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**March 2, 2026**

9:00 am – 10:00 pm | CST, Chicago

10:00 am – 11:00 am | EST, New York City

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# Training on UL 9540A, NFPA 855, and large-scale fire validation of 6.25 MWh BESS containers (US focus)



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# Welcome!

**Do you have any questions?**  

Send them in via the Q&A tab.  We aim to answer as many as we can today!

You can also let us know of any tech problems there.

**We are recording this webinar today.** 

We'll let you know by email where to find it and the slide deck, so you can re-watch it at your convenience.  



# Hithium ∞ Power 6.25MWh LSFT Introduction





**01** Advances in Technology

**02** Test Preparation

**03** Test Result

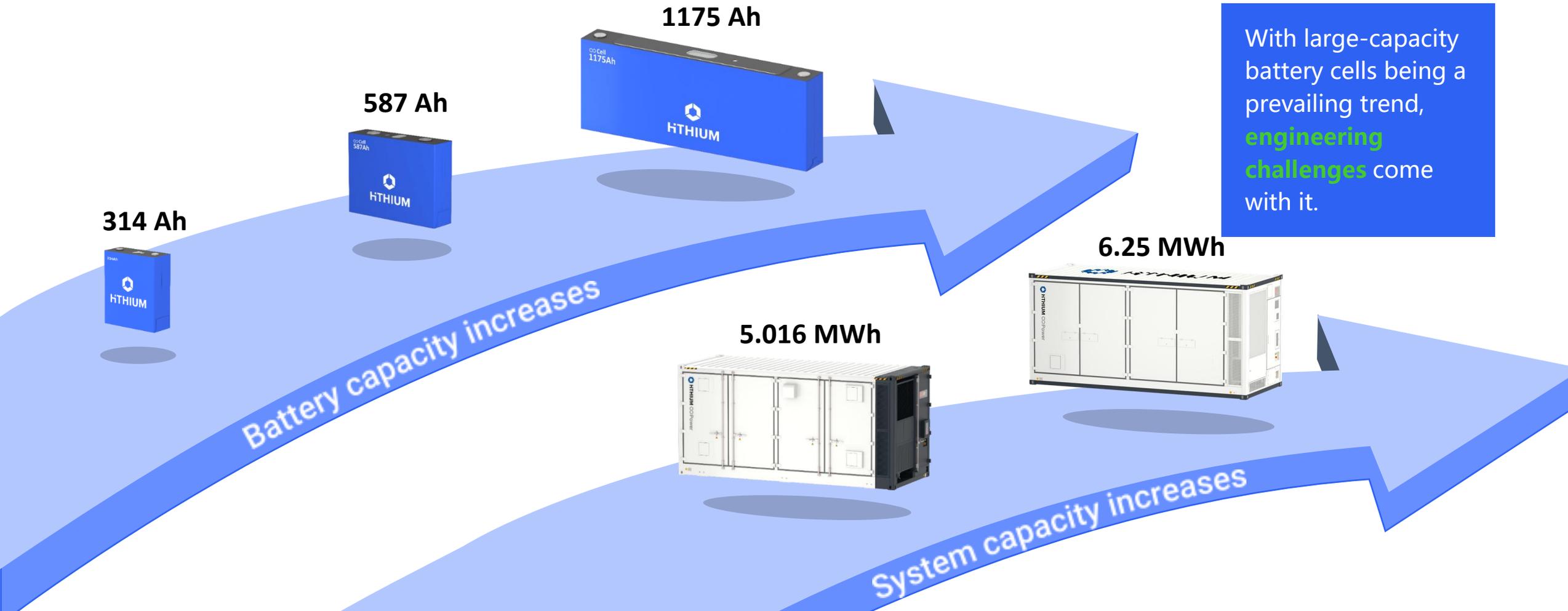
**04** HiTHIUM Product Safety Design



# Advances in Technology

Large-capacity battery cells have become a prevailing trend.

Cell capacity has increased from **587 Ah** to **1175 Ah**, while system capacity has increased to **6.25 MWh**, driving continuous improvement in energy density and cost-effectiveness of energy storage systems.





