amazon 18650 SOC "as shipped"		O2 %	VOC	CO	LEL %	HCN	HF	Particulate
		Min	20.9	0.3	5	0	0.6	0	0
		Max	20.9	26.4	206	0	1.4	0	0.188
9	18 NMC Mollicel ISS 21700 100% SOC		O2 %	VOC	CO	LEL %	HCN	HF	Particulate
		Min	20.9	0	0	0	0	0	0.004
		Max	20.9	0.6	3	0	0.6	0	100
10	2 LiFePO4 ESS (Prismatic) 1 charged, 1 uncharged		O2 %	VOC	CO	LEL %	HCN	HF	Particulate
		Min	20.9	2.1	3	0	0	0	NA
		Max	20.9	165	350	4	4.2	0	NA
11	48 NMC Zheijang Skateboard 21700 <40V SOC		O2 %	VOC	CO	LEL %	HCN	HF	Particulate
		Min	18.9	2.8	12	0	0	0	0.005
		Max	20.9	94.5	910	3	3	0.49	100
12	48 NMC Zheijang Skateboard 21700 100% SOC (49.6V)		O2 %	VOC	CO	LEL %	HCN	HF	Particulate
		Min	18.9	2.1	10	0	-2.6	0	0.003
		Max	20.9	87.5	1560	4	13.1	20	100
13	3 x NMC Zheijang Skateboard in Akkugrain Box (144 cells total) 100% SOC		O2 %	VOC	CO	LEL %	HCN	HF	Particulate
		Min	19.1	0.4	0	0	0	0	0.005
		Max	20.9	780	11400	37	80.5	0	100

Yellow = over OSHA PEL, Green = H2 over MIE 4% LEL

Contaminant/Sensor	Action Level
Hydrofluoric Acid (HF)	Cal/OSHA PEL = 0.4 ppm, STEL 1 ppm
Hydrogen Cyanide (HCN)	Cal/OSHA PEL = 10 ppm, Ceiling = 4.7 ppm
Hydrogen (H2) LEL%	Minimum Ignition Energy (MIE) is 4,000 ppm or 4% by volume
Carbon Monoxide (CO)	Cal/OSHA PEL = 25 ppm, Ceiling = 200 ppm Also a 40% cross-sensitivity with H2

SAN DIEGO LITHIUM-ION BATTERY FIELD STUDY DATA SUMMARY:

AIR SAMPLING

Sampling Method	Media	Target Analytes
ASTM-D-1945	Tedlar Bag, vacuum box, pump	H2, CO, O2 ppm (v/v) and (m/m)
NIOSH 6010	Colorimetric tubes, pump	HCN
NIOSH 7902	Filter cassette, pump	HF (vapor and soluble particulate)
NIOSH 7303	Filter cassette, pump	Ag, As, Ba, Be, Cd, Co, Cr, Cu, Mo, Ni, Pb, Sb, Se, Tl, V, Zn Expanded list: Al, Fe, Mn, Sr, Sn, Ti

Run #	Test Media	Air Sampling Data									
3	8 LiFePO4 18500 "Low SOC"		H2	CO	O2	HCN	HF (vapor)	HF (particulate, mg/m3)			
		ppm	260	<100	277k	ND	25	0.23			
			Cu	Ni	Sb	Zn					
		µg/m3	350	7	130	60					
7	8 NMC Mollicel ISS 21700 <100% SOC		H2	CO	O2	HCN	HF (vapor)	HF (particulate, mg/m3)			
		ppm	230	740	265K	ND	0.58	43			
			Ag	Ba	Co	Cu	Ni	Pb	Sb	Tl	Zn
		µg/m3	6	19	18000	29000	190k	30	570	130	9500
			Al	Fe	Mn	Sr	Ti				
		mg/m3	2500	140	21	1.1	64				
9	18 NMC Mollicel ISS 21700 100% SOC		H2	CO	O2	HCN	HF (vapor)	HF (particulate, mg/m3)			
		ppm	400	790	255k	2.5	0.94	1.3			
			Ba	Co	Cu	Ni	Sb	Tl	Zn		
		µg/m3	3	2800	650	26000	210	20	350		
			Al	Mn	Sr	Ti					
		mg/m3	2400	6.6	0.76	2.9					
11	48 NMC Zheijang Skateboard 21700 <40V SOC		H2	CO	O2	HCN	HF (vapor)	HF (particulate, mg/m3)			
		ppm	230	740	265k	ND	0.58	43			
			Co	Cu	Ni	Sb	Zn				
		µg/m3	220	43	1900	120	70				
			Al	Mn							
		mg/m3	70	0.24							
12	48 NMC Zheijang Skateboard 21700 100% SOC (49.6V)		H2	CO	O2	HCN	HF (vapor)	HF (particulate, mg/m3)			
		ppm	240	1480	247k	0.87	0.77	24			
			Ba	Co	Cu	Ni	Pb	Sb	Tl	Zn	
		µg/m3	21	7600	7500	70000	430	1400	60	1100	
			Al	Fe	Mn	Sr	Sn	Ti			
		mg/m3	1000	12	6.9	0.83	21	4.2			
13	3 x NMC Zheijang Skateboard in Akkugrain Box (144 cells total) 100% SOC		H2	CO	O2	HCN	HF (vapor)	HF (particulate, mg/m3)			
		ppm	14400	16720	264k	ND	0.56	17			
			Ba	Co	Cu	Ni	Pb	Sb	Zn		
		µg/m3	46	3600	2300	33000	220	240	470		
			Al	Fe	Mn	Sr	Sn	Ti			
		mg/m3	650	13	0.54	0.15	21	1.8			

Yellow = over OSHA PEL, Green = H2 over MIE 4% LEL

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NIOSH 6010	Colorimetric tubes, pump	HCN
NIOSH 7902	Filter cassette, pump	HF (vapor and soluble particulate)
NIOSH 7303	Filter cassette, pump	Ag, As, Ba, Be, Cd, Co, Cr, Cu, Mo, Ni, Pb, Sb, Se, Tl, V, Zn Expanded list: Al, Fe, Mn, Sr, Sn, Ti

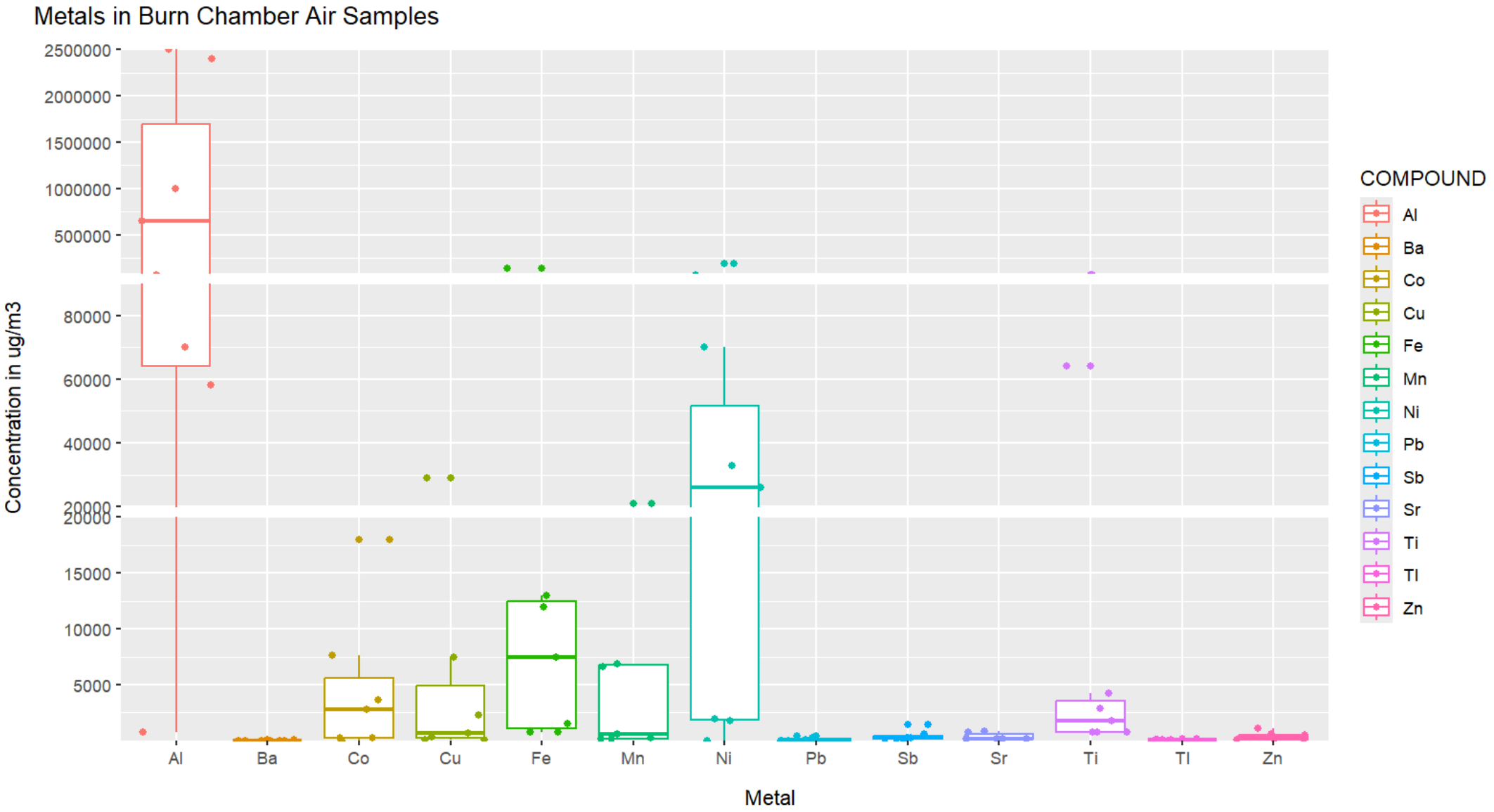
Run #	Test Media	Air Sampling Data									
3	8 LiFePO4 18500 "Low SOC"		H2	CO	O2	HCN	HF (vapor)	HF (particulate, mg/m3)			
		ppm	260	<100	277k	ND	25	0.23			
			Cu	Ni	Sb	Zn					
		µg/m3	350	7	130	60					
7	8 NMC Mollicel ISS 21700 <100% SOC		H2	CO	O2	HCN	HF (vapor)	HF (particulate, mg/m3)			
		ppm	230	740	265K	ND	0.58	43			
			Ag	Ba	Co	Cu	Ni	Pb	Sb	Tl	Zn
		µg/m3	6	19	18000	29000	190k	30	570	130	9500
			Al	Fe	Mn	Sr	Ti				
		mg/m3	2500	140	21	1.1	64				
9	18 NMC Mollicel ISS 21700 100% SOC		H2	CO	O2	HCN	HF (vapor)	HF (particulate, mg/m3)			
		ppm	400	790	255k	2.5	0.94	1.3			
			Ba	Co	Cu	Ni	Sb	Tl	Zn		
		µg/m3	3	2800	650	26000	210	20	350		
			Al	Mn	Sr	Ti					
		mg/m3	2400	6.6	0.76	2.9					
11	48 NMC Zheiang Skateboard 21700 <40V SOC		H2	CO	O2	HCN	HF (vapor)	HF (particulate, mg/m3)			
		ppm	230	740	265k	ND	0.58	43			
			Co	Cu	Ni	Sb	Zn				
		µg/m3	220	43	1900	120	70				
			Al	Mn							
		mg/m3	70	0.24							
12	48 NMC Zheiang Skateboard 21700 100% SOC (49.6V)		H2	CO	O2	HCN	HF (vapor)	HF (particulate, mg/m3)			
		ppm	240	1480	247k	0.87	0.77	24			
			Ba	Co	Cu	Ni	Pb	Sb	Tl	Zn	
		µg/m3	21	7600	7500	70000	430	1400	60	1100	
			Al	Fe	Mn	Sr	Sn	Ti			
		mg/m3	1000	12	6.9	0.83	21	4.2			
13	3 x NMC Zheiang Skateboard in Akkugrain Box (144 cells total) 100% SOC		H2	CO	O2	HCN	HF (vapor)	HF (particulate, mg/m3)			
		ppm	14400	16720	264k	ND	0.56	17			
			Ba	Co	Cu	Ni	Pb	Sb	Zn		
		µg/m3	46	3600	2300	33000	220	240	470		
			Al	Fe	Mn	Sr	Sn	Ti			
		mg/m3	650	13	0.54	0.15	21	1.8			

