INTERNATIONAL ASSOCIATION OF FIRE FIGHTERS

PREPARATION AND RESPONSE TO LITHIUM-ION BATTERY INCIDENTS

THE FDNY EXPERIENCE

March 30, 2026

LI-ION BATTERIES IN NYC

Evolving challenge for the FDNY

Multi-faceted issue

- Emergency Response issue
- Fire Prevention Policy issue

Different applications of battery technology

- Handheld devices or appliances
- Micromobility (E-bikes, E-scooters)
- Electric Vehicles
- Energy Storage Systems

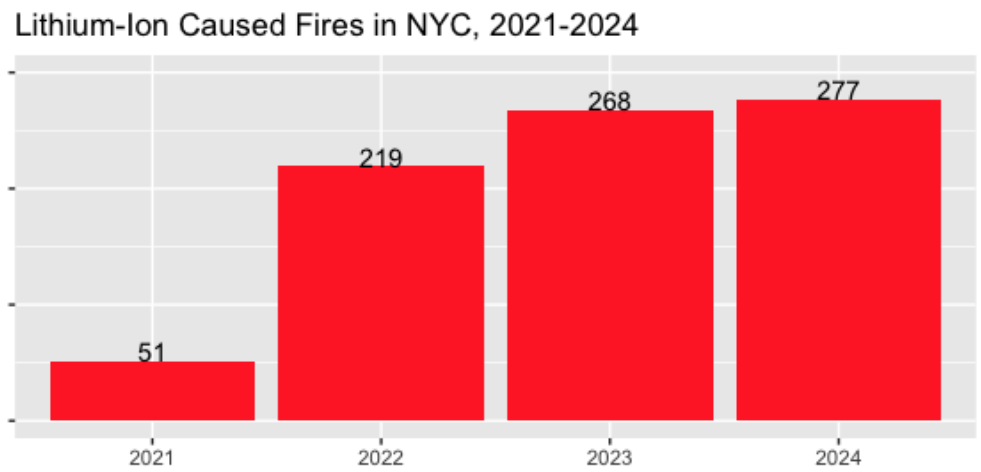
EVOLVING FIRE HAZARD

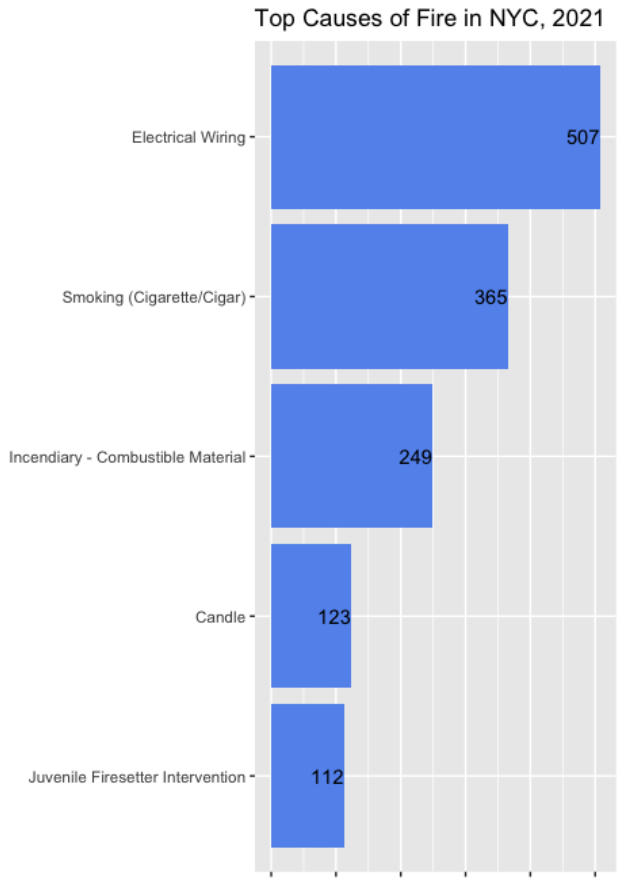
Li-ion batteries now the 3rd leading cause of fires in NYC

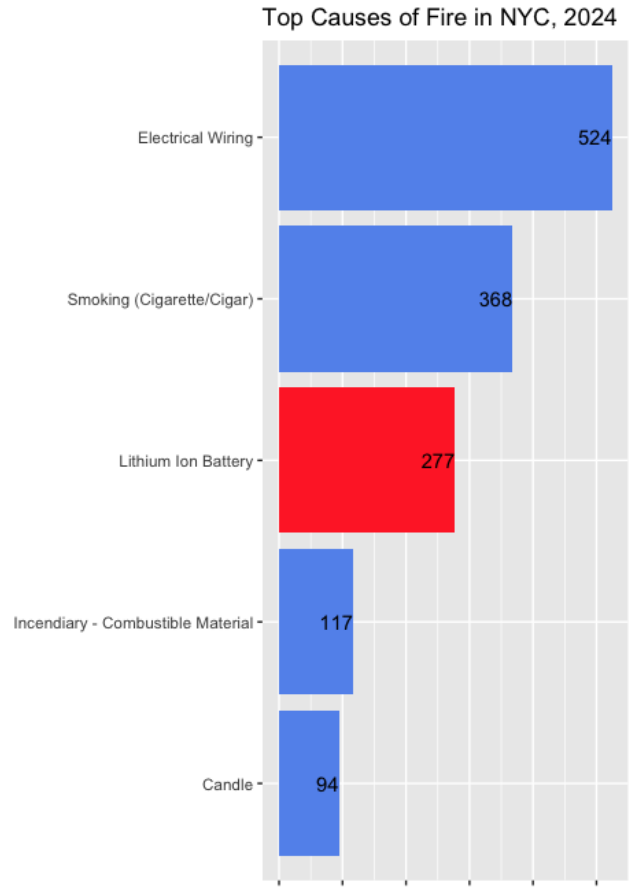
Dramatic increase since 2021

Majority are micromobility devices

- Roughly 70% are E-bike or E-scooter
- Remainder are non-mobility devices







LETHAL CONSEQUENCES

80 Madison St, New York, NY
6/20/2023

E-Bike store fire, all perished from apartments above

- 2 females: 74 yrs / 82 yrs
- 2 males: 71 yrs / 82 yrs

565 W 190th St, New York, NY
5/7/2023

- Battery fire appears to be from moped. All 4 residents perished, room did not flash - battery blocked exit
- 2 Females: 94 yrs / 29 yrs
- 2 Males 58 yrs / 20 yrs