 Australia, July 2021



 South Korea, June 2024



 USA, May 2024



 USA, January 2025

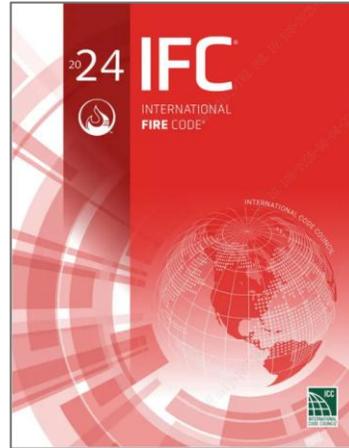
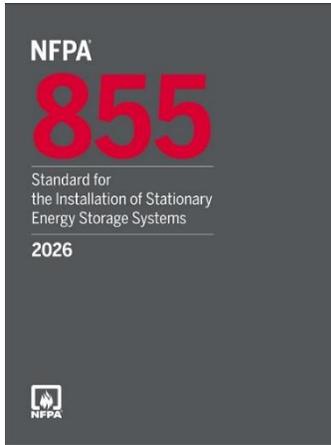
- More projects means greater risk and more media exposure
- Fires are still exceeding low probability
- Strategy is to stop spread but allow the fire to burn out

**Sample incidents from the wider industry**



# Test Preparation

∞Power 6.25MWh's large-scale fire test complies with the latest standards: **NFPA 855 (2026)** and **UL 9540A (2025)**.



9.2.1 Where required elsewhere in this standard, fire testing in accordance with Section 9.2 shall be conducted on a representative ESS in accordance with UL 9540A and large-scale fire testing to collect data for gas production at a cell level, thermal runaway propagation at a module level, and thermal runaway propagation potential between ESSs.

1207.1.7 Large-scale fire test. Where required elsewhere in Section 1207, large-scale fire testing shall be conducted on a representative ESS in accordance with UL 9540A.

“NFPA 855 provides minimum requirements for the installation of stationary energy storage systems (ESS) to mitigate fire, explosion, and electrical hazards.”

“**Maximized Space**. NFCC compliant and UL 9540A certified, enabling 3ft spacing for high-density BESS deployments”

Target Cabin A (fully configured) was set with its cabin door, control cabinet door, and ventilation louvers open, and the fan inoperative; Cabins B, C, and D (single-cluster each) had their cabin doors closed.



With Heat Flux (\*10)

