



# **FIRE DEPARTMENT – NEW YORK CITY (FDNY)**

## **ENERGY INITIATIVES AND IMPACT ON PUBLIC SAFETY**

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**LEO SUBBARAO – MANAGER SUSTAINABILITY UNIT**









# Safety Challenges

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- Fire
- Explosion
- Toxicity

Batteries considered Li-Ion, Lead Acid(VRLA), Nickle Cadmium and Flow Batteries

Small – Hoverboard Fire



Medium – FM Burn Test - Cabinet



A fire engulfs an energy storage system at a cement plant in Jechon, North Chungcheong Province, Monday. / Courtesy of North Chungcheong Province Fire Service Headquarters

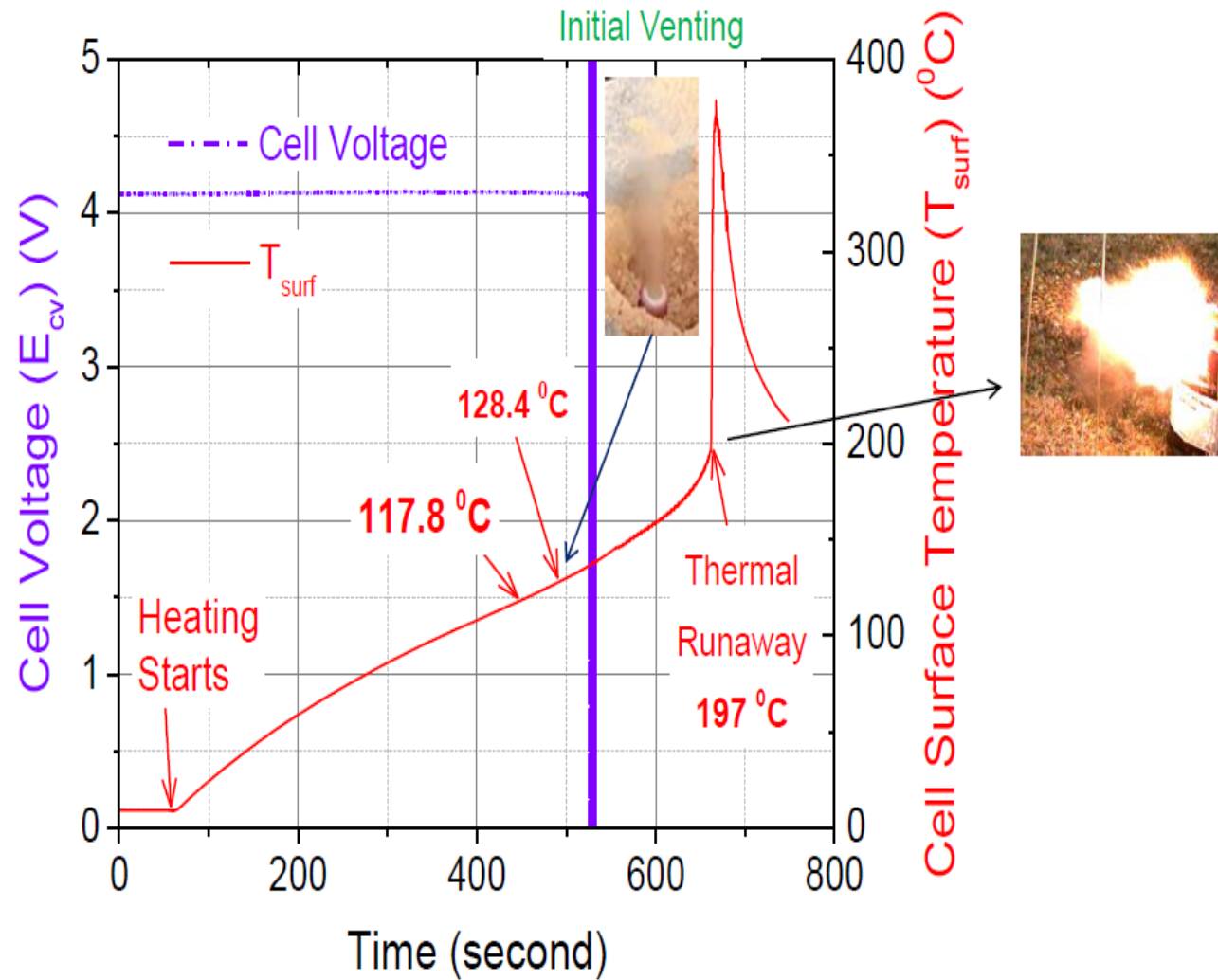




# Batteries and Thermal Runaway

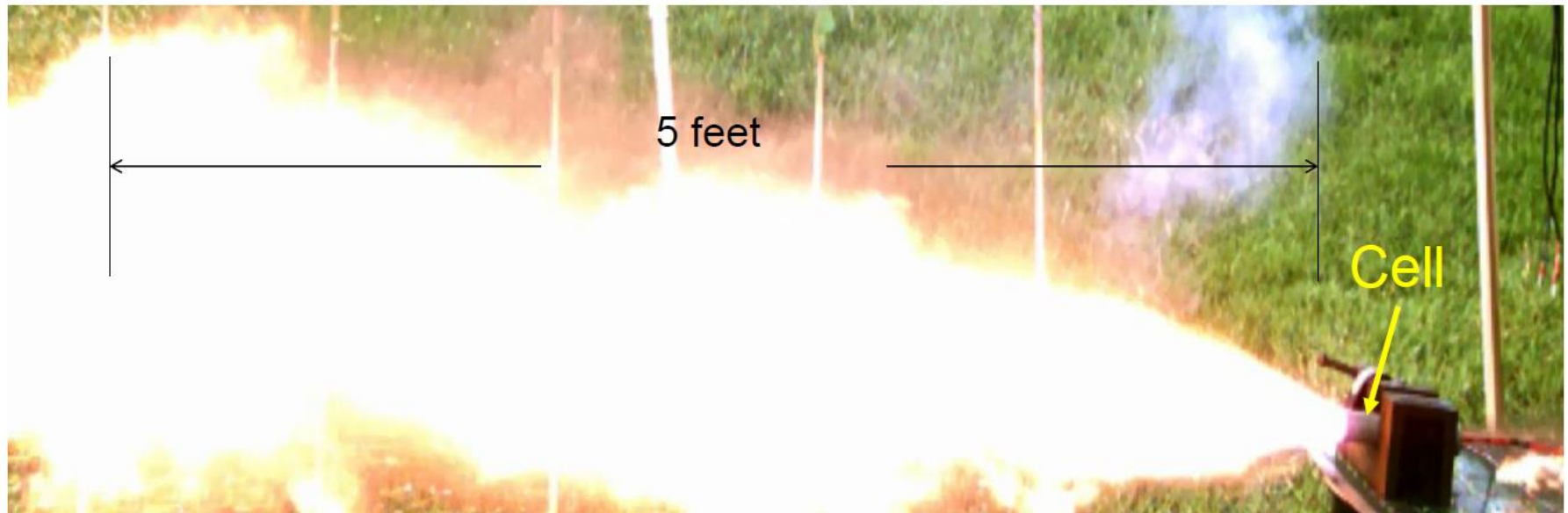
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- Certain technologies susceptible to thermal runaway:
  - VRLA
  - NiCd and NiMH
  - Lithium Ion
- Other technologies are not susceptible to thermal runaway, but can generate hydrogen
  - Flow batteries
  - Flooded Batteries