Yellow = over OSHA PEL, Green = H2 over MIE 4% LEL

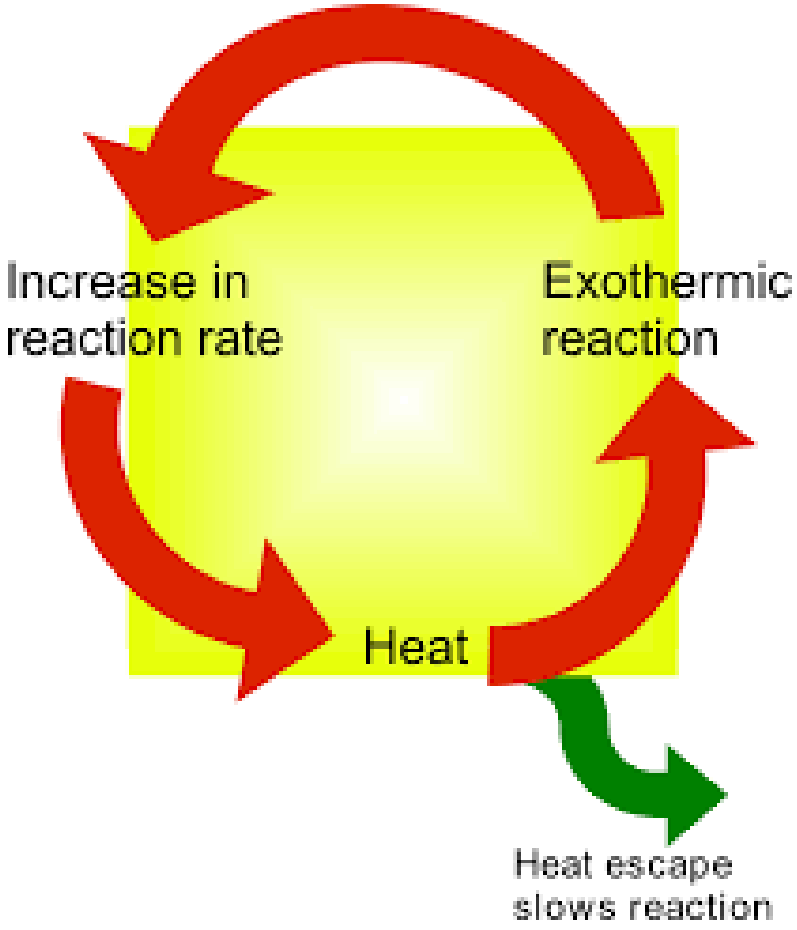
Occupational/Industrial Limits for Metals of Concern (µg/m^3)

Metal	Carcinogen?	IDLH	NIOSH REL (10-hr TWA)	OSHA PEL (8-hr TWA)
Aluminum	No	-	10,000	15,000
Antimony [a]	No	50,000	500	500
Arsenic [a,b]	Yes	500	2b	10
Barium	No	50,000	500	500
Beryllium [a,c]	Yes	400	0.5	2
Cadmium [a]	Yes	900	N.E.	0.005
Chromium [a]	No	250,000	0.5	1
Cobalt [a]	No	20,000	0.05	0.1
Copper [d]	No	100,000	1	1
Iron	Yes	2,500,000	5,000	10,000
Lead [a,e]	No	100,000	50	50
Manganese [a,f]	No	500,000	1,000	5,000
Mercury [a,g]	No	10,000	0.1	100
Molybdenum	No	1,000,000	5,000	5,000
Nickel [a,h]	Yes	10,000	15	1000
Selenium [a,i]	No	100	200	200
Silver	No	10,000	10	10
Strontium	No	-	-	-
Thallium	No	15,000	100	100
Titanium	No	-	-	15,000
Tin	No	25,000	2,000	2,000
Vanadium [j]	No	35,000	50	50
Zinc	No	500,000	5,000	15,000

IDLH = Immediately Detrimental to Life and Health
NIOSH = National Institute of Occupational Safety and Health REL= Recommended Exposure Limit
OSHA = Occupational Safety and Health Administration PEL= Permissible Exposure Limit
a Metals designated as Hazardous Air Pollutants by the EPA.
b NIOSH REL for arsenic is a 15-minute ceiling
c OSHA PEL for beryllium has a 30-minute ceiling of 5 µg/m3
d Additional REL of 0.1 and PEL of 0.1 for copper fume
e NIOSH REL for lead is an 8-hour TWA standard
f NIOSH short term exposure limit (STEL) for manganese is 3,000 µg/m3 and the PEL is a
g NIOSH REL for mercury for skin is 50 µg/m3 and the REL is a ceiling
h Nickel as Ni(CO)4 has an IDLH of 14,000 µg/m3 and an REL and PEL of 7 µg/m3
i Selenium as SeF6 has an IDLH of 2000 µg/m3 and an REL and PEL of 400 µg/m3
j NIOSH REL for vanadium is a 15-minute limit


Metals in Burn Chamber Air Samples
Concentration in ug/m3
2500000
2000000
1500000
1000000
500000
80000
60000
40000
20000
20000
15000
10000
5000
Al
Ba
Co
Cu
Fe
Mn
Ni
Pb
Sb
Sr
Ti
Tl
Zn
Metal
COMPOUND
Al
Ba
Co
Cu
Fe
Mn
Ni
Pb
Sb
Sr
Ti
Tl
Zn

Differences in LIB Fires



Toxic gas release → hazardous atmosphere

Hydrogen gas release → explosion potential

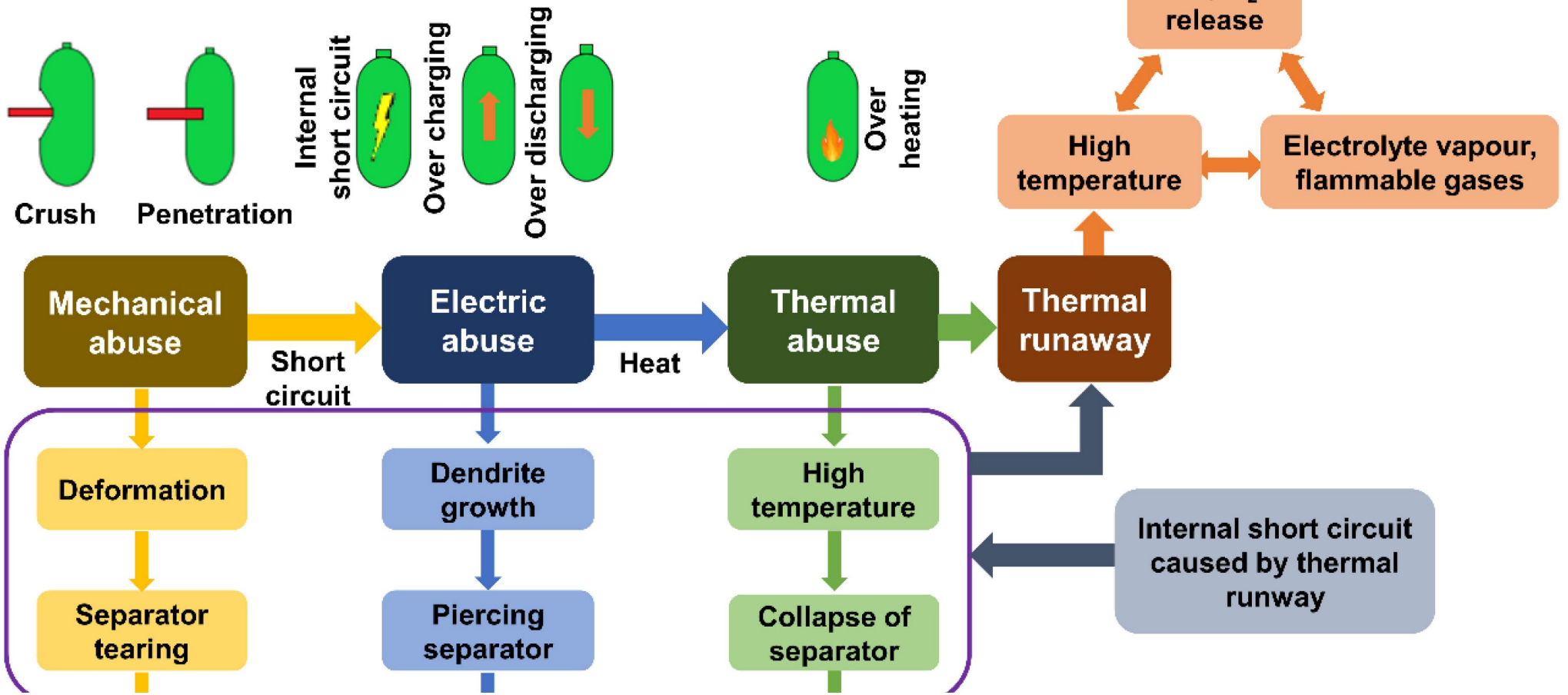
Higher than normal burn temperatures → thermal runaway reaction