More than 300 Thermocouples

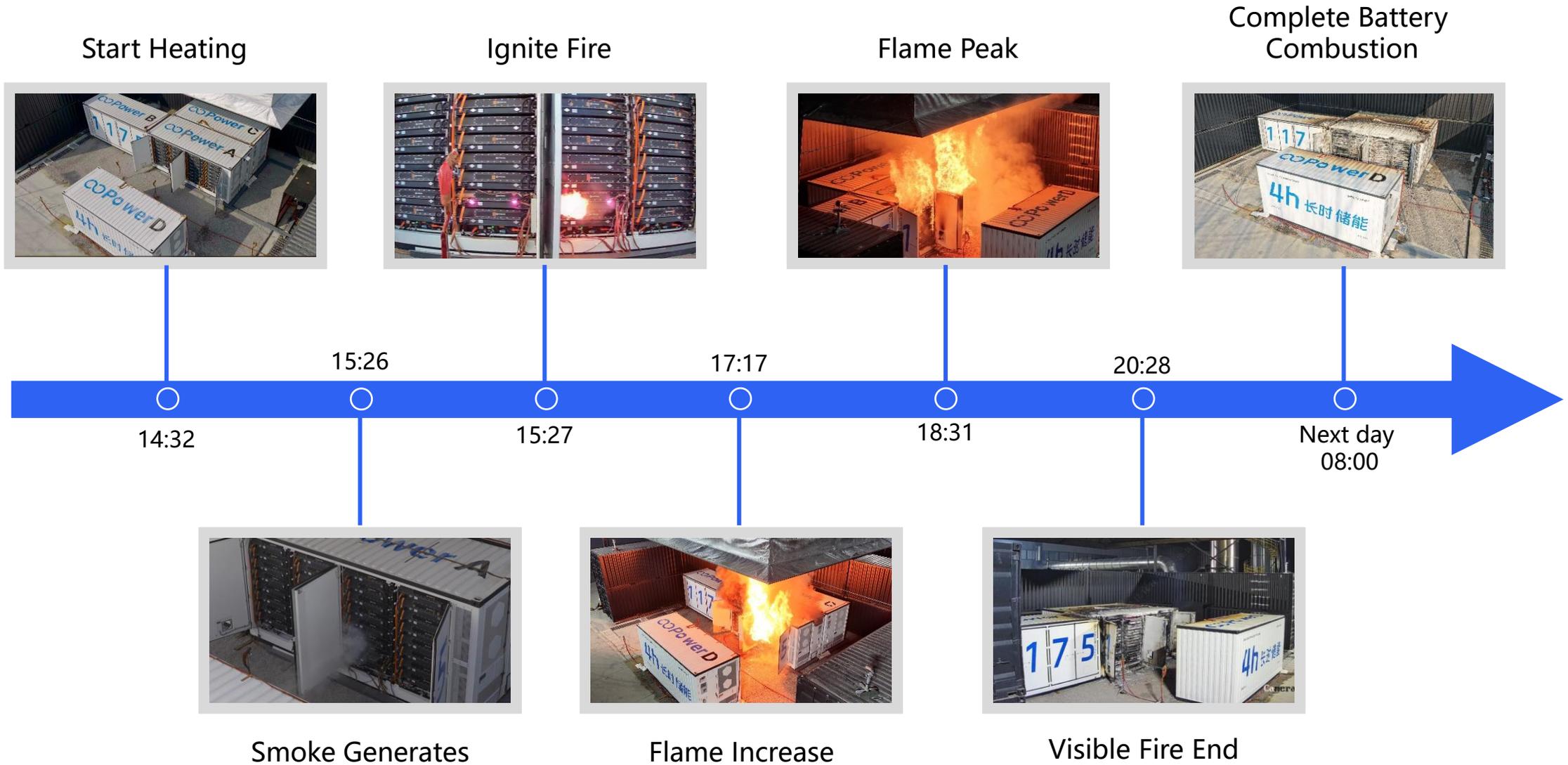
More than 30 Voltage detectors

Gas Analysis

...



Test Result



According to UL Solutions (Test Organization)'s evaluation, Hithium's ∞Power 6.25MWh container has passed large scale fire test.

<b>Exposure</b>	<b>Limit</b>	<b>Comment</b>	<b>Result</b>
Cells within the target enclosures	Average temperature of venting temperature from the Cell Level test, Section 7	The Max temperature measured for the battery cell is below the average venting temperature from Cell level test.	<b>PASS</b>

## 1

### Test Condition

- World First All Open-door Fire Test 6MWh+ (&5MWh+)
- 100%SOC full charged
- Fire Suppression System Deactivated
- 15 cm Minimal Spacing, Back-to-Back & Side-to-Side
- Heating 2 cells into thermal runaway

## 2

### During Test

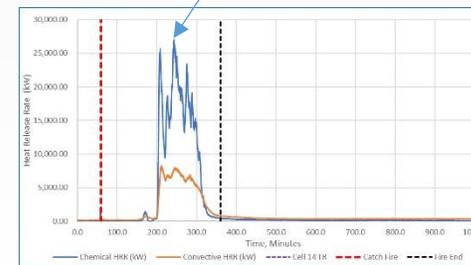
- Took about 1h to trigger thermal runaway
- Successful ignition from igniter but not heating
- 4 hours on fire and total combustion exhausted at 14 hours

## 3

### Test Result

- No propagation between containers
- Modules of target containers remained intact
- No critical structural deformation or collapse observed
- Heat release rate peaked multiple times.

Peak HRR: 27 MW



## 4

### Post Test

- Gas composition analysis
- Residue analysis
- Smoke release rate
- Residue recycling



# Hithium Product Safety Design

Building multi-level safety protection from cell to pack to system, ensuring the safety of large-capacity energy storage systems.