25-71 46 STREET,QUEENS,NY
4/10/2023

- E-Scooter, Fake UL charger recovered
- (1) Female 19 yrs
- (1) Male 7 yrs

FINDINGS FROM REALITY: *FDNY DATA ANALYSIS*

Geographic clustering

- *Distinct socio-economic areas*

Seasonal impact

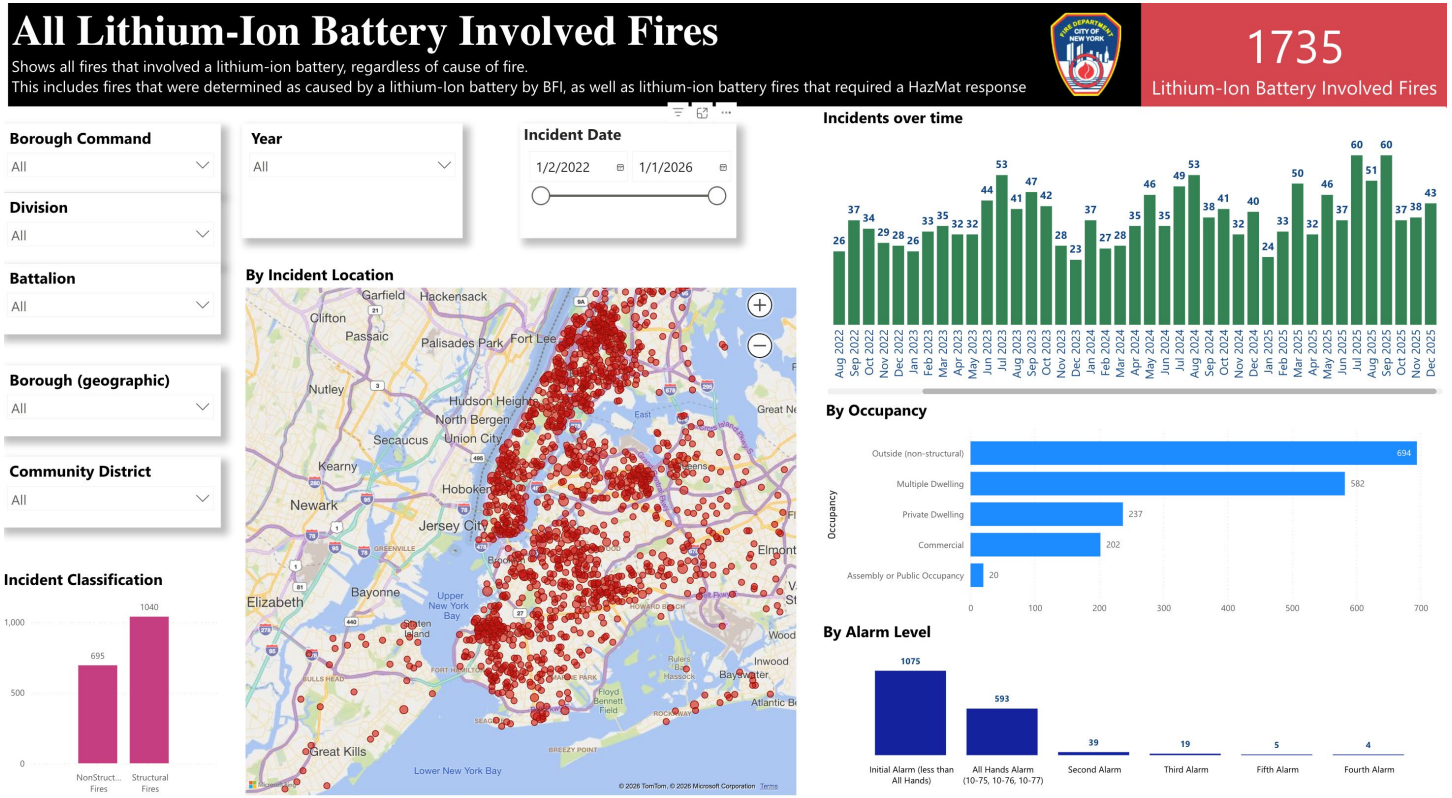
- *More Li-ion fires in summer*

Structural fires are more severe

- *Outdoor fires have lower impact*

Micromobility as common cause

- *Mobility devices are key concern*



FDNY INITIATIVES

- ***Lithium-ion Task force***
  - Hazmat, Fire Investigation,
  - Fire Prevention, Community affairs

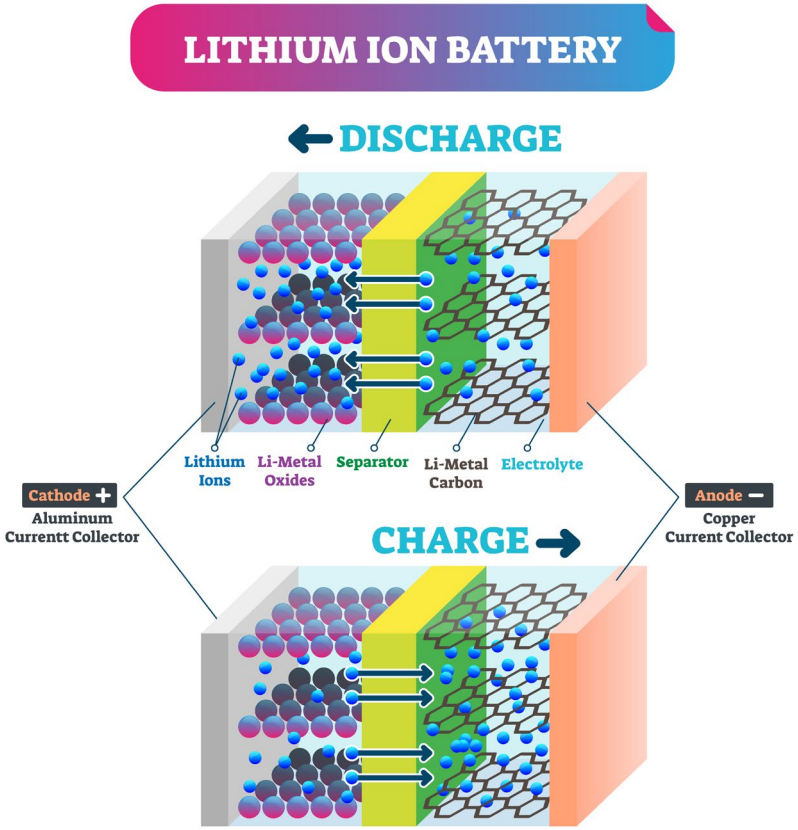
- ***Data-driven community outreach***
  - Messaging is critical
    - *Keep devices outside*
    - *Fires still occur when not charging*

BATTERY CHEMISTRY AND THERMAL RUNAWAY

LI-ION CELL CONSTRUCTION

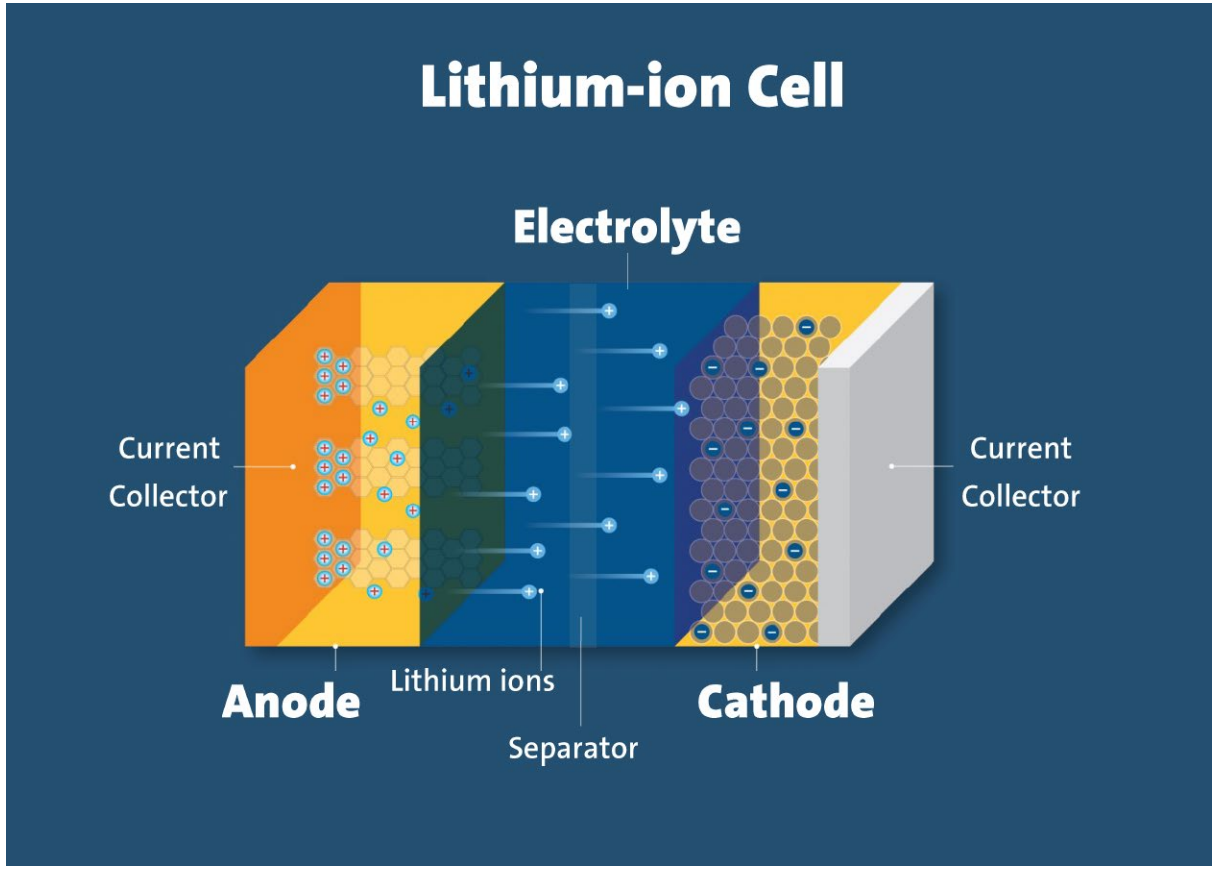
- **Physical format** – Pouch, prismatic, cylindrical
- **Four major internal components:**
  - **Cathode** – Aluminum foil with metal oxide coating (NiCoAl, NiMnCo, LiFePO, LiCoOx, LiMnOx)
  - **Anode** – Copper foil with carbon coating
  - **Separator** – Plastics (polyethylene, polypropylene; 0.001 to 0.0003 in. thick)
  - **Electrolyte** – Organic solvent (carbonates), lithium salts ($LiPF_6$) and “additives”
- **Safety features** – Vents, switches, fuses, circuitry, “polyswitch,” etc.