- Chemical reaction – rapid degradation
- Does not require external oxygen
- Nearly impossible to stop once it starts
- Could happen in seconds or days

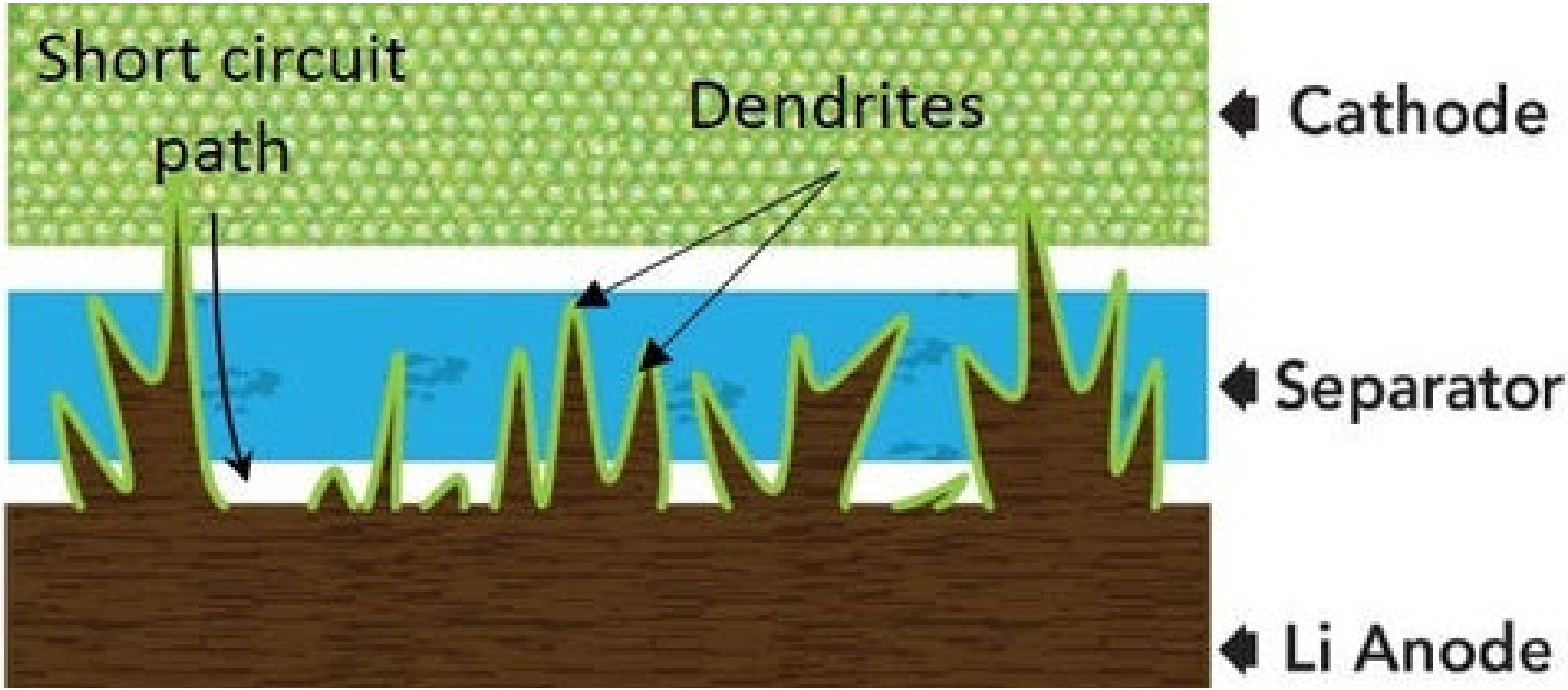
Re-ignition is possible – minutes, hours, days, weeks, months, even years later!

Causes of Battery Failure

Manufacturer Defect



Dendrites



Thermal Propagation

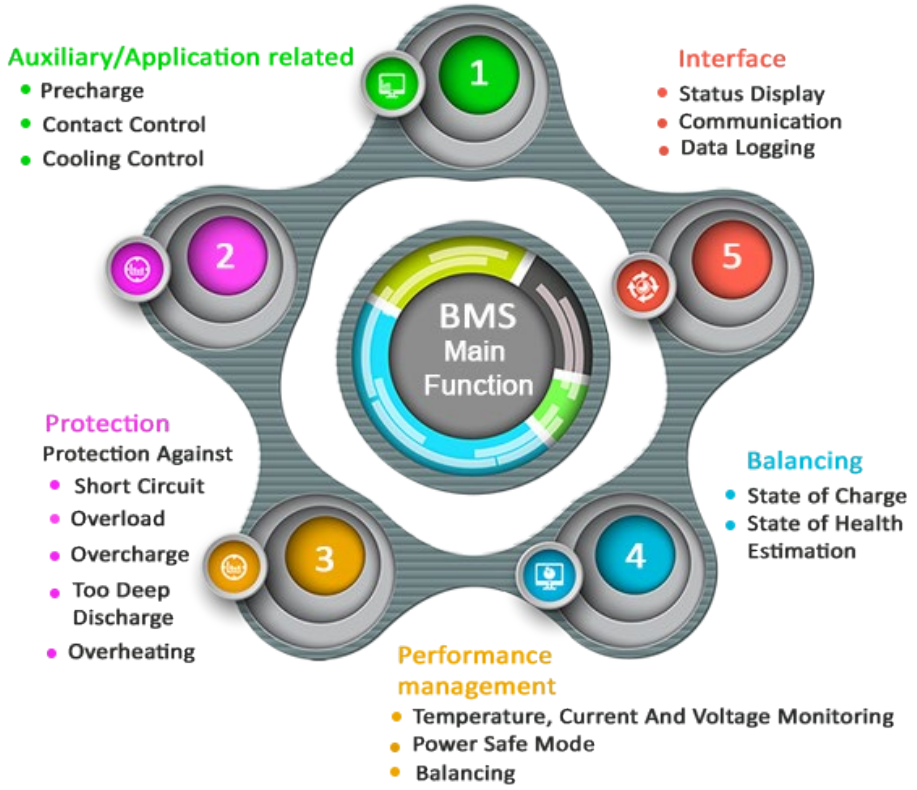
- Thermal propagation results in a domino effect:
  - Thermal runaway heat in one battery will trigger thermal damage and/or thermal runaway in neighboring cells.
  - Thermal damage to neighboring cells may result in delayed thermal runaway or delayed thermal propagation ignition (Reignition).

Limiting thermal propagation is primary goal:

- Direct cooling of neighboring cells may limit/prevent thermal propagation
- Removing exposed cells (i.e., removing other e-bikes, loose cells, immersing in water, etc.)

Preventing Battery Failure

- A battery pack built together with a battery management system with an external communication data bus is a smart battery pack.
- **A smart battery pack must be charged by a smart battery charger.**



Primary Presentations of LIBs

- Energy Storage Systems
- Electric Vehicles
- Micro-mobility
- Consumer Products

Residential

kWh

Commercial

kWh - MWh

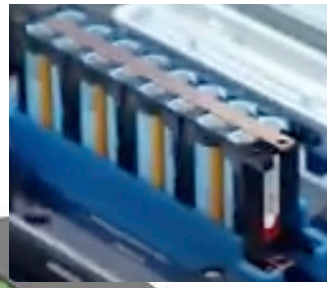
Utility-Scale

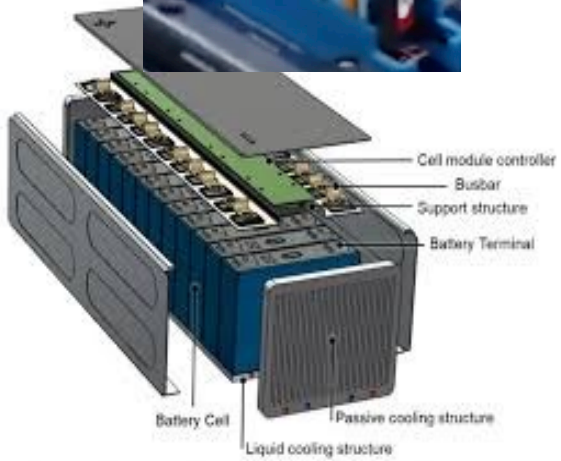
MWh - GWh

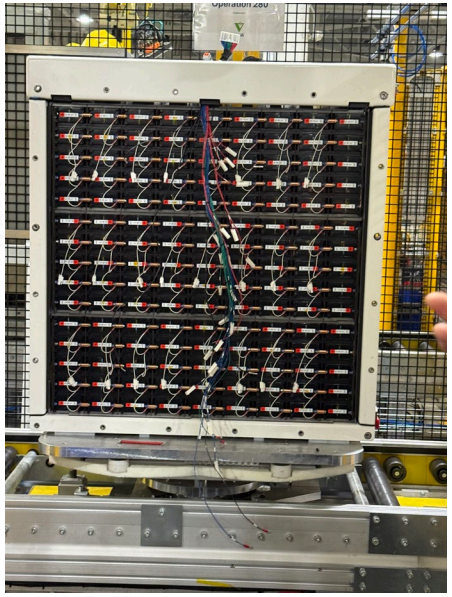
Battery Energy Storage System (BESS)