**$T_{surf}$  or  $E_{cv}$  do not provide any clue to critical events until it is too late!**

# Extent of A Typical Thermal Runaway



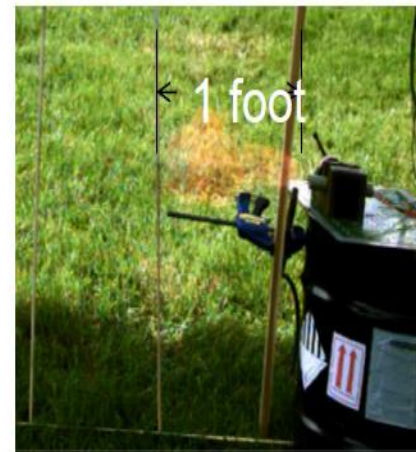
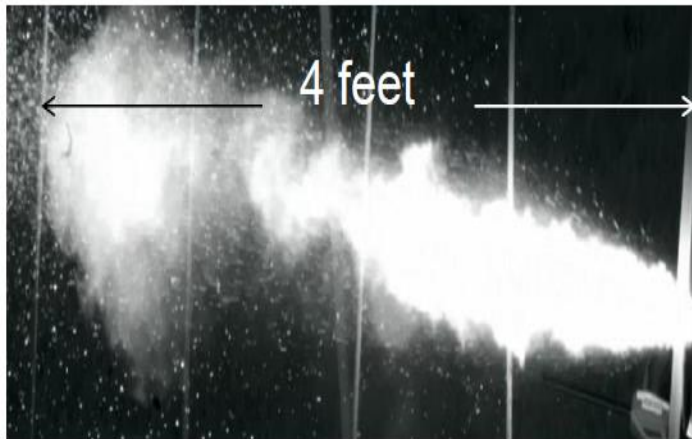
- **Typical Fire During Thermal Runaway**
- **Duration of fire varies between 0.25 s to 1.0 s**
  - *0.25 s in cold environment (5 °C – 10 °C); >0.9 s in warmer environ. (20 °C – 25 °C)*



# Normal TR vs. TR Without the Vented Solvent



- ✓ TR in a single cell generates ~55 kJ
- ✓ Pre-TR vented solvent generates 32 kJ
  - ...*while burning on top of receiving cells*
- ✓ Remove the solvent ahead of TR
  - ...and generate a smaller fire, away from the receiving cells