Combustible components: cathode, separator, electrolyte, case (sometimes)

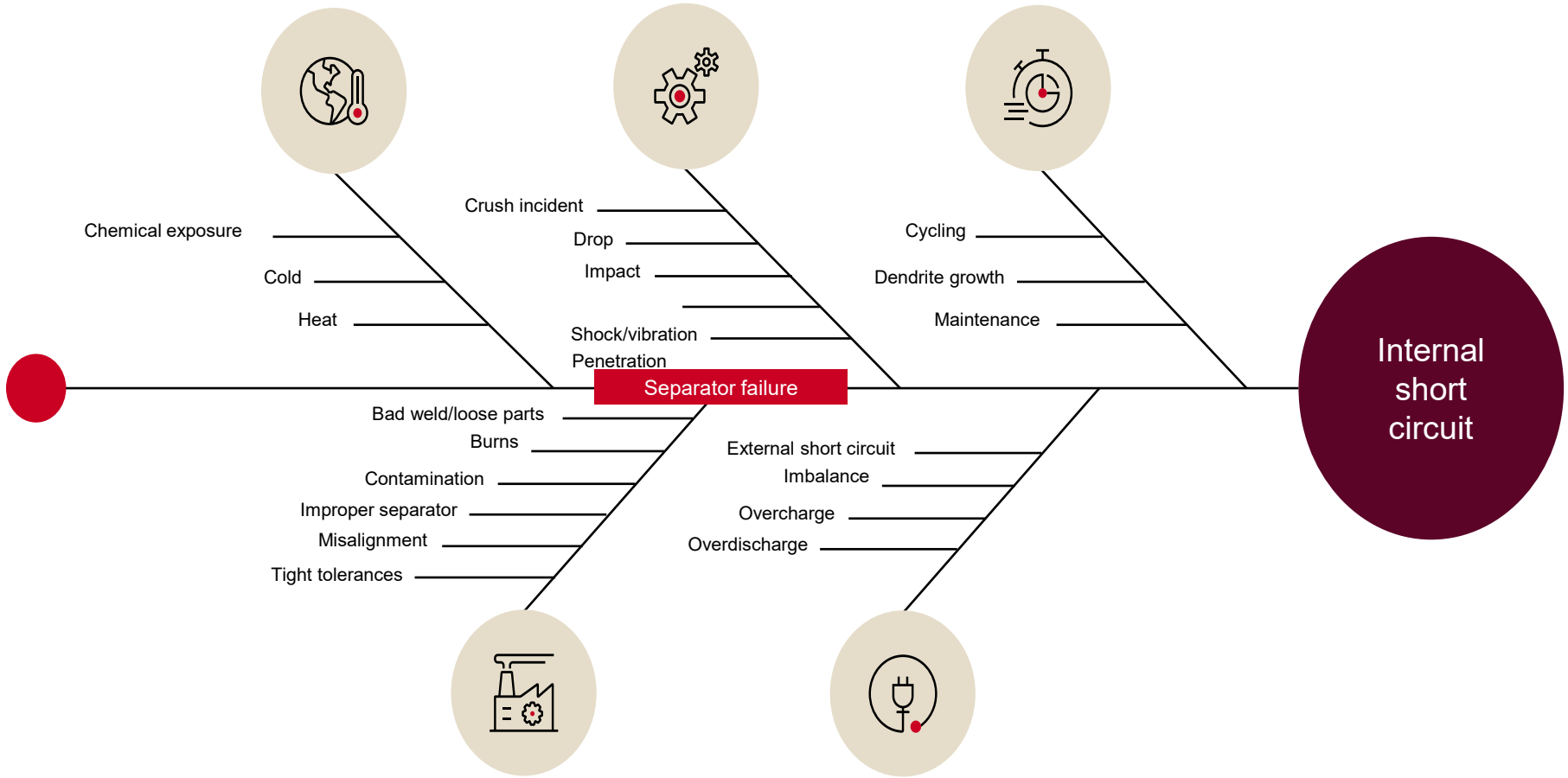


THERMAL RUNAWAY

- When an electrochemical cell increases its temperature through **self-heating** in an uncontrollable fashion
- When the cell's generation of heat is at a higher rate than the heat it can dissipate



COMMON CAUSES OF THERMAL RUNAWAY IN LI-ION BATTERIES

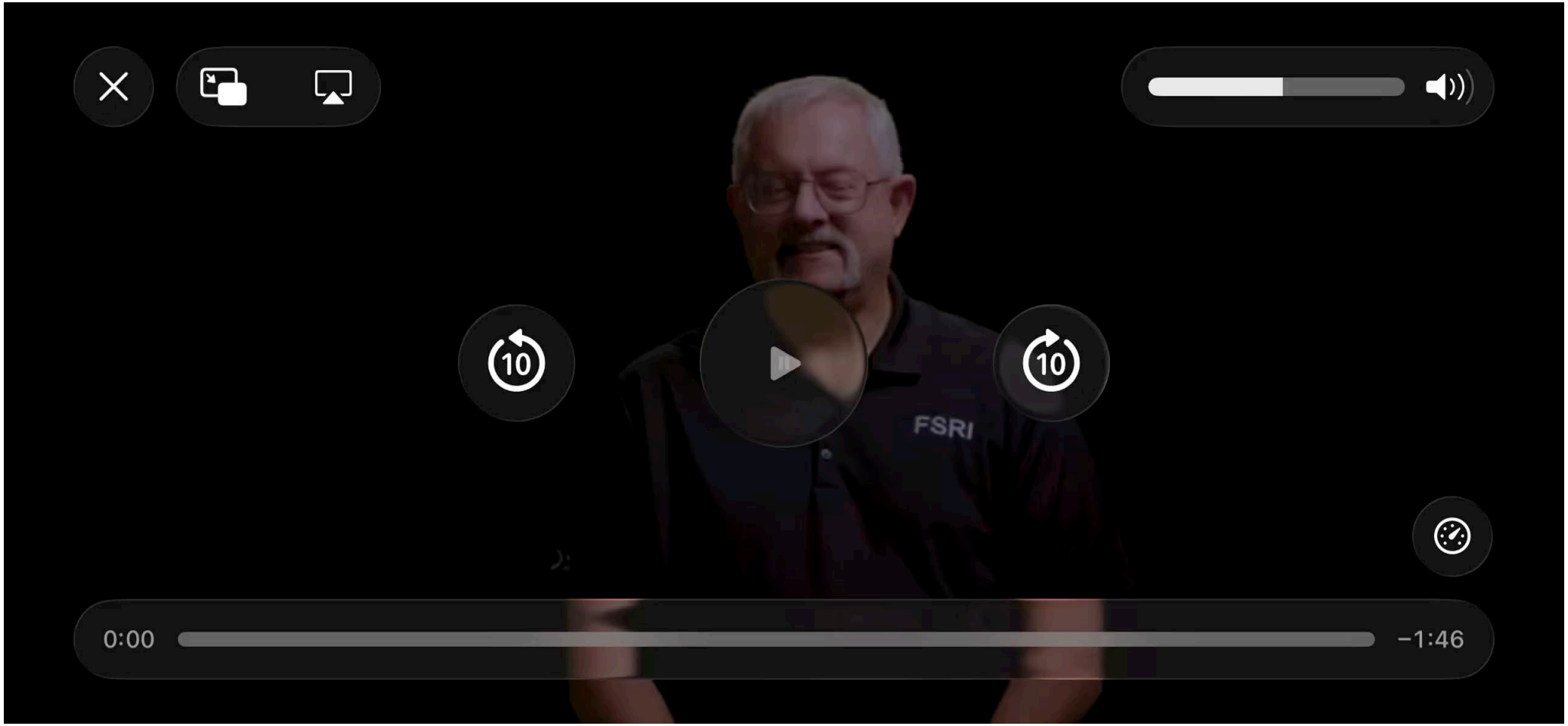


EXPLOSIVE FLAMING

Types of flaming hazards:

- **Rapid heat release rate (HRR) increase** – Unprecedented fire growth rate compared to ordinary combustibles
- **Flame jetting** – Strong plume, risk of igniting adjacent combustibles/batteries
- **Cell/material ejection** – Additional ignition sources
- **Stranded energy and reignitions** – Thermal runaways, fire and explosion hazards occurring hours/days after the initial event

FSRI VIDEO



LI-ION BATTERIES ON THE FIREGROUND

MOBILITY DEVICES IMPACT ON THE FIREGROUND

- Cause of the fire
- Advanced Fire Upon Arrival
- People Trapped
- Deflagration and Explosion
- Impact on Fire Behavior
- Inhalation injuries
- Overhaul
- Reignition