Unit 3

BESS Structure





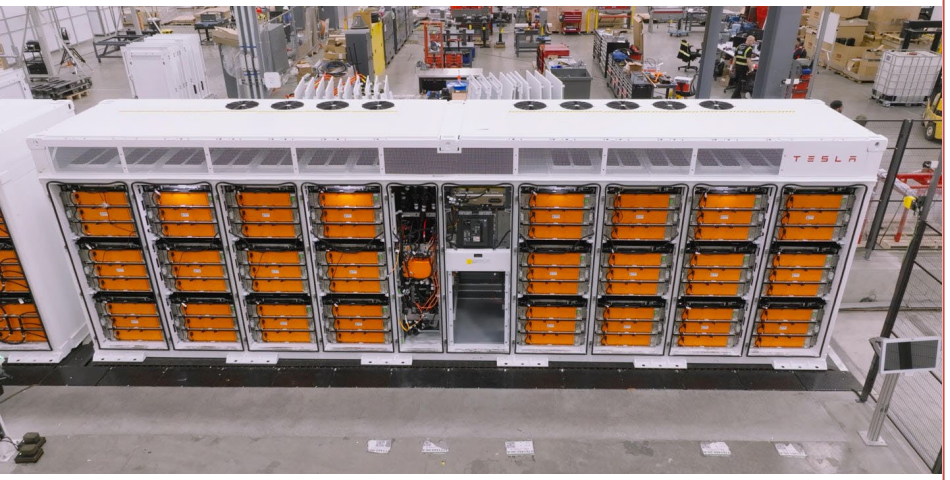


Cells → Modules → Racks

Can be made up of single or multiple racks

BESS Response

Codes and Standards



Codes

- NFPA1 – Fire Code
- IFC – International Fire Code

Standards

- NFPA 855 –
  - Changed after Surprise, AZ
  - Access restrictions
  - Increased monitoring requirements
  - Hazard Mitigation Analysis (HMA)
  - Stricter ventilation system requirements
  - Fire prevention/mitigation technology
    - Varies by manufacturer
- UL 9540
  - Roadmap for how systems are designed, built, tested, and used

Codes and Standards

Performance Standards – 9540A

UL 9540A is a test method for evaluating thermal runaway propagation for battery energy storage system

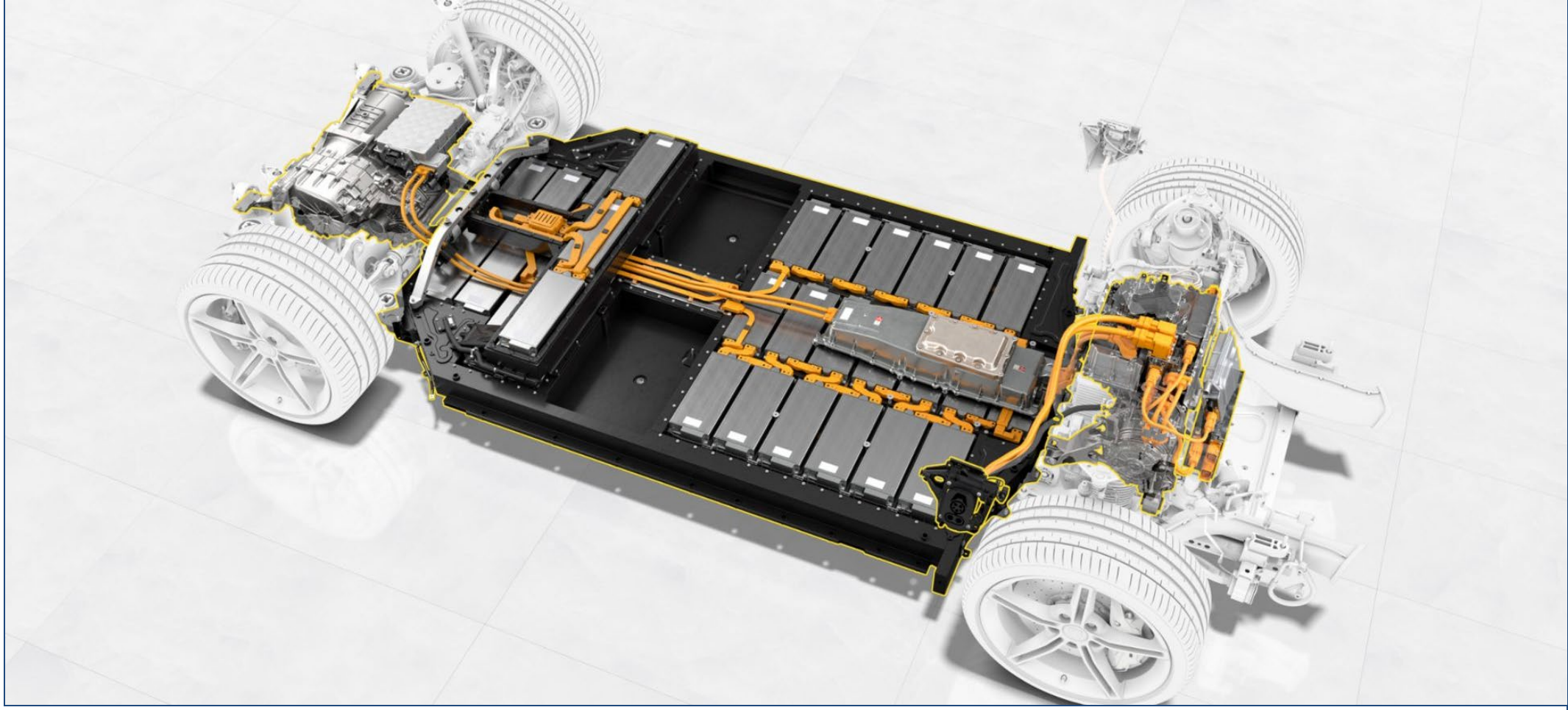
CSA TS-800

"CSA TS-800" refers to a standardized test procedure developed by the CSA Group, designed to evaluate the fire safety of large-scale battery energy storage systems (BESS) by simulating a fully involved fire event and assessing if it propagates to nearby units or external exposures

Residential BESS

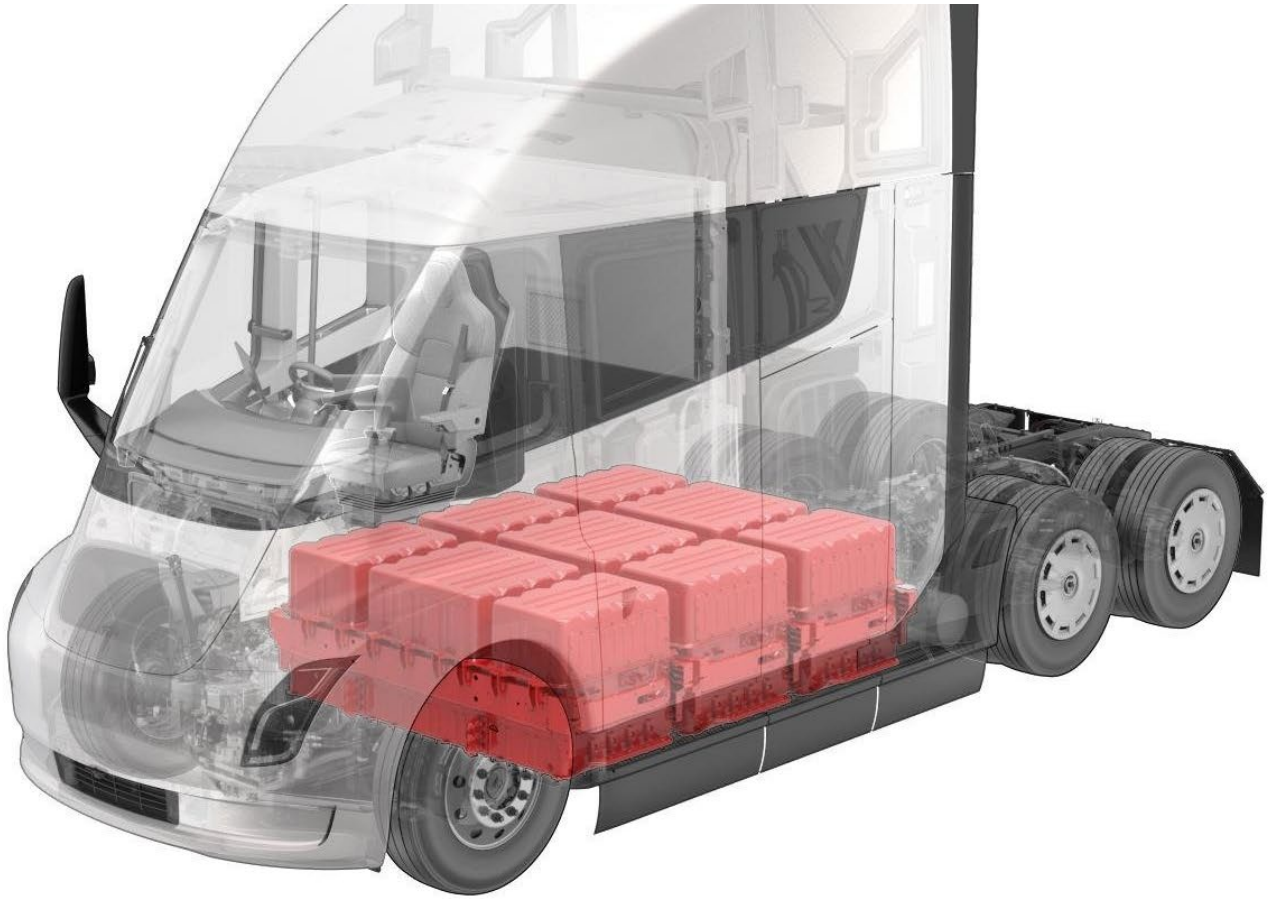
FSRI estimated the amount of gas released from a residential BESS and what would happen if it caught a source of ignition.