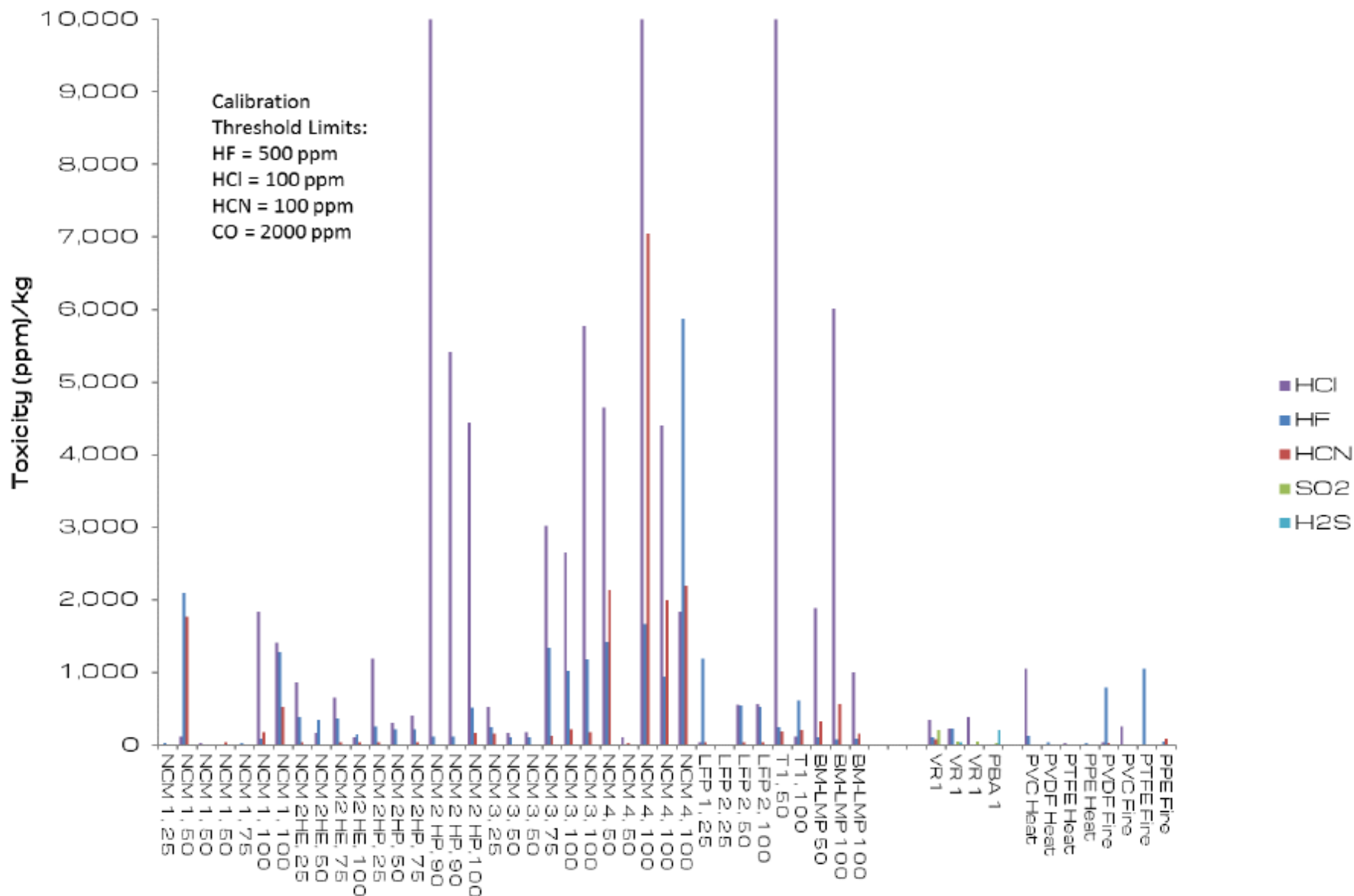


Pre-TR Solvent generates 32 kJ of Heat

235<sup>th</sup> Electrochemical Society: A06 - Battery Safety and Failure