CAUSE OF THE FIRE

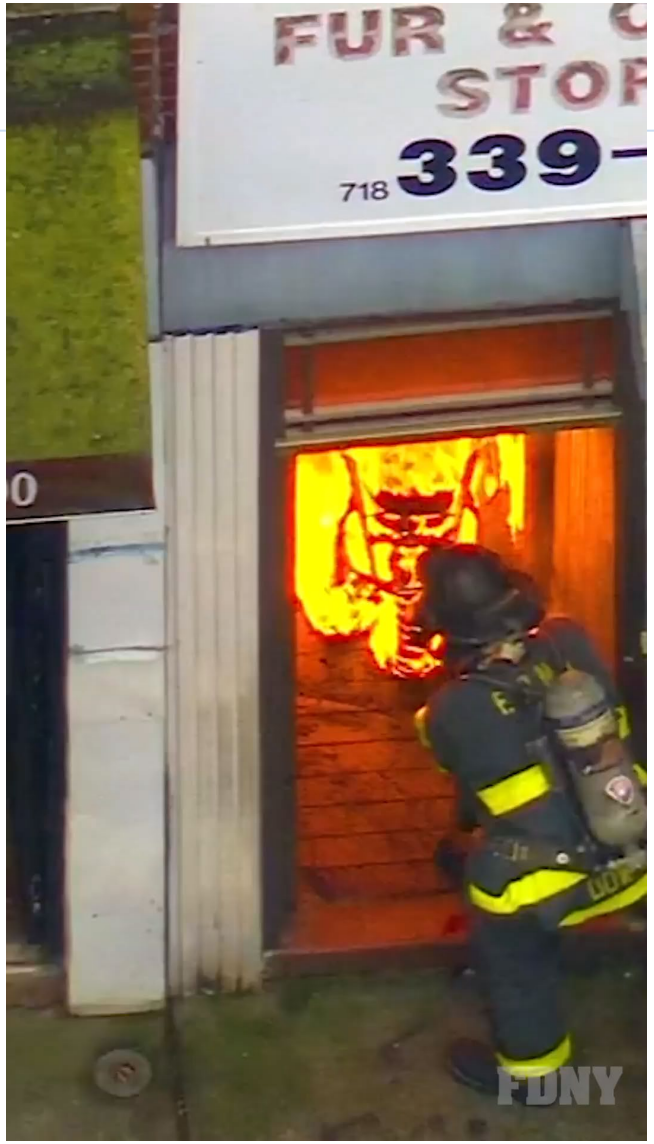
ADVANCED FIRE UPON ARRIVAL

- Battery Failure to Flashover in roughly 1 minute
- Minimal reaction time
  - Trapped occupants
- Deflagration can fail windows
  - Fully vented fire

RAPID FLASHOVER

PEOPLE TRAPPED

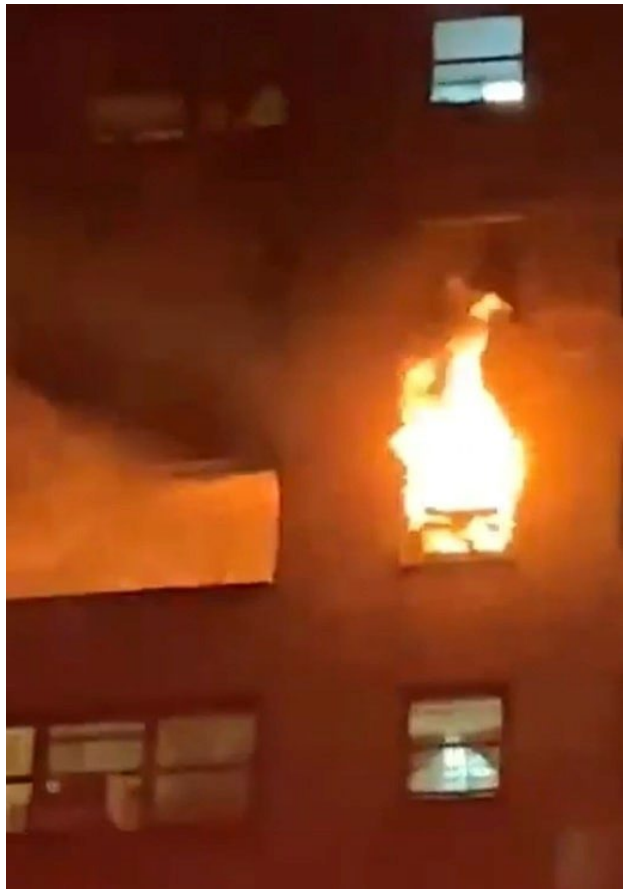
- The public often stores and charges mobility devices near means of egress

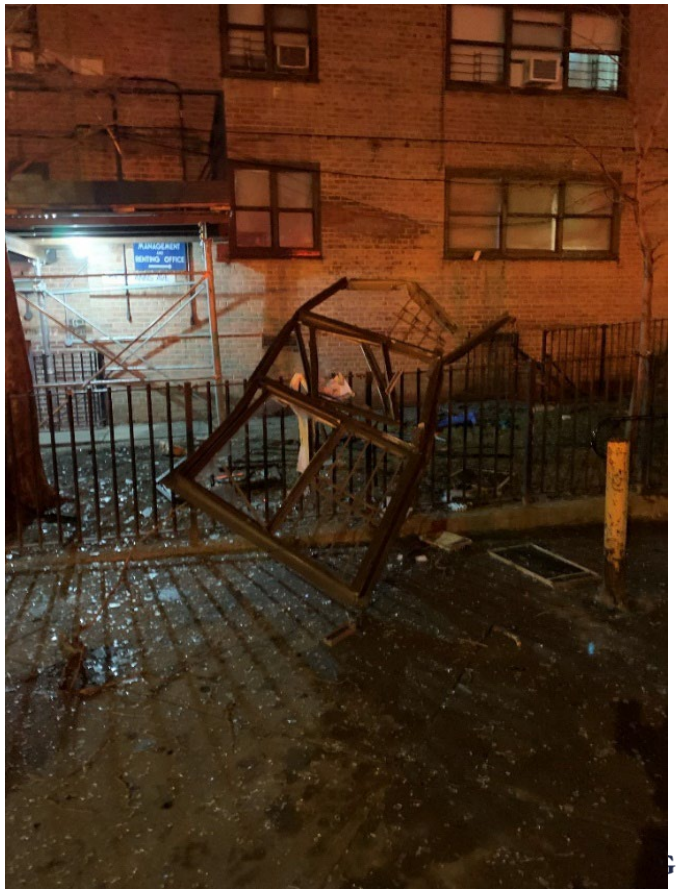


DEFLAGRATION AND EXPLOSIONS

Accumulation of flammable gases within enclosure can lead to explosion

Ejected window frame landed 15' from FDNY member



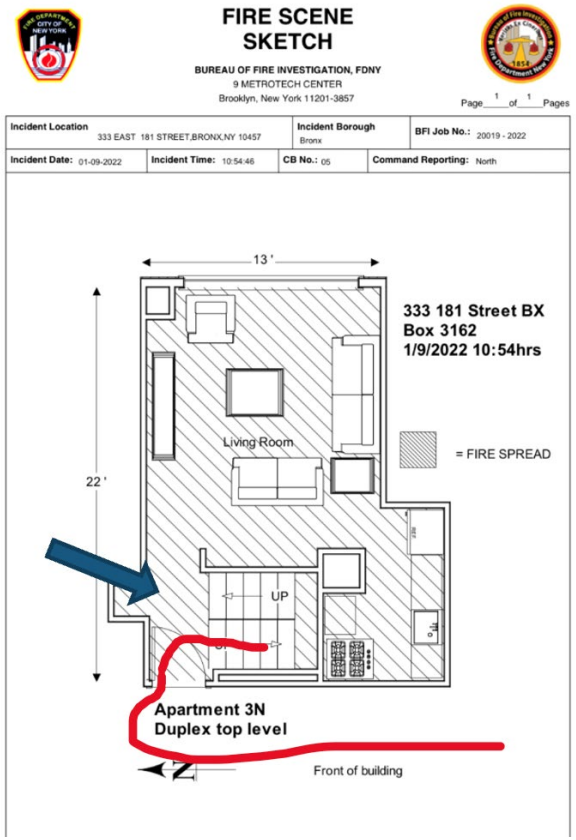


DELAYED IGNITION

- Failure gases are flammable
  - Hydrogen gas is most prominent
- Delayed ignition leads to explosive concentrations
- 3 minutes before ignition
- *Video @ 2x speed

IMPACT ON FIRE BEHAVIOR

- Unexpected rapid fire growth (like a wind driven fire)
- Potential deflagration and failure of windows
- Potential secondary fire behind nozzle or search team
- Potential loss of water from burst length



BATTERY FAILURE CAN THREATEN HOSELINE

INITIAL FIRE SUPPRESSION

Water works...but it's not perfect

- Once thermal runway has started it can not be stopped
- Our goal is to prevent propagation
- Water can damage healthy batteries
- For extinguishment, water needs to access burning material
- Li-ion batteries can burn underwater

IMPACT ON OVERHAUL

- Cells can be ejected from the module
- Approximate how many are missing
- Inspect impacted batteries
- Rakes and shovels may be required to locate stray cells
- Cells can fail unexpectedly

If you are in the room with a heat impacted battery you <u>must</u> be wearing your SCBA

INHALATION THREATS

- Hydrogen
- Hydrogen Fluoride
- Carbon Dioxide
- Dimethyl Carbonate
- Ethane
- Ethylene
- Methane
- Ethyl methyl carbonates

A single 18650 cell at 100% SOC releases 8 liters of gas

RE-IGNITION HAPPENS

OVERPACKING BATTERIES

Damaged batteries must be properly packaged

- Hazmat units overpack for safe removal
- Fire containment overpack material
- FDNY uses standard overpack drums
  - 5, 16, 55 gallon
- Consider specialized drums
  - Higher watt/hour storage per drum

WE DO NOT USE ELEVATORS!!!