Large Scale BESS in Transit Strategic and Tactical Considerations



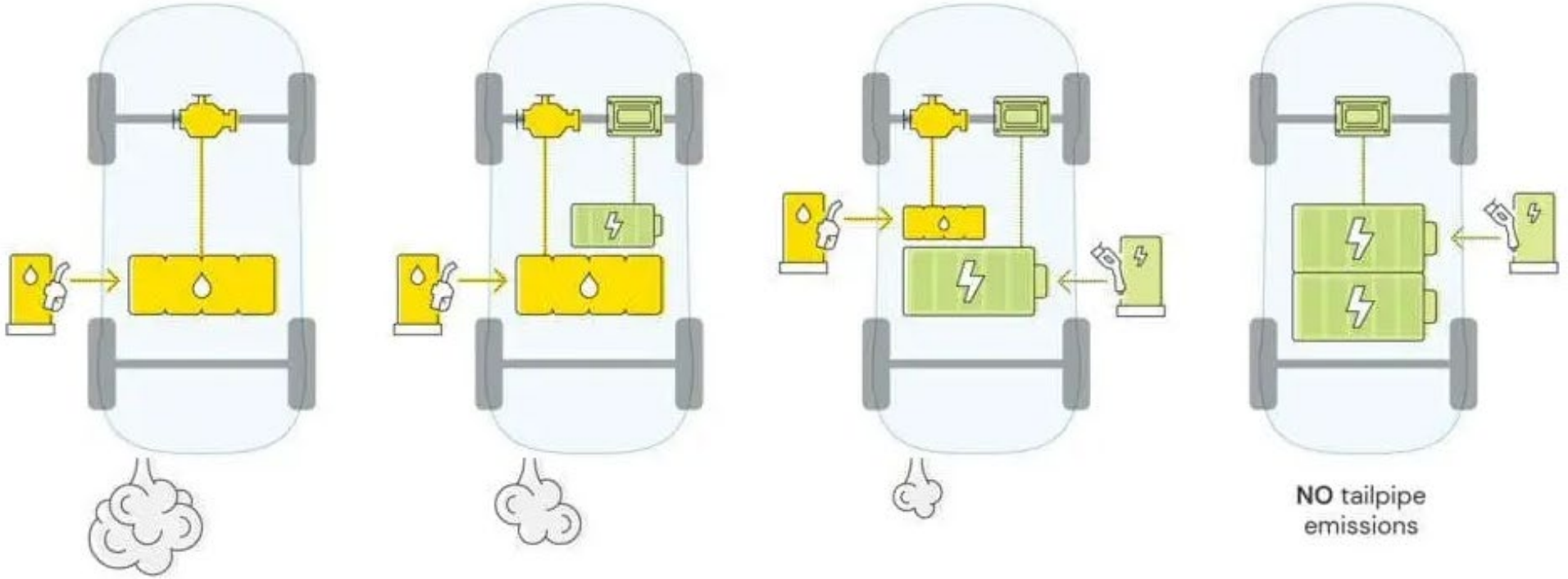
Battery Electric Vehicles (BEV)

Voltage in Lithium-Ion Battery Tech



- Cell Phones = 3.4 to 4.5V
- E-Scooter = 28 to 48V
- E-Bike = 48 to 52V
- Prius = 200V
- Tesla = 350 to 400V
- F150 Lightning = 400V
- GMC Hummer = 400V
- Ford Mach-e = 450V
- Trolley/Subway/Metro = 600V
- Tesla Truck = 800V (reported)
- Tesla Semi = 1000V (reported)

Electric Vehicle Background



ICE
Internal
Combustion
Engine

HEV
Hybrid
Electric
Vehicle

PHEV
Plug-in Hybrid
Electric
Vehicle

BEV
Battery
Electric
Vehicle

How quickly do they ignite?

Gas Emission

Tesla Battery Ignition

Tesla Model S parked in underground residential apartment building carpark. Battery had been damaged 30 minutes earlier after driving into an open manhole cover. Time elapsed: 10 seconds.

Vapor showing

Vapor cloud explosion

Jeep 4xe


Newsflare

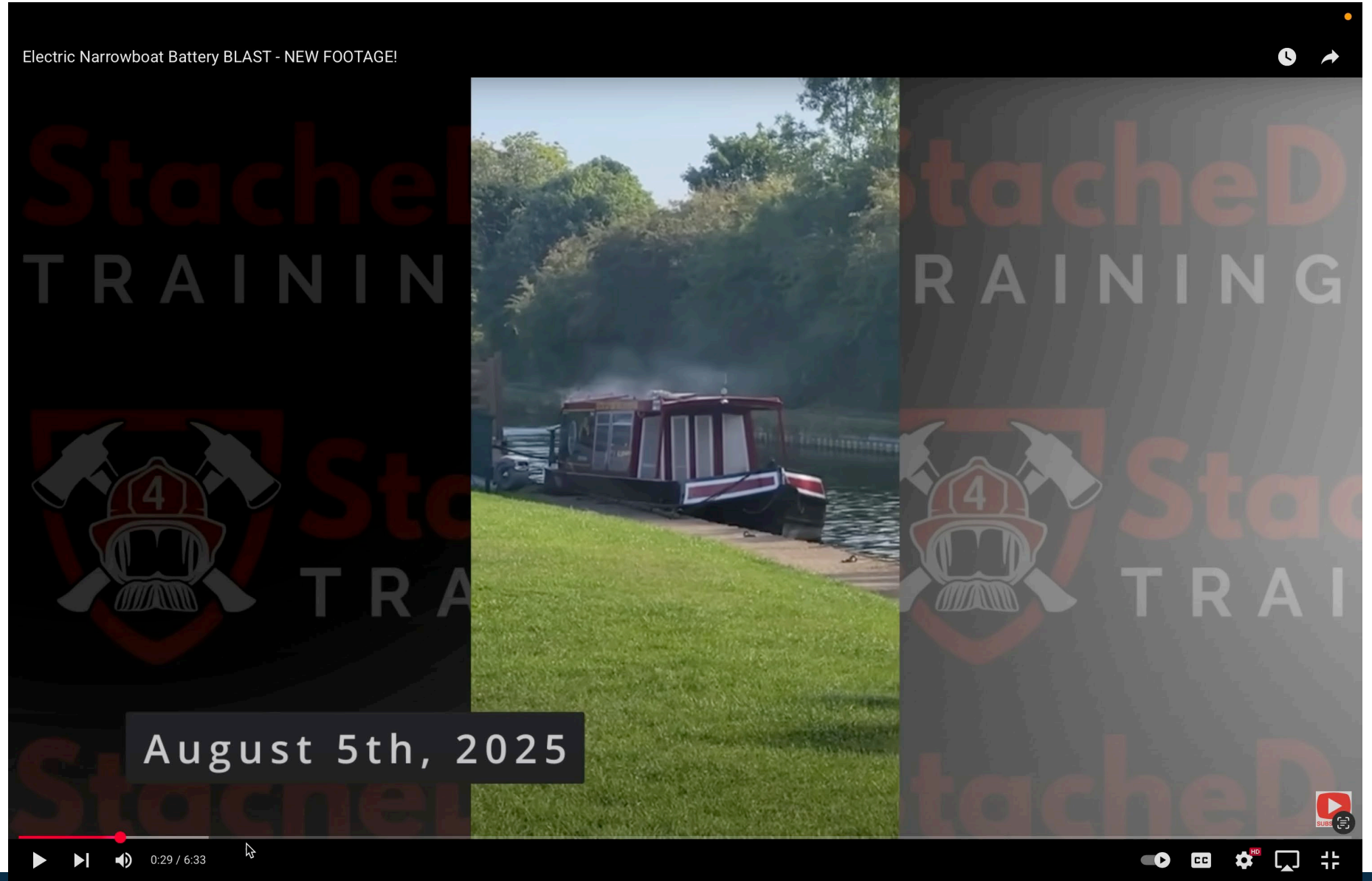
Philadelphia, June 2025

France


yourTV


BUS LINES LTD.
eLION

A Vessel is a Type of Vehicle!



BEV Fire – Inside Hazards

BEV Fire – Post Hurricane

BEV Battery Recovery – Post Wildfire

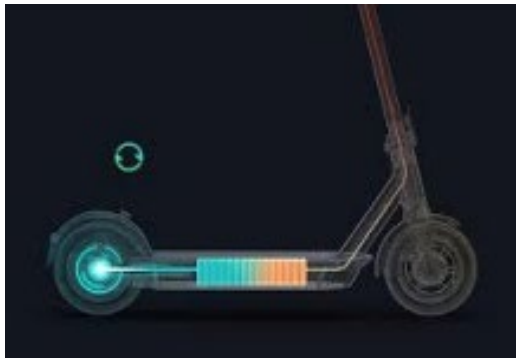
Micro Mobility

Micro-Mobility Devices

(i) Electric Unicycle

(ii) Egret (kick electric scooter)

(iii) Electric Scooter



(iv) Three-wheeler Electric Scooter

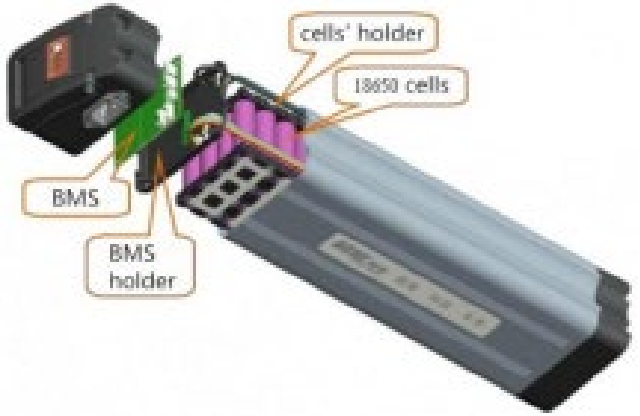
(v) Electric Mobility Cart

(vi) Electric Bike (bicycle)