## Cell

### Intrinsic safety (safety structure)

- Overhang Design
- Explosion Valve Design
- High-resistance Insulation Design



### Intrinsic safety (chemical system)

- High thermal stability cathode: doping/coating
- High thermal stability anode: surface defect modification
- High-safety electrolyte: safety additives

## Pack

### Passive safety (flame resistance)

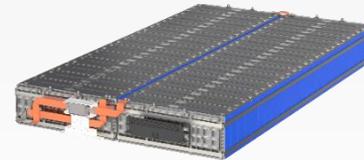
- Flame-resistant composite material casing
- Fiber + Resin RTM

### Passive safety (thermal propagation prevention)

- Thermal insulation pad

### Active safety (thermal management)

- Stamped liquid cooling plate
- High-efficiency heat exchange pipeline



## System

### Passive safety (explosion suppression)

- Active air intake and exhaust



### Active safety (early warning)

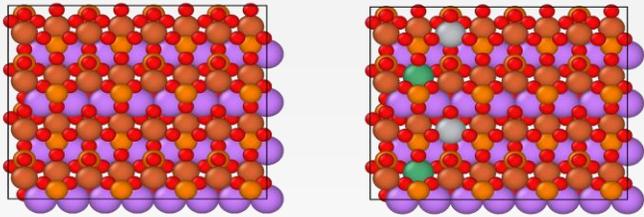
- Real-time status monitoring
- Risk warning

### Passive safety (fire protection)

- Combustible gas detection
- Optional extras

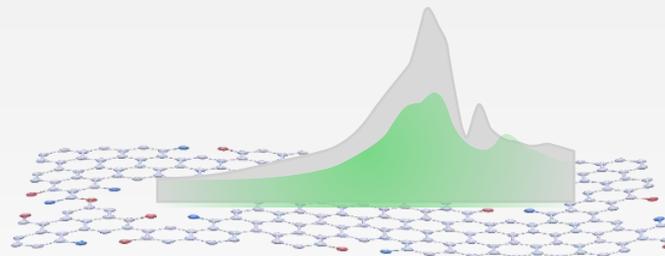
Greater capacity represents greater energy, making safety a critical challenge that must be overcome for large battery cells.

The research and development team has adopted the approach of "**proactive improvements and passive guidance**" to achieve effective control of safety risks in large batteries.



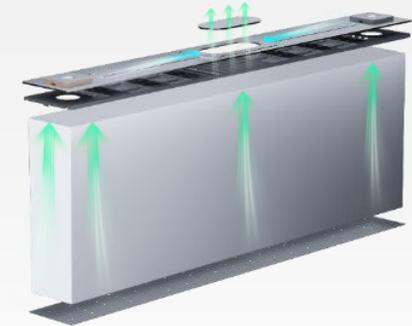
Multi-element doped lithium iron phosphate cathode material

By doping LFP with multiple elements, the structural stability and thermal stability of the LFP material under high-temperature environments are enhanced.



Low surface defect anode material reduces thermal effects

The anode utilizes thermally stable graphite to reduce surface defects and mitigate thermal effects.