Modes, May 26-31, Dallas, TX



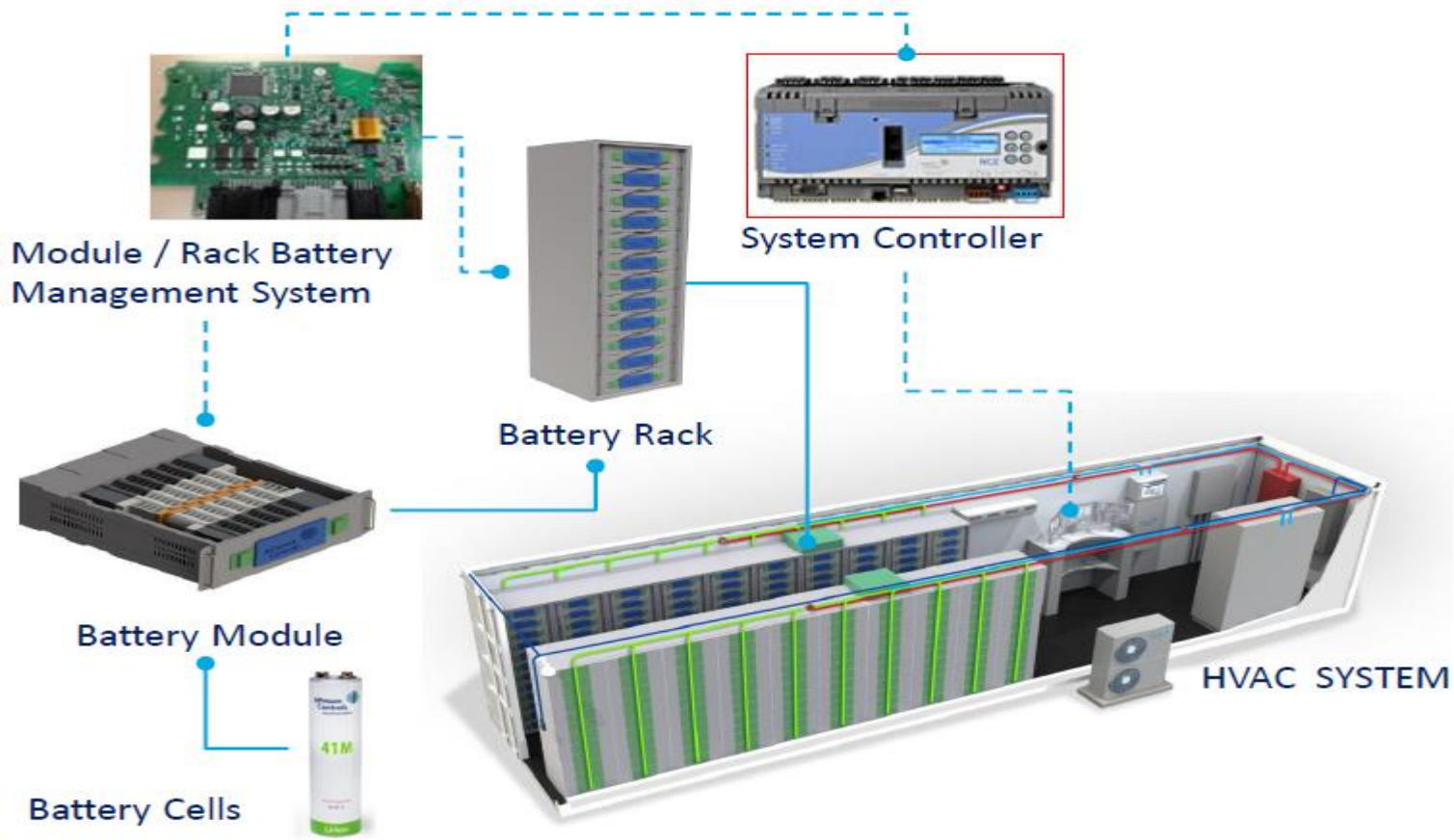
**PEAK ppm/kg of Material in 0.44 m<sup>3</sup> - Batteries vs. Plastics**