(vii) Hoverboard

(viii) Segway

(ix) Electric Caster Board



Micro-Mobility Devices Statistics

- FDNY LIB fires:
  - 44 in 2020
  - 268 in 2023 -18 fatalities
  - 279 in 2024 - 6 fatalities
- SDFD LIB fires:
  - 104 in 2023
- Public exposure concerns
  - Stored and charged inside occupied residences and businesses
  - Stored near entry and exit ways
  - Can ignite with little-to-no warning

<u>Rekindling is possible.</u>

Consumer Products

Consumer Products: Examples

Tool Battery Fires

Vape Battery Fires

Cell Phone Battery Fires

Lithium-ion Battery Alternative Energy Interface

Lithium-ion Battery Alternative Energy Interface

https://youtu.be/TQpCYmHTGkQ?si=waxMseIbAh_ewxWJ

Lithium-ion Battery Alternative Energy Interface

cng truck fire explosion LA

Transportation and Packaging

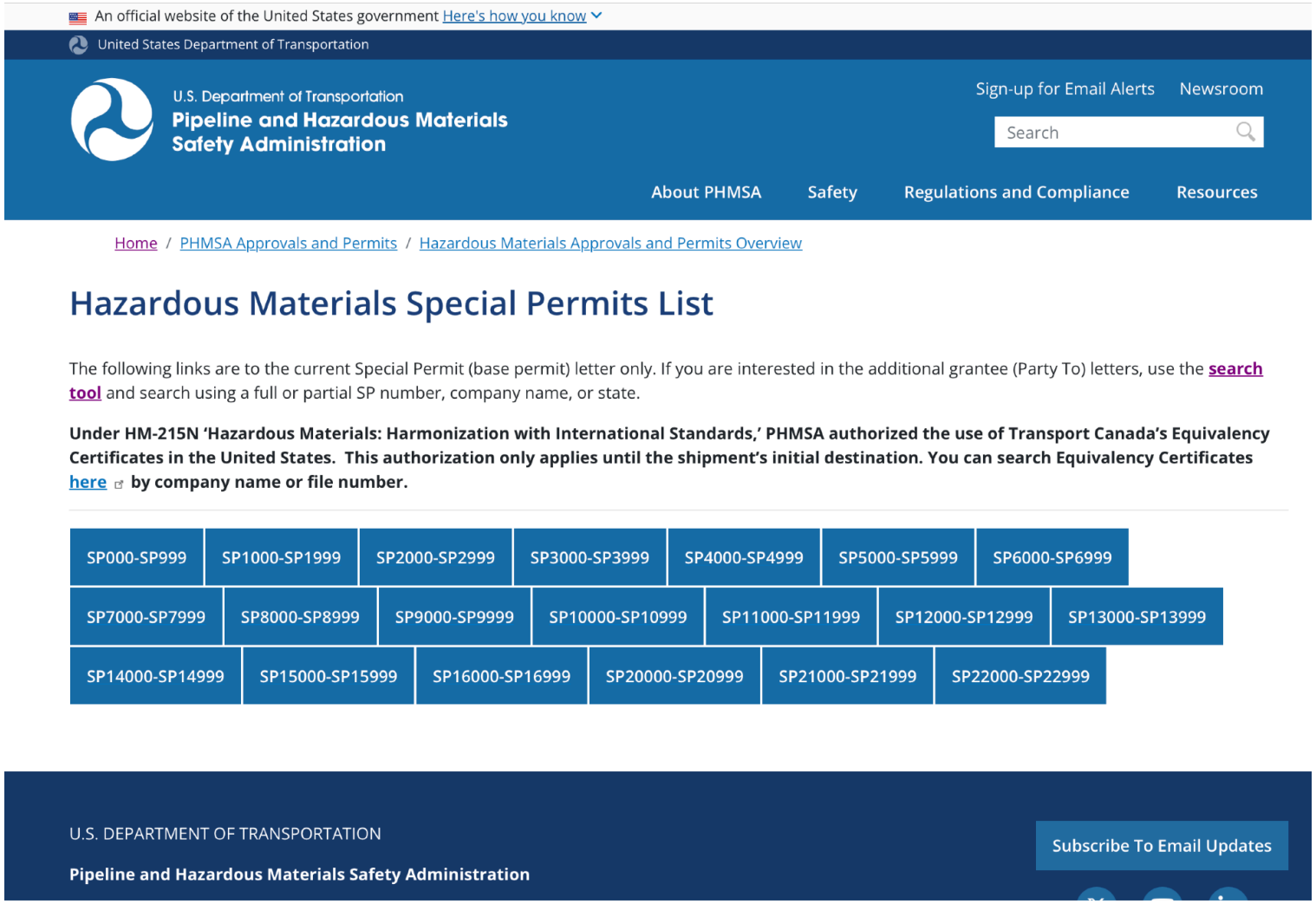
49 CFR 173.185 Lithium Cells and Batteries ???

Presents regulations for shipment of batteries

- (a): Classification
- (b): Packaging
- (c) exceptions for smaller lithium-ion cells and batteries
  - (1)(i)...may not exceed: 20Wh for cell or 100 Wh for a battery
- (d): Lithium cells or batteries shipped for disposal or recycling
- (e): Low production runs and prototypes
- (f): Damaged, defective, or recalled cells or batteries
- (g): Limited exceptions to restrictions on air transportation of medical device batteries.
- (h): Approvals…does not conform to the provisions…, conditions approved by the Associate Administrator (e.g., special permits)

DOT Regulations: New, EOL, or DDR Batteries ???

DOT-SP (Special Permits)



U.S. Department of Transportation
Pipeline and Hazardous Materials Safety Administration

1200 New Jersey Avenue, SE
Washington, DC 20590

SPECIAL PERMIT AUTHORIZATION

DOT-SP 16532

EXPIRATION DATE: 2028-02-29

GRANTEE: The Battery Network Inc.
Atlanta, GA

In response to your February 26, 2026, application for party status to DOT-SP 16532, The Battery Network Inc. is hereby granted party status to DOT-SP 16532 as a shipper only in accordance with 49 CFR 107.113.

Copies of this special permit may be obtained by accessing the Office of Hazardous Materials Safety Homepage at https://www.phmsa.dot.gov/approvals-and-permits/hazmat/special-permits-search. The most recent revision of the special permit supersedes all previous revisions of the special permit. Photo reproductions and legible reductions of this special permit are permitted. Any alteration of this special permit is prohibited.

If you have questions regarding this action please call the Office of Hazardous Materials Safety, General Approvals and Permits Branch at (202) 366-4535.

Issued in Washington D.C. on **March 12, 2026.**

for William Quade
Acting Associate Administrator for Hazardous Materials Safety

Tracking Number: 2026024992

DUNS Number on file: 127451855

DOT-SP (Special Permits)

7. SAFETY CONTROL MEASURES:

a. PACKAGING:

(1) Each damaged, defective, or recalled lithium cell or battery, including those packed with equipment, or each piece of equipment containing such cells or batteries must be individually packed in individual, non-metallic inner packaging that completely encloses the cell, battery, or equipment, as applicable.

(2) Each cell, battery, or equipment inside the inner packaging must be surrounded:

(i) With non-combustible, non-conductive, and inert absorbent material sufficient to absorb any release of electrolyte; or

(ii) Completely with at least 2 inches of a thermally insulating fire suppressant surrounding each cell, battery, or equipment as described in the April 9, 2019 supplemental information which is on file with the Office of Hazardous Materials Safety Approvals and Permits Division. The thermally insulating fire suppressant must be in a sufficient quantity to absorb all of the potential release of electrolyte; suppress lithium cell/battery fires, heat and smoke; absorb the smoke, gases and flammable vapors and electrolytes during a thermal runaway incident; and will protect from the effects of shock and vibration and prevent movement of the cells, batteries and/or the equipment, and that is sufficient to absorb any release of electrolyte.

(3) The inner packaging containing the damaged, defective, or recalled lithium cell or battery or those contained in or packed with equipment must be placed in a 55-gallon, 30-gallon or 5-gallon metal or plastic drum meeting the Packing Group I performance level.

(4) The inner packaging or outer packaging must be leak-proof to prevent the potential release of electrolyte.

DOT-SP (Special Permits)

b. OPERATIONAL CONTROLS:

(1) Each cell and battery must be protected against short-circuiting.