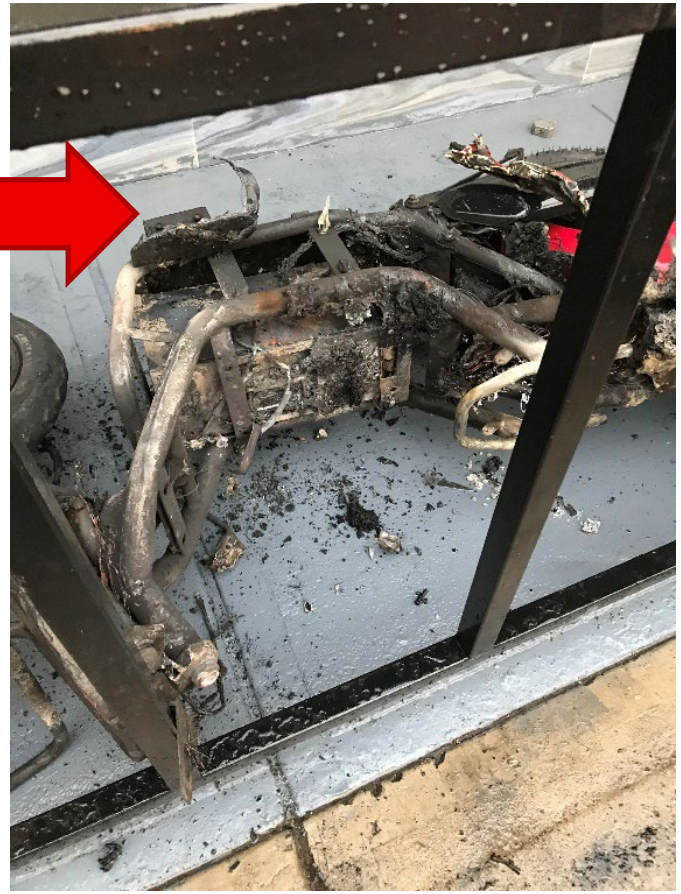
- ***No FDNY member is to ride in an elevator with a damaged/heat impacted battery or device***

- Overpacked drums may be moved via unmanned elevator if FD has control of elevator and with approval of the incident commander

TOOLS OF THE TRADE

Batteries may need to be extracted from remains of mobility device

- Battery Operated Sawzall
- Battery Operated Mini Cutter
- Manually Operated Combi/tool
- Portable worktable



IMPROPERLY PACKAGED BATTERIES

Secondary responders

- Transportation
- Disposal
- Recycling

Capacity issues

- Large capacity batteries
- Large battery quantity

BESS

Battery Energy Storage Systems

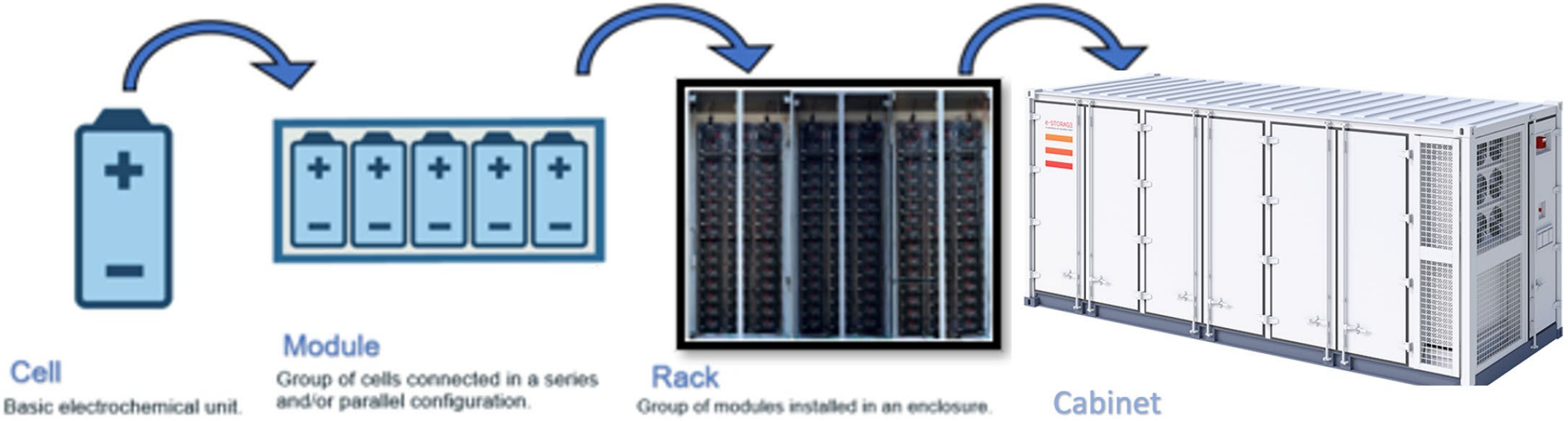
WHAT IS BATTERY ENERGY STORAGE?

A few batteries can power a tool

Add a few more and they can move a person

Add a whole bunch and they can power an entire building

BESS IS A BIG SYSTEM OF SMALL BATTERIES



DIFFERENT SIZES FOR DIFFERENT USES

Store energy from any source to be used later

- Peak shaving
- Back-up power
- UPS

Large BESS

Medium BESS

Small BESS

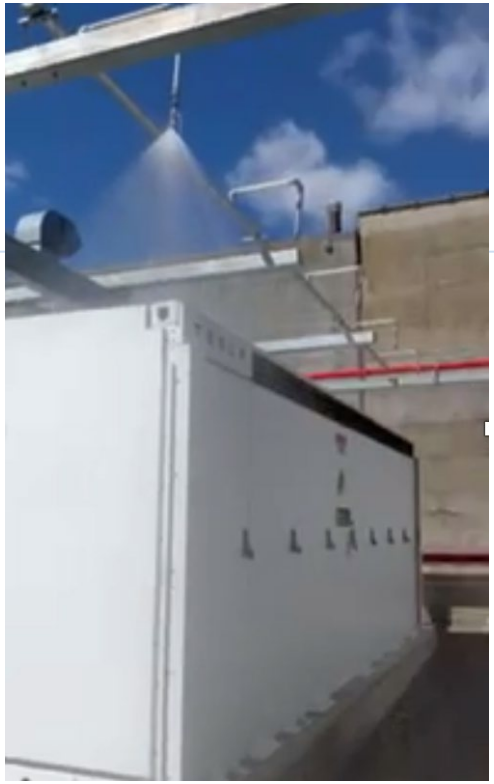
BESS IN THE URBAN ENVIRONMENT

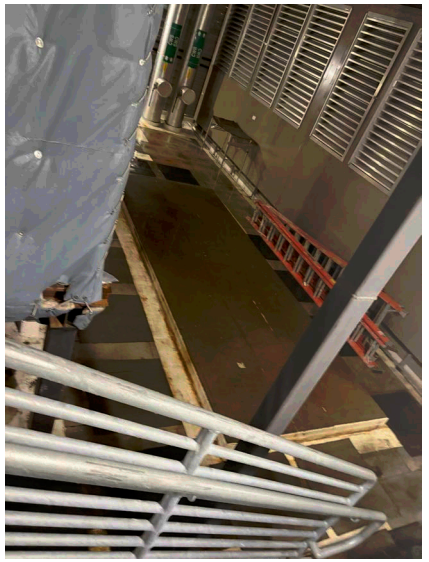
They can be anywhere…

by Ezra Lee/NYT Wirecutter; source photos by Rachel Wharton/NYT Wirecutter, Copper

TODAY IN NYC

- Outside BESS only…so far
- No residential…yet
- No high-rise…yet
- Large BESS needs sprinkler system
- Supervision required (COF)

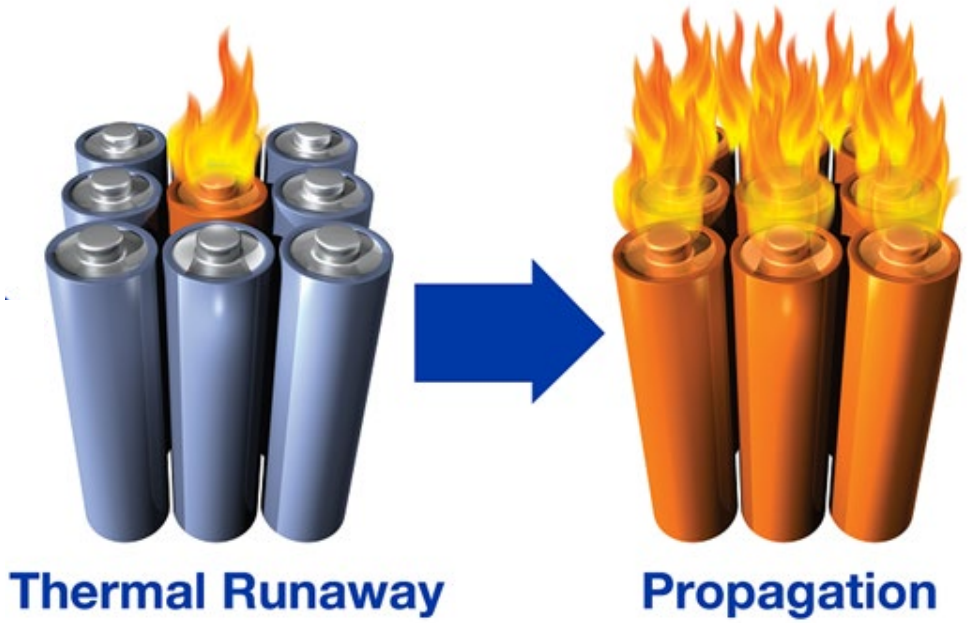




WHAT CAN GO WRONG?