**Figure 4 Peak ppm per kg (in a 0.44 m<sup>3</sup> volume) for all batteries tested as compared to plastics.**



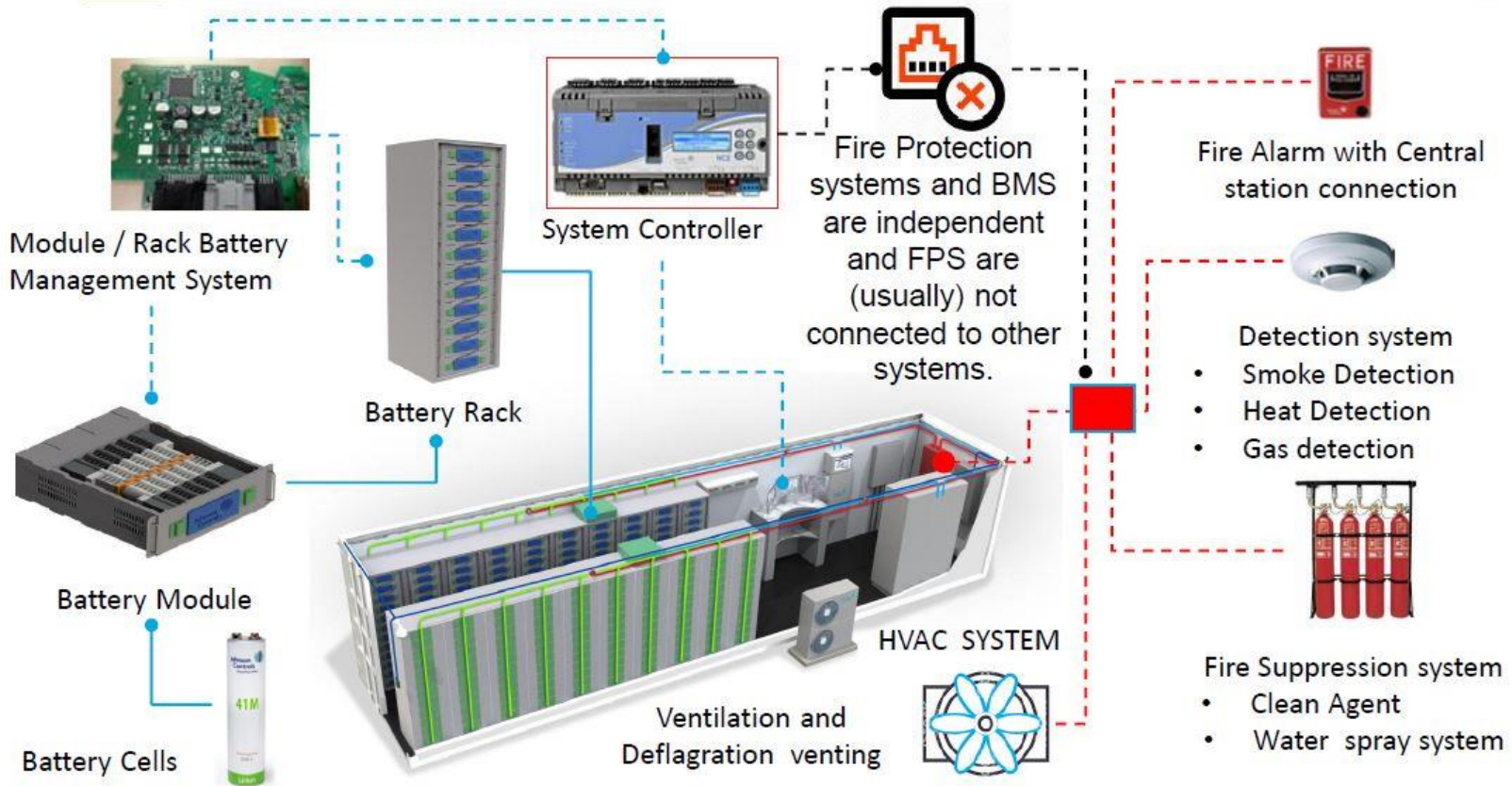
# STANDARD BESS DESIGN







# FDNY Protection Requirements





# Rules and Regulations

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- NFPA 855 (Expected 2020)
- International Fire Code (IFC Chapter 12)
- NYC Regulations (Currently under development)



# Rules and Regulations (cont.)

NYC Outdoor Requirements			
Protection	Small	Medium	Large
Lithium Ion			
Fire Suppression	No	No*	Yes
Dry Water-Based Pipe	No	No*	Yes
Fire Detection	No	Yes	Yes
Exhaust	No	No*	Yes
Explosion Protection	No	Yes	Yes
UL Listings	Yes	Yes	Yes
UL 9540A	Yes	Yes	Yes
VRLA			
Fire Suppression	No	No*	Yes
Dry Water-Based Pipe	No	No*	Yes
Fire Detection	No	Yes	Yes
Exhaust	No	No*	Yes
Explosion Protection	No	Yes	Yes
UL Listings	Yes	Yes	Yes
UL 9540A	No	No	No**

NiCAD			
Fire Suppression	No	No*	Yes
Dry Water-Based Pipe	No	No*	Yes
Fire Detection	No	Yes	Yes
Exhaust	No	No*	Yes
Explosion Protection	No	Yes	Yes
UL Listings	Yes	Yes	Yes
UL 9540A	No	No	No**
Flow Battery			
Fire Suppression	No	No*	Yes
Dry Water-Based Pipe	No	No*	Yes
Fire Detection	No	Yes	Yes
Exhaust	No	No*	Yes
Explosion Protection	No	Yes	Yes
UL Listings	Yes	Yes	Yes
UL 9540A	No	No	No**

\*Unless Full Scale Testing requires system to be provided

\*\*If no sufficient data is available, UL 9540A can be utilized to gather data to engineer Explosion/Fire Suppression systems





# Rules and Regulations (cont.)

National Outdoor Requirements		
Protection	Walk-in Units	Cabinets
Lithium Ion		
Fire Suppression	Yes	No
Dry Water-Based Pipe	No	No
Fire Detection	Yes	No
Exhaust	Yes	No
Explosion Protection	Yes	No
UL Listings (9540)	Yes	Yes
Full Scale Fire and Fault	No <sup>1</sup>	No
VRLA		
Fire Suppression	No	No
Dry Water-Based Pipe	No	No
Fire Detection	Yes	No
Exhaust	Yes	No
Explosion Protection	Yes	No
UL Listings (9540)	Yes	Yes
Full Scale Fire and Fault	No <sup>1</sup>	No

NICAD		
Fire Suppression	Yes	No
Dry Water-Based Pipe	No	No
Fire Detection	Yes	No
Exhaust	Yes	No
Explosion Protection	Yes	No
UL Listings (9540)	Yes	Yes
Full Scale Fire and Fault	No <sup>1</sup>	No
Flow Battery		
Fire Suppression	Yes	No
Dry Water-Based Pipe	No	No
Fire Detection	Yes	No
Exhaust	Yes (Ventilation)	Yes
Explosion Protection	No	No
UL Listings (9540)	Yes	Yes
Full Scale Fire and Fault	No <sup>1</sup>	No

<sup>1</sup> Full Scale Fire and Fault Results used to justify exemption from separation distances, MAQ's, Fire suppression density, Explosion Control and separation distances



# Required Listings and Test Method

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UL 1973 - Standard for Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications

UL 9540 - Standard for Energy Storage Systems and Equipment

UL 9540A - Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems



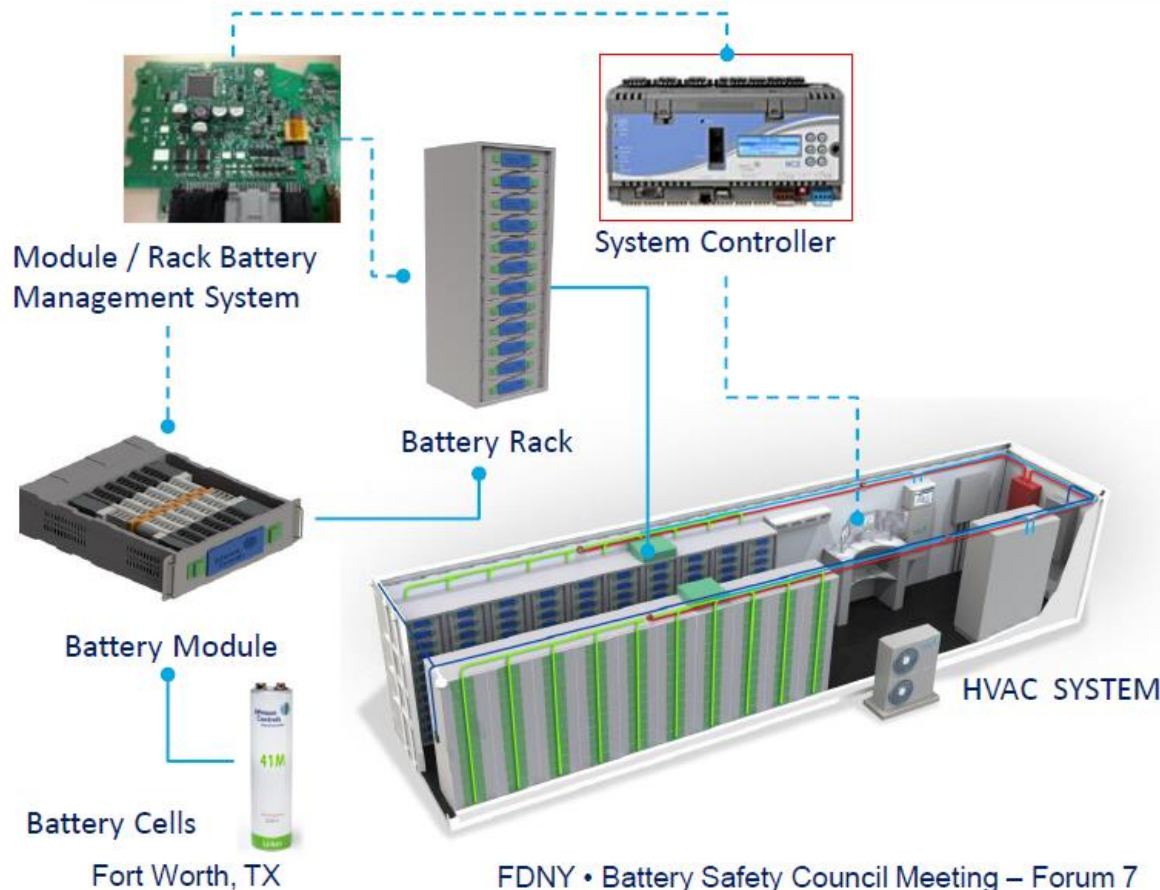
Questions?