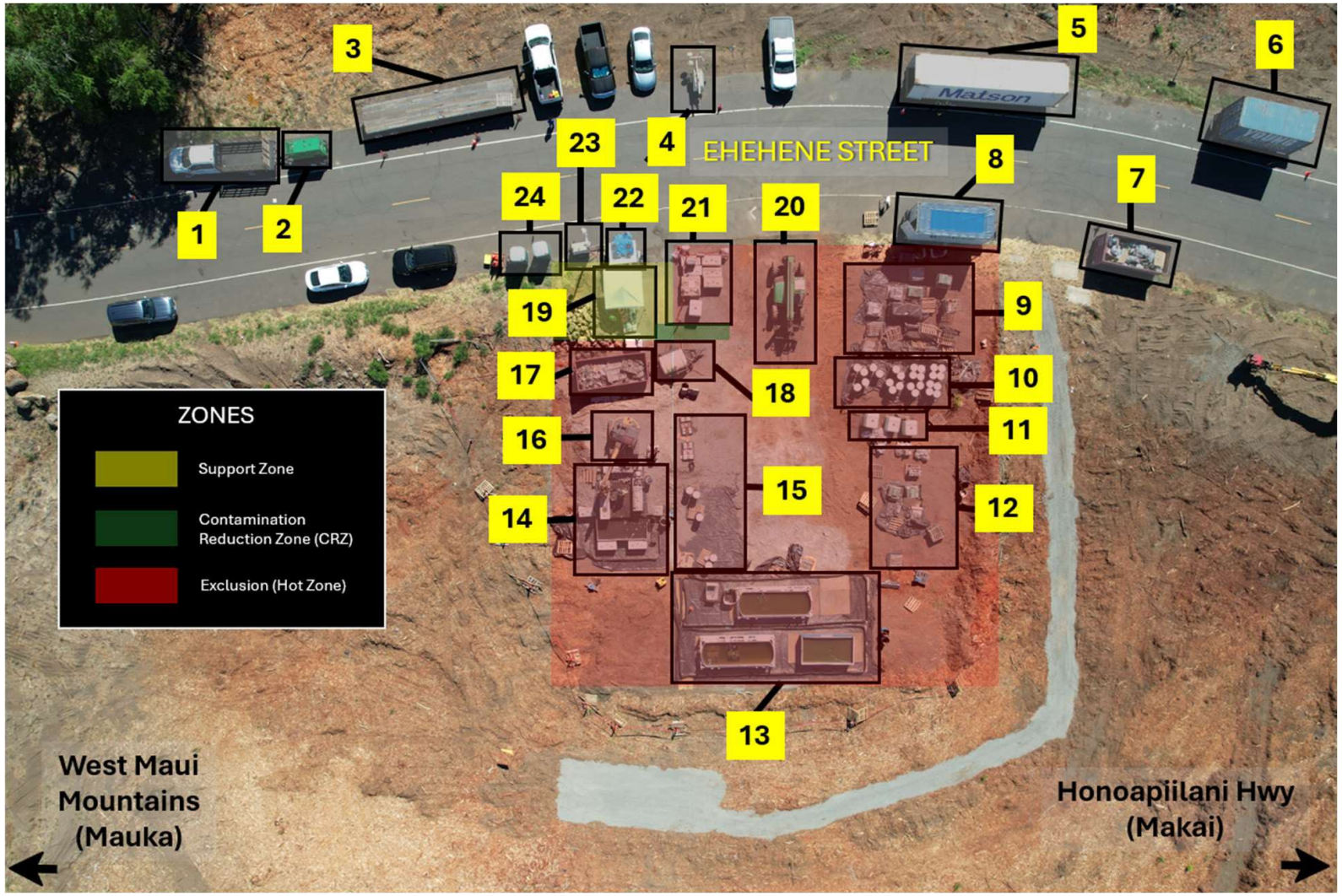
(2) A lithium metal cell or battery individually or contained in equipment in an inner packaging may not exceed 5 g or 25 g in lithium metal content, respectively. Each inner packaging may contain no more than 5 g or 25 g of lithium content for cells or batteries, respectively.

(3) A lithium ion cell or battery individually or contained in equipment in an inner packaging may not exceed 60 Wh or 300 Wh in energy content, respectively. Each inner packaging may contain no more than 60 Wh or 300 Wh of energy content for cells or batteries, respectively.

(4) Cells or batteries liable to rapidly disassemble, dangerously react, produce a flame or a dangerous evolution of heat or a dangerous emission of toxic, corrosive or flammable gases or vapors under normal conditions of transport may not be transported except under paragraph 7.b.(4) of this special permit. The damaged or defective cell or battery may be transported if for a period of at least seven (7) days prior to transport there is no evidence of venting, leakage, heat, smoke, fire or other adverse reaction.

Processing/Recycling/Disposal

Ukumehame Lithium-Ion Batteries

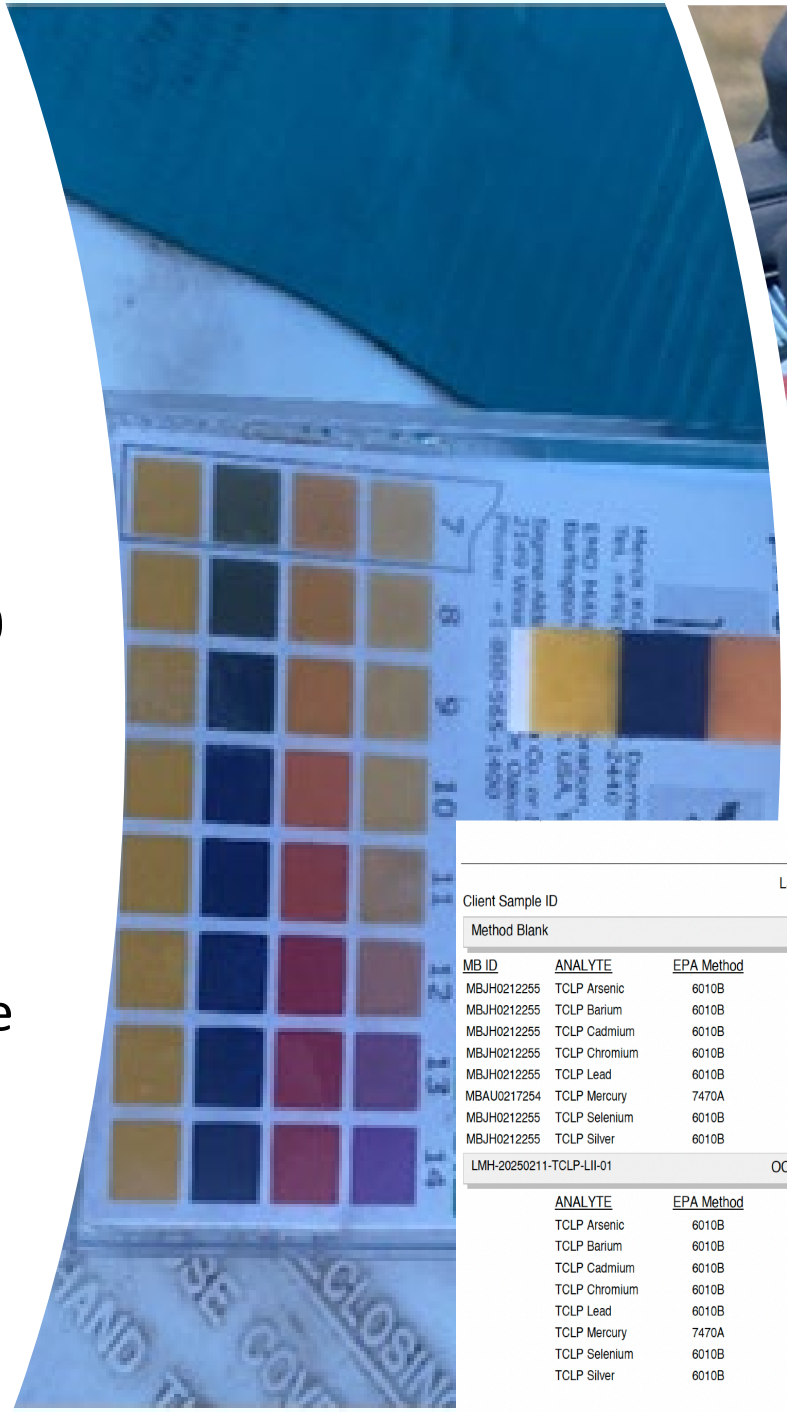


1. Utility Vehicle
2. Generator
3. Trailer
4. Light Tower #1
5. 40 ft. Container - Processed NiMH Transport Container
6. 20 ft. Container – Unused 55-gal Drum Storage
7. 20 yd. Roll O□ Box - Municipal waste
8. 20 ft. Container - Custom Battery Shipping Trailer with Breathable Water-Resistant Tarpaulin
9. Post-Process Staged NiMH Batteries
10. Post-Process Staged Li Batteries in 55-gal Drums
11. 300-gal Totes with Mixed Brine Water*
12. Initial Pre-Process Battery Staging Area
13. Three (3) Mixed Brine Water Tanks^
14. Crush Pad$ with one (1) Mixed Brine Water Tank^
15. Drum Handling and Preparation Area
16. Excavator
17. 20 yd. Roll O□ Box - Scrap Metal
18. Water Bu□alo with 100’ Fire Hose and Fog Nozzle using Potable H2O
19. Command Post Tent
20. Telehandler
21. EcoBlocks (Concrete Blocks)
22. Supply Box with First Aid Kit
23. Light Tower #2
24. Portable Toilets


SUNBELT RENTALS

Profiling Waste

- Lithium-ion batteries (DDR or non-damaged)
  - Universal waste (40 CFR 273.2)
  - Characteristic Hazardous Waste: D001 and D003 (40 CFR 261, fully regulated under 49 CFR)
  - More restrictive State waste disposal requirements
- Non-battery waste
  - Profile “not-battery” waste according to normal RCRA process, past generator knowledge is that it is no longer characteristic/hazardous



Metals

Client Sample ID	Lab Sample Number	Date Received	Date Sampled	Matrix
Method Blank				Soil

MB ID	ANALYTE	EPA Method	Result	Units	Date Extracted	Date Analyzed	Qual	DF
MBJH0212255	TCLP Arsenic	6010B	<0.080	mg/l	02/12/25 17:00	02/13/25 12:36	--	1
MBJH0212255	TCLP Barium	6010B	<0.040	mg/l	02/12/25 17:00	02/13/25 12:36	--	1
MBJH0212255	TCLP Cadmium	6010B	<0.020	mg/l	02/12/25 17:00	02/13/25 12:36	--	1
MBJH0212255	TCLP Chromium	6010B	<0.020	mg/l	02/12/25 17:00	02/13/25 12:36	--	1
MBJH0212255	TCLP Lead	6010B	<0.080	mg/l	02/12/25 17:00	02/13/25 12:36	--	1
MBAU0217254	TCLP Mercury	7470A	<0.010	mg/l	02/17/25 14:25	02/17/25 17:28	--	1
MBJH0212255	TCLP Selenium	6010B	<0.20	mg/l	02/12/25 17:00	02/13/25 12:36	--	1
MBJH0212255	TCLP Silver	6010B	<0.020	mg/l	02/12/25 17:00	02/13/25 12:36	--	1