Damaged cells can fail

- Thermal runaway produces failure gases
- Failure gases can burn



<u>Critical concerns</u>

- ***Explosion*** – Failure gases in confined space
- ***Propagation*** – Burning cells damage other cells

FDNY RESPONSE STRATEGY

<u>Primary Tactic</u> = ***Allow BESS to consume itself***

- Ensure safety features operate properly

<u>Key Concern</u> = ***Protect Exposures***

- Water used to prevent fire spread

Request Haz-Mat Response

- HM Battalion, HMC1, HMTU will respond

Contact COF and SME for Guidance

- Phone number on site

RESPONSE PARTNERS

FDNY Certificate of Fitness

- COF holder is responsible for assisting emergency response
- Available by phone
- Can respond to scene if needed
- Has access to BMS data

KEY QUESTION: DO WE USE WATER?

Water can extinguish the fire…if it can reach it

- Batteries are in weatherproof container

But…water can possibly make it worse

- Water damage can cause cell failure

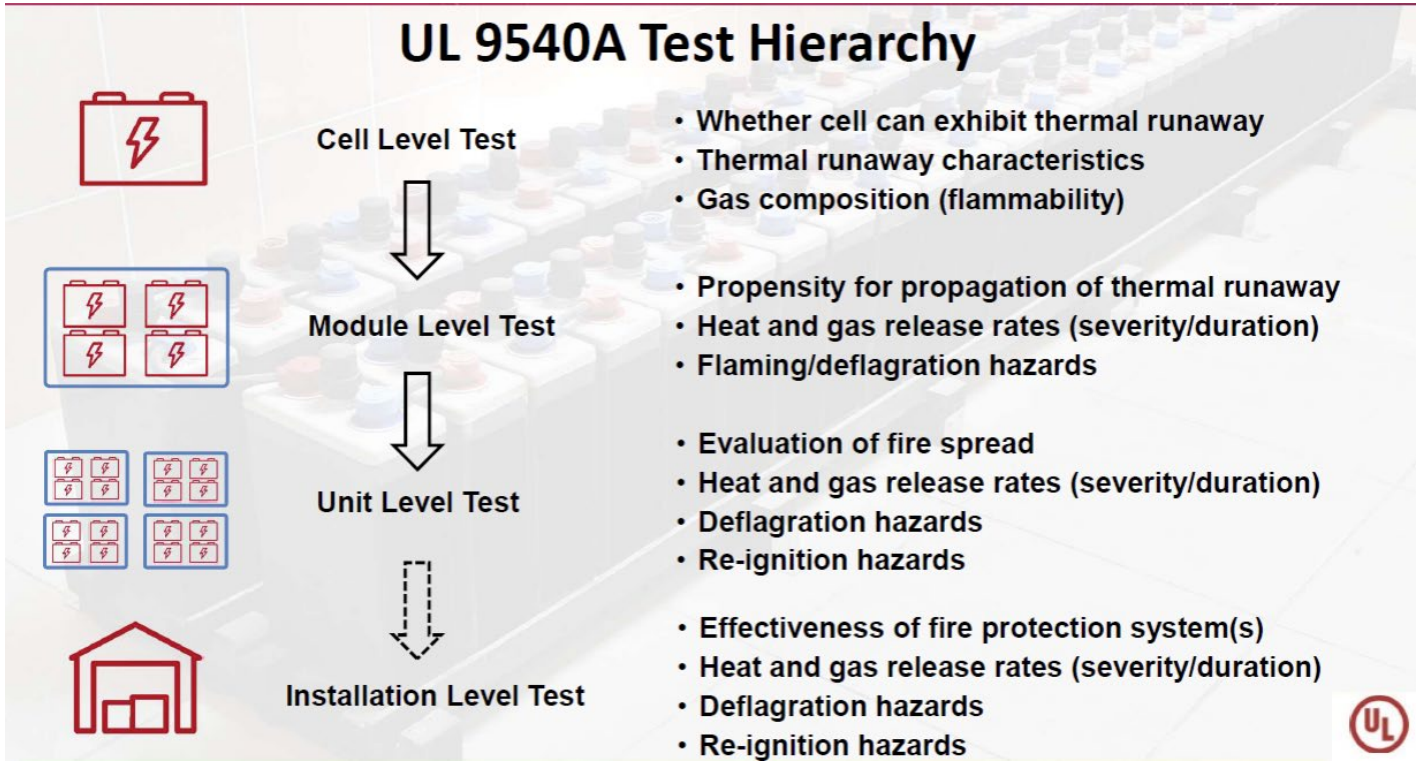
Water used to prevent extension

- Cool surrounding exposures
- Contain flame front if needed

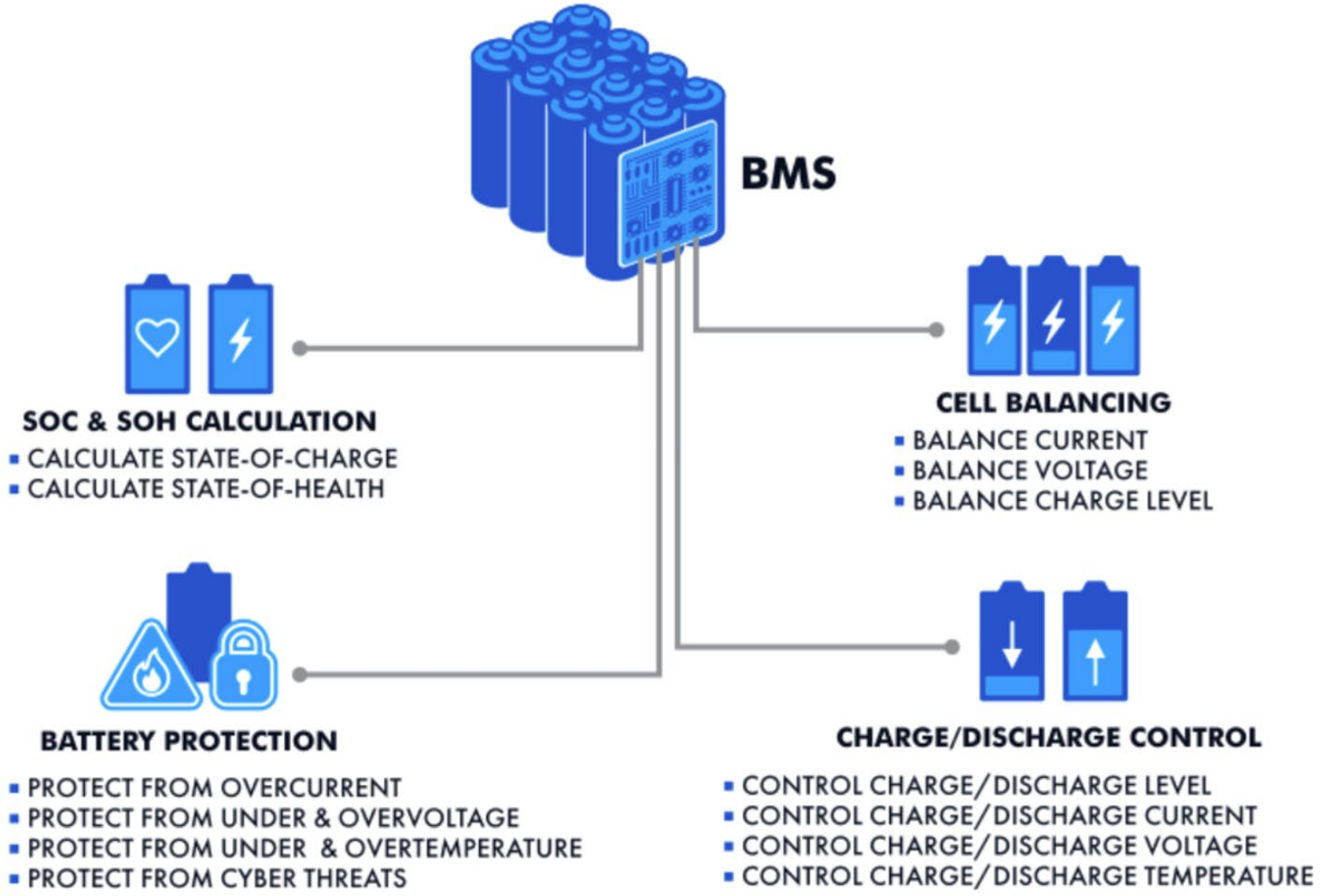
SAFETY STANDARDS ARE CRITICAL

NFPA 68: Deflagration Panels

NFPA 69: Active Ventilation



BATTERY MANAGEMENT SYSTEM



FDNY RESPONSE RESOURCES

- Green Energy Training Day for all officers
- Updated response procedures
- Emergency Information Cards with site-specific information