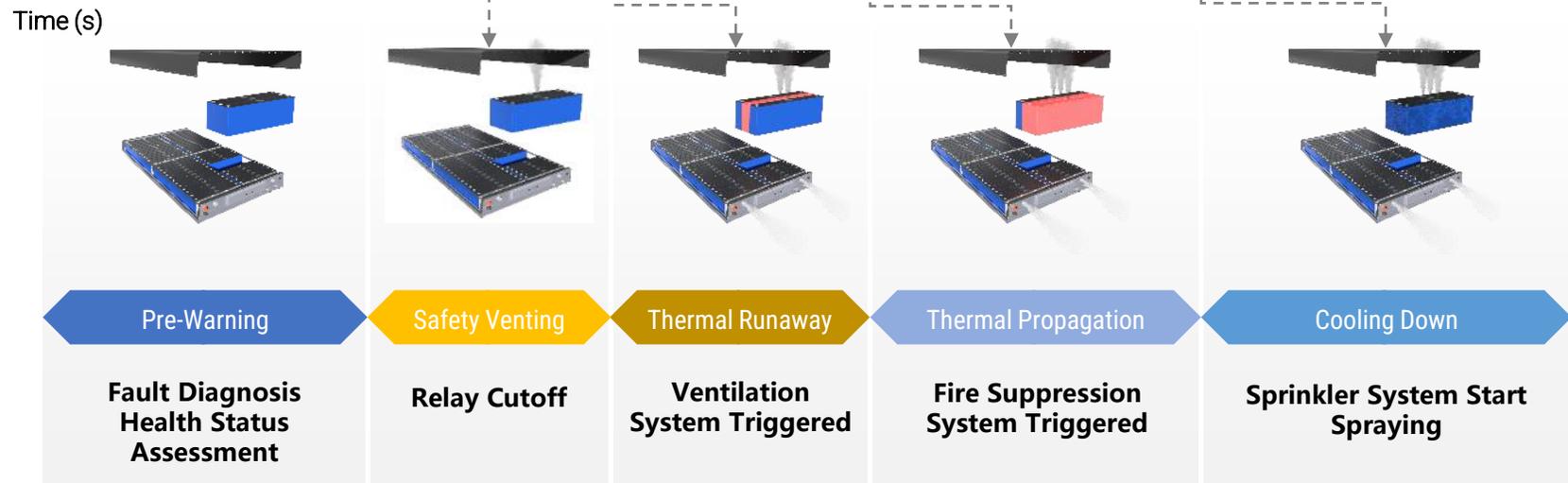
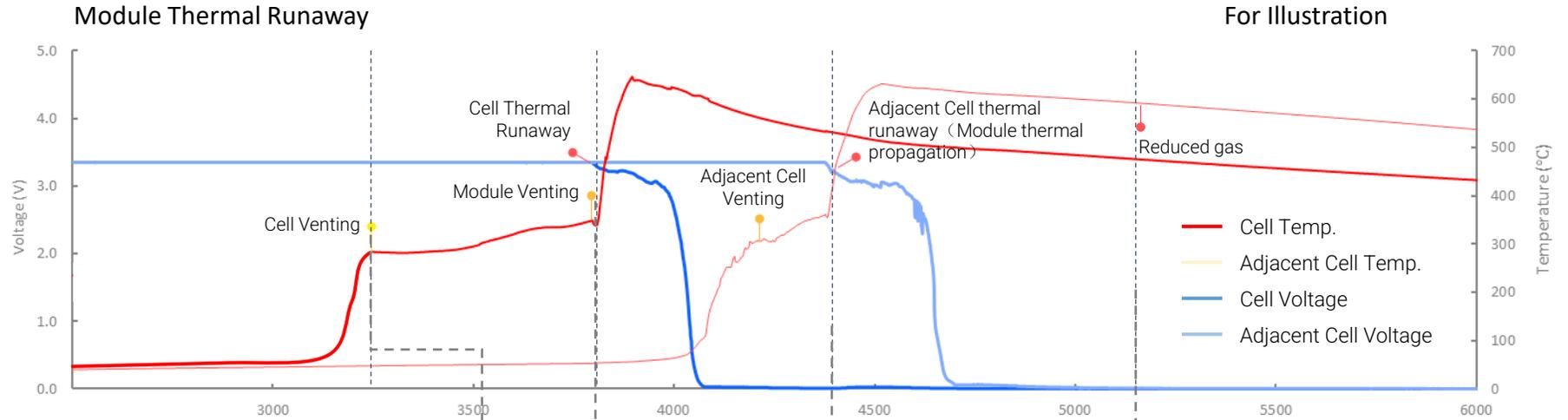
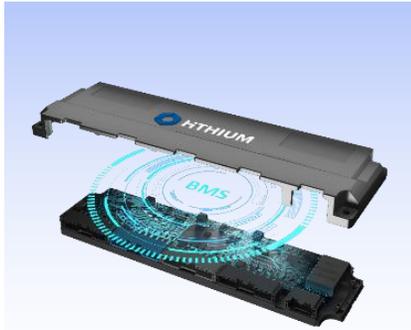
3x3+1 three-dimensional air channel

Oversized explosion-proof valve with directional opening technology

Utilizes a three-dimensional airflow channel design, featuring three rapid gas pathways per dimension, achieving 360° gas transmission channels.