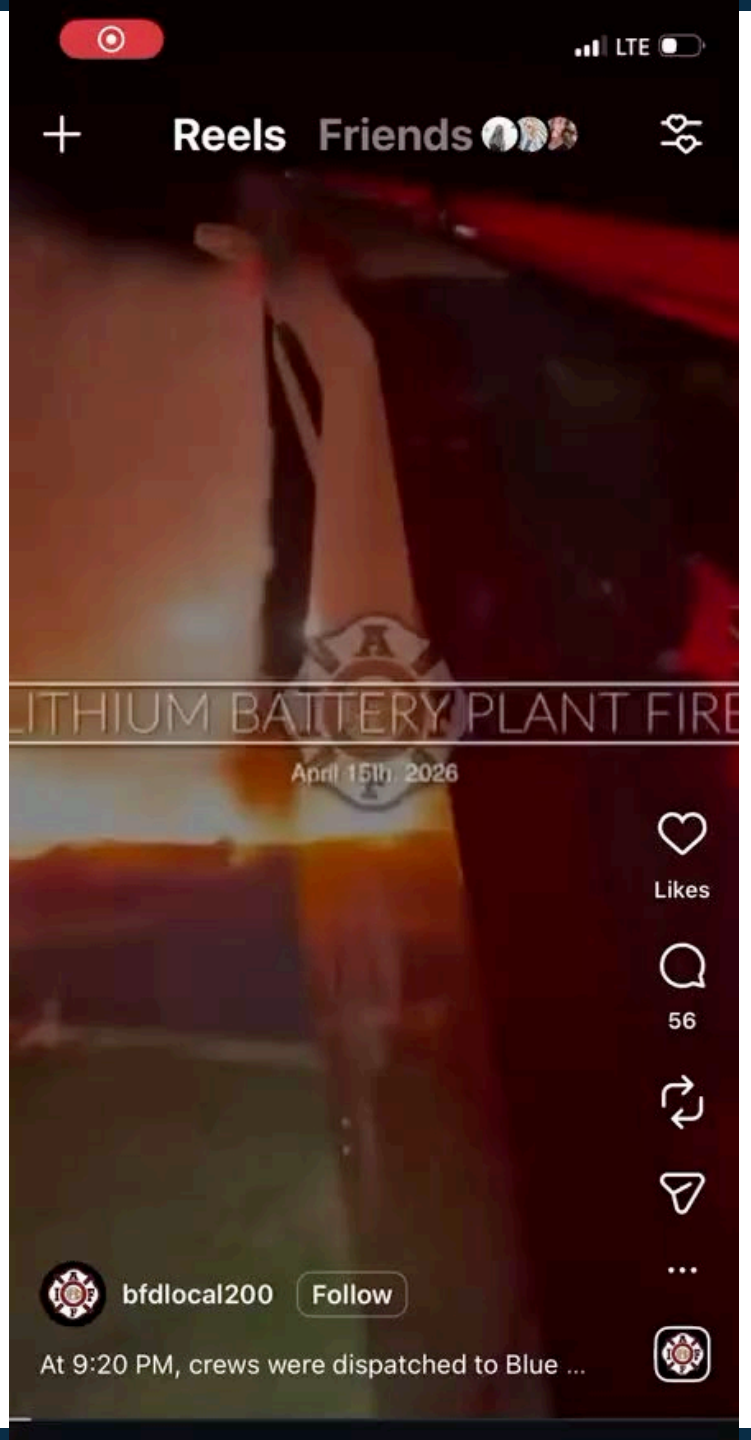
LMH-20250211-TCLP-LII-01		OCAQ1203-01	2/11/2025 14:52	2/11/2025 12:30	Solid

ANALYTE	EPA Method	Result	Units	Date Extracted	Date Analyzed	Qual	DF
TCLP Arsenic	6010B	<0.080	mg/l	02/12/25 17:00	02/13/25 12:44	--	1
TCLP Barium	6010B	<0.040	mg/l	02/12/25 17:00	02/13/25 12:44	--	1
TCLP Cadmium	6010B	0.022	mg/l	02/12/25 17:00	02/13/25 12:44	--	1
TCLP Chromium	6010B	0.074	mg/l	02/12/25 17:00	02/13/25 12:44	--	1
TCLP Lead	6010B	<0.080	mg/l	02/12/25 17:00	02/13/25 12:44	--	1
TCLP Mercury	7470A	<0.010	mg/l	02/17/25 14:25	02/17/25 17:33	--	1
TCLP Selenium	6010B	<0.20	mg/l	02/12/25 17:00	02/13/25 12:44	--	1
TCLP Silver	6010B	<0.020	mg/l	02/12/25 17:00	02/13/25 12:44	--	1

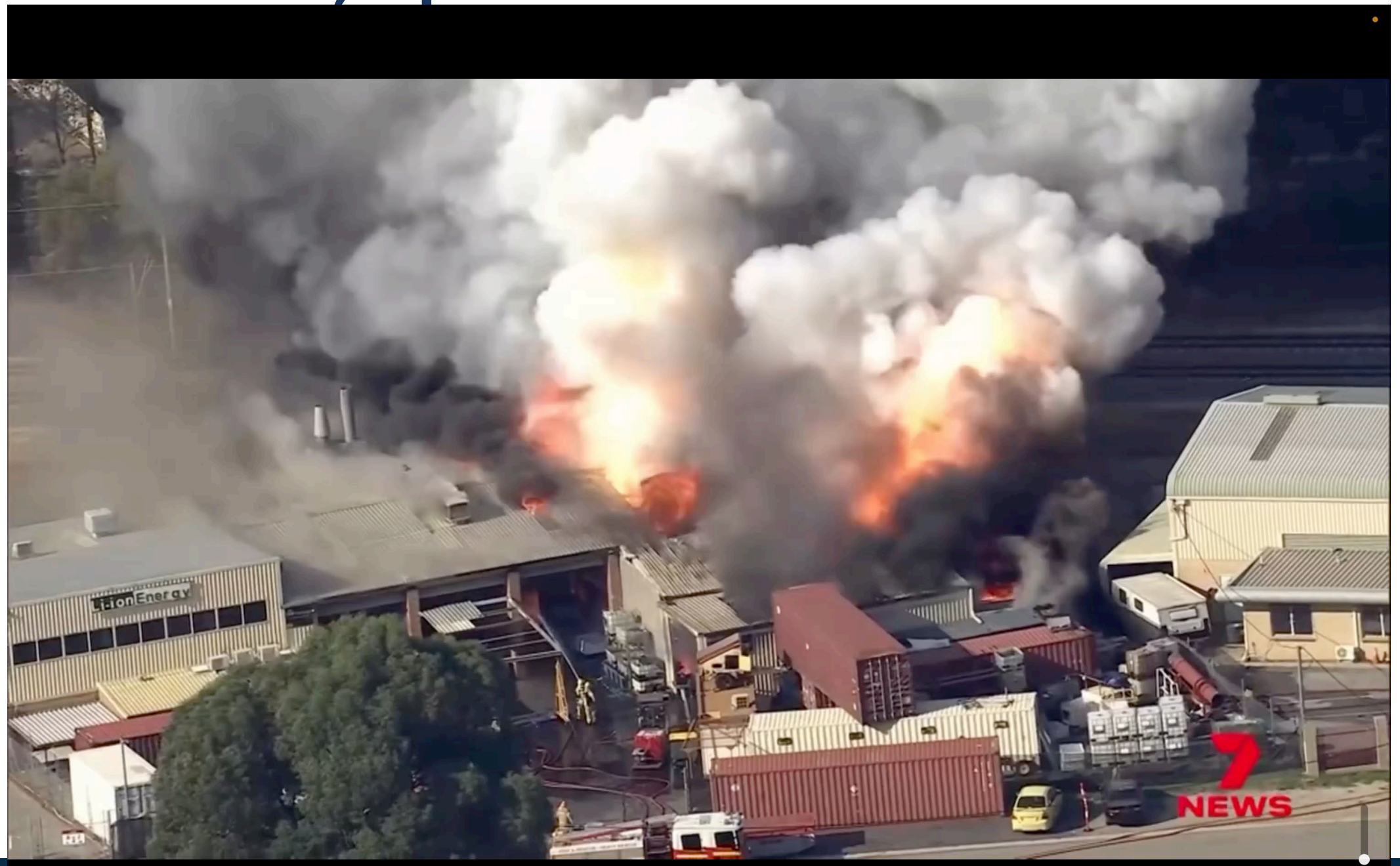
Off-Site Rule Applicability

- Is my material a waste?
- Applies to both disposal and recycling of DDR batteries and deconstructed not-batteries. All forms are still considered waste under RCRA.
- Applicable to recycling because:
  - Recycled by reclaiming (maintains solid waste designation) of "spent materials"
  - Covered under 40 CFR 261.2(c)

Off-Site Rule Compliant



Australia, April 2026



EPA Emergency Management Branch

What does the EPA Emergency Management Branch do?

- Respond to urgent threats to human health or the environment including:
  - Hazardous chemical releases
  - Oil or fuel spills into or near waters of the U.S.
  - Pollutant or contaminants (e.g. sewage, ricin, anthrax)
- Biological, Chemical, Radiological, and Disaster preparedness
- Provide training to State, Territory, Local and Tribal agencies

What can EPA do for you during a Lithium-Ion Battery fire?

- Via phone call:
  - Provide technical expertise on response actions and disposal via phone call.
- Via response action with FOSC involvement
  - Respond to larger fires and provide on the ground technical expertise as well as contractor air monitoring support for community protection.
  - Provide responder/worker health and safety expertise.
  - Provide treatment and disposal options that are otherwise not available.

EPA On-Scene Coordinator Lithium-Ion Battery Response Guide

Written by the Lithium-Ion Battery Task Force

October 2025

Lithium-Ion Battery Ad Hoc Subcommittee

Lithium-Ion Battery Emergencies Operational Guidelines

ICS 1150

Contact Info

National Response Center
800-424-8802

Region 8 Duty On-Scene Coordinator
303-293-1788

Eric Sandusky, Region 8 FOSC
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Contact Info

Greg Jenkins,
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Thank You!

Questions?