EMERGENCY INFORMATION CARD (EIC)

BESS (BATTERY ENERGY STORAGE SYSTEM)

2380 Arthur Kill Rd, SI

EMERGENCY CONTACT: 833-723-3377 ext 2

CONTACT INFORMATION	**SITE INFORMATION**
COF: **833-723-3377 ext 2** SME: **650-681-6060** (Tesla) Owner: **888-683-2922** (NineDot Energy) Alarm Central Station: **866-686-2946** FDNY ID #24 (Rapid Response Monitoring)	Number of BESS Enclosures: **7** Energy capacity of each enclosure: **750 kW / 3100 kWh** Total energy capacity of entire site: **5 MW / 21 MWh** Equipment brand name: **Tesla Megapack 2** Battery chemistry used: **Lithium Ion LFP** Grid support system: **Yes**

RESPONSE FOR FIRE ALARM (NO APPARENT CONDITION)

- Contact COF holder or Subject Matter Expert: 833-723-3377 ext 2
- Do not enter site until advised by COF/SME
- When advised by COF/SME, enter site and access the Fire Alarm Control Panel (site lock combo: 4-5-5-3)

RESPONSE FOR FIRE/SMOKE

Primary Operational Strategy:

- Defensive operation: allow the BESS safety features to control the fire (BESS is designed to be self-containing)
- Hoselines are used primarily for exposure protection, can extinguish fire if exposure is threatened
- If advised by COF/SME, water spray system can be supplied via the FDC with 150 psi

Initial Actions:

- **Request a HazMat response:** Required for any emergency, fire or smoke
- **Contact COF holder or Subject Matter Expert:** 833-723-3377 ext 2
- **Establish an initial Danger Zone:** Closest BESS is 15 feet from Exp 1. Do not enter site, unless advised by COF/SME
- **Stretch dry supply line to FDC:** Secure water source, do NOT charge system unless advised by COF/SME and HazMat Unit
- **Stretch a precautionary hoseline:** Intended for exposure protection, straight stream or fog stream can be used
- **Stop power supply to BESS:** E-STOP is next to FDC on Exp 1 wall
- **Consider availability of Large Caliber Streams:** Consider potential blast area when positioning apparatus

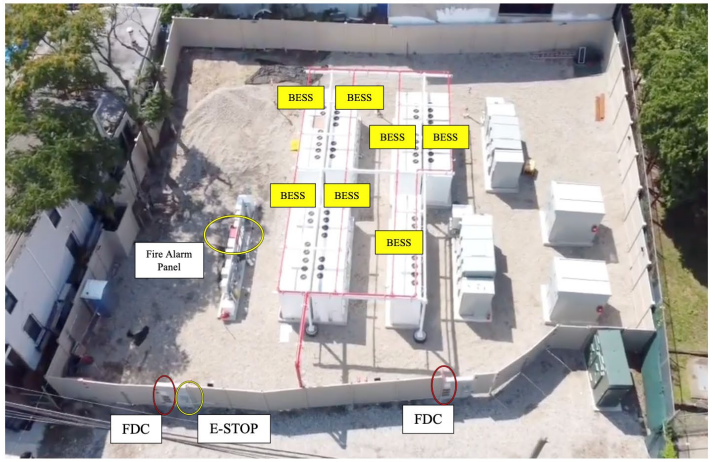
SITE RESOURCES

- **E-STOP Location**: Exp 1 wall, use 1620 key or 2642 key
- **First Responders Box Location:** Exp 1 wall, use 1620 key or 2642 key, contains Emergency Management Plan
- **FDC Location**: Exp 1 wall, either of the two FDC present can be used
- **Hydrant Location**: on Arthur Kill Rd, across the street and 90 feet to the west
- **Fire Alarm Control Panel Location**: Inside site, on the exposure 2 side, roughly 20 ft from front entrance
- **Water Spray System:** Dry system, 40 spray/sprinkler heads, requires 1,800 GPM of water supply via FDC

EXPOSURES	**HAZARDS**
- Exp 1: Street (Arthur Kill Rd) - Exp 2: 2-story wood frame building - Exp 3: 1-story masonry building (23 ft high) - Exp 4: Lot	- Overhead wires - Explosion / Deflagration - Electric shock or arcing

EMERGENCY INFORMATION CARD (EIC)

BESS - 2380 Arthur Kill Rd, SI



Exp 1 wall
FDC, E-STOP, First responders Box

Fire Alarm Panel
Located inside site

CHALLENGES AHEAD…

Interior BESS

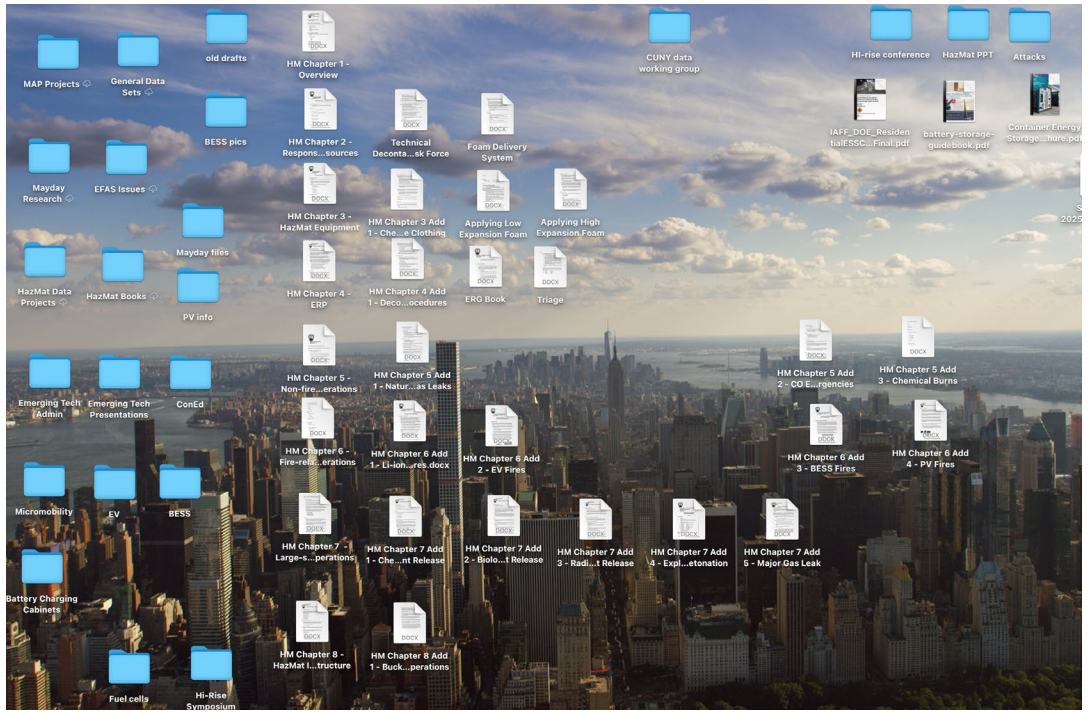
- Where are they located in the building?
- What safety systems are enough?

Keeping track of where they are

- Who maintains the data?
- How are firefighters made aware?

When does a battery become a BESS?

- What is a plug-in energy storage thing?
- What appliances have them?