Thank You





# What The BMS Can Do?

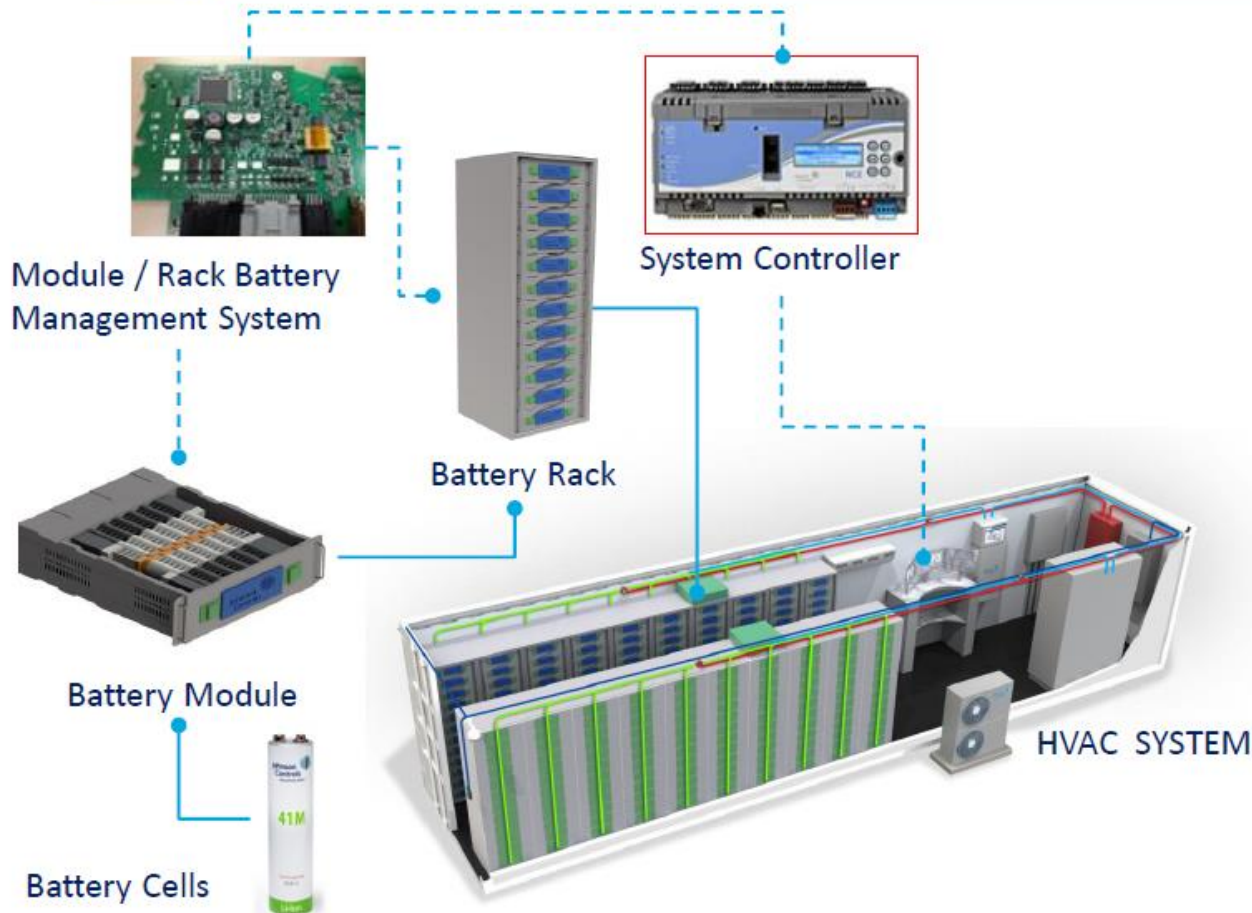


## Protect human safety of device's operator:

- Detect unsafe operating conditions and respond
- Protect cells damage due to abuse/failure cases (abuse from users or in abnormal conditions)
- Prolong life of the batteries
- Maintain battery in a safe operational state
- Provide the application controller with system statuses for safe operations



# What The BMS Can't Do?



**BMS cannot protect the system beyond all failure such as:**

- shorts or manufacturing flaws within cells.
- Protect against wiring shorts or loose / bad connections.
- Provide proper protection when improperly designed, integrated or installed.



# First Responders Issue



At a Safe distance:

- Information from BMS to interpret the point at which thermal runaway can be mitigated.
- Notify First Responders to site if failure occurs





# First Responders Issue

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Fire Department does not want to inadvertently destroy systems by initiating operations (Water Spray system), Unless:

- There is visible smoke or flame from container/cabinet

It is not always obvious to FD Operations if a failure event has passed the point where thermal runaway cannot be mitigated, especially if there is no visible smoke/flame (containers are sealed)

**Rely on BMS to guide First Responders on the condition of system**





# First Responders Issue

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**FDNY will stage remotely from system – Operate at a distance**

What we look for in BMS:

Data transmission from the BMS to be continuously monitored (on a 24/7 basis) by a remote monitoring facility

Remote monitoring facility shall, without delay, make notification to the Fire Department in the event a system exceeds or appears likely to exceed thresholds at which fire, explosion or other serious adverse consequences may result

Remote monitoring facility shall be staffed by trained and knowledgeable personnel retained by the manufacturer or installer of such system.