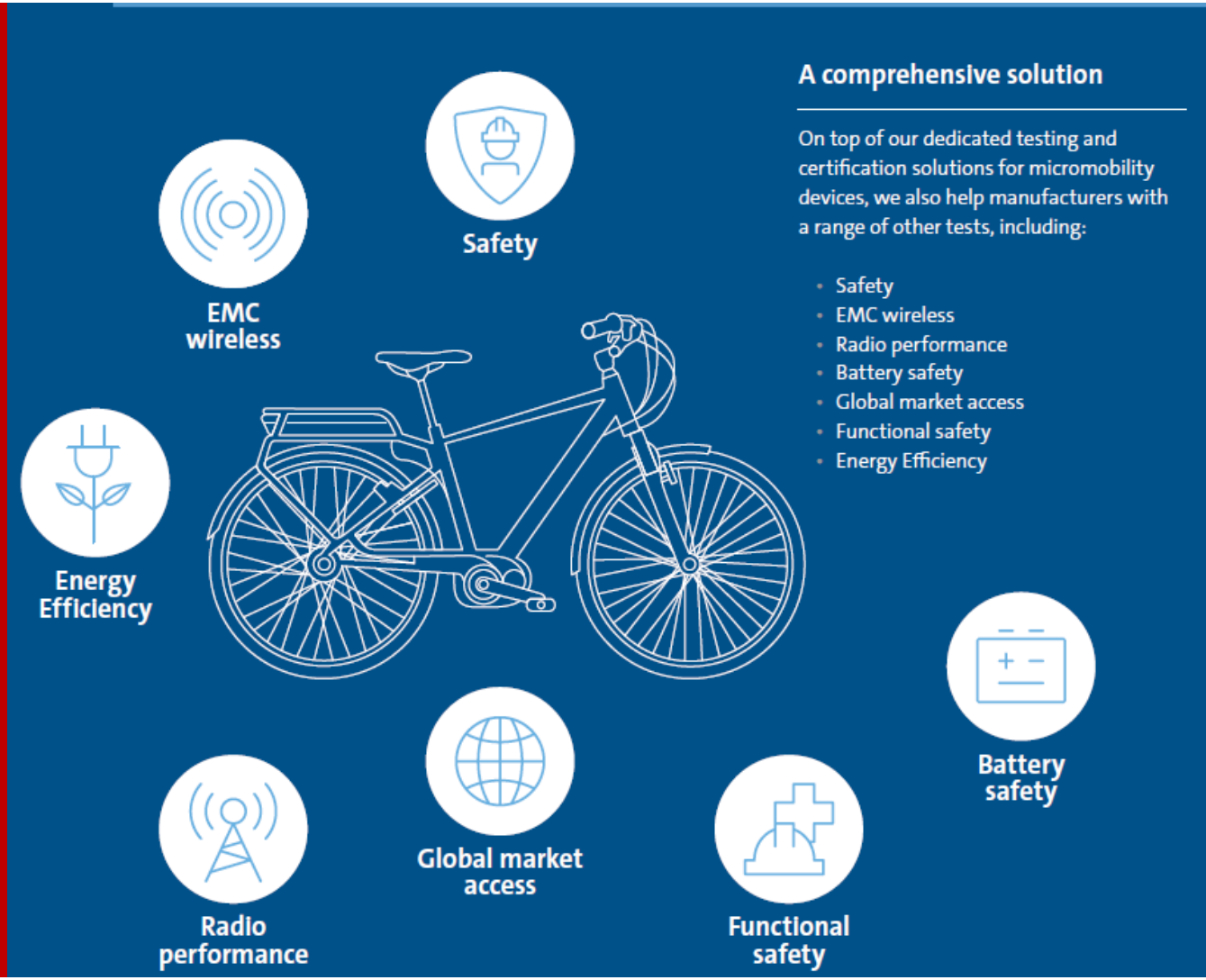


OVERVIEW OF PRODUCT STANDARDS AND FIRE CODES

UL SOLUTIONS - *WORKING FOR A SAFER WORLD*

UL Solutions brings safety science to life, helping businesses solve pressing challenges and innovate with confidence.

Safety. Science. Transformation.™



UL SOLUTIONS
NORTH AMERICA ADVANCED BATTERY LABORATORY

HOW STANDARDS ARE DEVELOPED

- Proposal submitted via UL Standards & Engagement Collaborative Standards Development System (CSDS)
- Proposal undergoes review and refinement by the Technical Committee (TC) comprised of a balanced mix of subject matter experts
- Consensus among TC members determines adoption or rejection of proposed standard
- Successful proposal results in new/revised standard that is published for global stakeholders

MODEL FIRE CODES

2024 International Fire Code (IFC)

- References both UL 2272 & UL 2849 for listing and labeling of devices
- Section 322 Powered MicroMobility Devices (Highlights)
- Specific requirements and restrictions for device charging locations and operations
- Li-ion battery-specific Fire Safety Plan required

2027 International Fire Code (IFC), proposals

- Expansion of requirements to include more types of battery-powered equipment and devices
- Expansion of requirements to cover a wider range of battery chemistries (not just Li-ion)
- Additional reference standards: UL 1487 and UL 4900

MODEL FIRE CODES

2024 NFPA 1 Fire Code

- References both UL 2272 & UL 2849 for listing and labeling of devices
- Section10.21 Powered Micromobility Devices
- Specific requirements and restrictions for device charging locations and operations

2027 NFPA 1 Fire Code

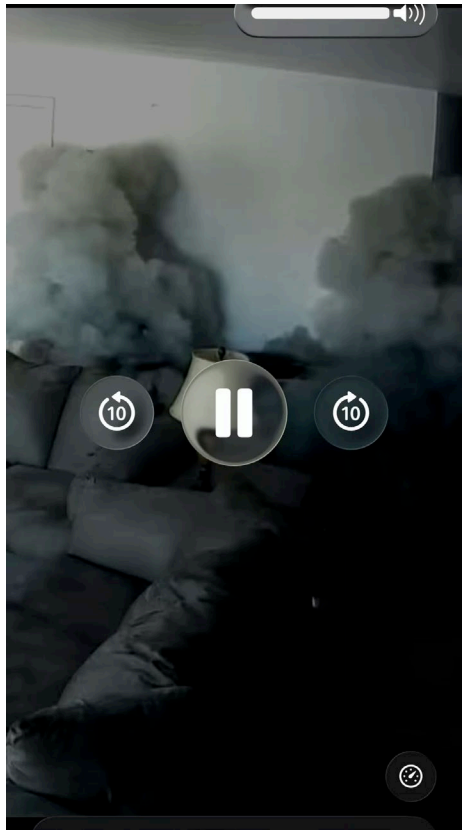
- Based on extensive work by a A Task Group, new requirements for NFPA 1 will be included in the 2027 edition

NFPA 800
BATTERY SAFETY CODE

This document is currently in development

PUBLIC EDUCATION AWARENESS PROGRAMS

TAKE C.H.A.R.G.E. OF BATTERY SAFETY PSA



C.H.A.R.G.E

TAKE CHARGE OF BATTERY SAFETY

Take C.H.A.R.G.E. of Battery Safety.

The best way to be safe is to prevent a lithium-ion battery fire from starting. Take these important actions now.

C — **Choose certified products.**

H — **Handle with care.**

A — **Always stay alert for warning signs.**

R — **Recycle devices and batteries properly.**

G — **Get out quickly if there's a fire.**

E — **Educate others on safe practices.**

RESOURCES

Complimentary resources available from UL Solutions

UL Research Institutes Fire Safety Research Institute (FSRI) public education from UL Solutions:

E-Bike/Micromobility Device Safety: Product Certification: https://www.UL.com/news/e-bikemicromobility-device-safety-product-certification

E-Bikes Certification: Evaluating and Testing to UL 2849: https://www.UL.com/services/e-bikes-certificationevaluating-and-testing-ul-2849

Enhance Workplace Lithium-ion Battery Safety: https://www.UL.com/insights/enhance-workplace-lithium-ion-battery-safety

Reese's Law and CPSC Rule Mandate Battery Safety: https://www.UL.com/news/reeses-law-and-cpsc-rule-mandate-battery-safety

The Importance of Functional Safety in Batteries and Micromobility Products – On-demand webinar: https://www.UL.com/resources/importance-functional-safety-batteries-and-micromobility-products

Follow this QR code for resources that include:

www.UL.com/BatterySafetyResources

Resources available from UL Research Institutes FSRI

Fire service considerations with Li-ion battery ESS

https://training.fsri.org/course/104/fire-service-considerations-with-lithium-ion-battery-energy-storage-systems

https://training.fsri.org/

Science of fire and explosion hazards from Li-ion batteries

https://training.fsri.org/course/111/the-science-of-fire-and-explosion-hazards-from-lithium-ion-batteries

THANK YOU!
ANY QUESTIONS?

EVALUATION AND WIN AN IPAD!

- **Submit your workshop and overall evaluations to be automatically entered in two drawings for a new iPad!**
- **Complete your evaluations using the IAFF app:**
  1. Download the IAFF app and sign in with your iaff.org username
  2. Tap the 2026 Strive for Excellence Summit event image to enter the event's dashboard
  3. Tap "Sessions" and tap on the workshops you attended
  4. Tap "Evaluation" and complete the evaluation
  5. Tap "Submit"

For the event's overall evaluation, follow steps 1 and 2, then tap "Event Evaluation" located in the event's Dashboard.