**Active Safety:** Proprietary multi-modal warning algorithms, multi-dimensional sensing, and redundant control technology enable precise warning, monitoring, and control, ensuring proactive safety performance of the energy storage system.



## BMS

Functional Safety SIL2	Cyber Security SL2
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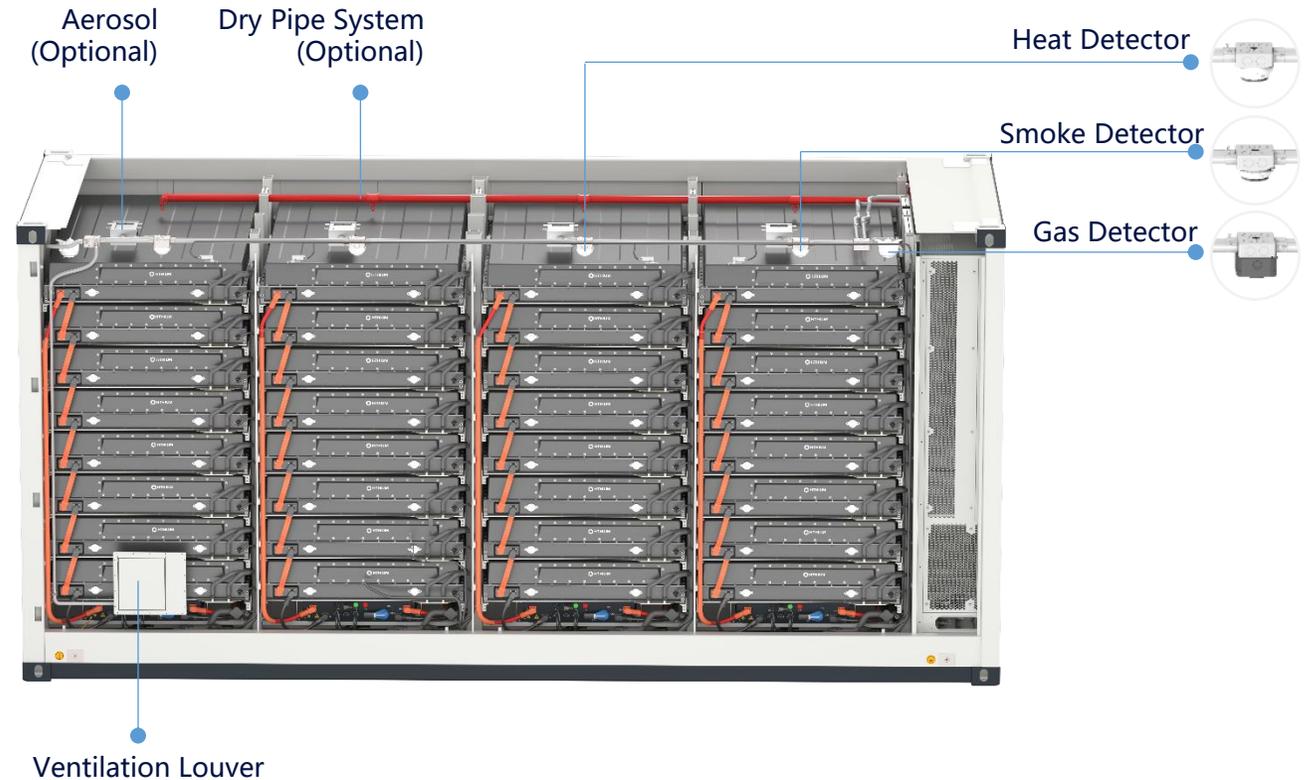
Design in accordance with NFPA 855 Authorized 3<sup>rd</sup> Party Safety Validation



**National Fire Protection Association:**  
Standards for stationary storage battery systems

- NFPA 69 Analysis
- NFPA 70E Assessment
- NFPA 72 Compliant Alarm System
- ESS Fire Extinguishing/ Suppression System Design Review
- Hazard Mitigation Analysis
- Optional extras: NFPA 68 Analysis...

All key components with UL and/or CE



*Configurations of the Fire protection system may differ for specific projects*

Together we create a more  
sustainable future...



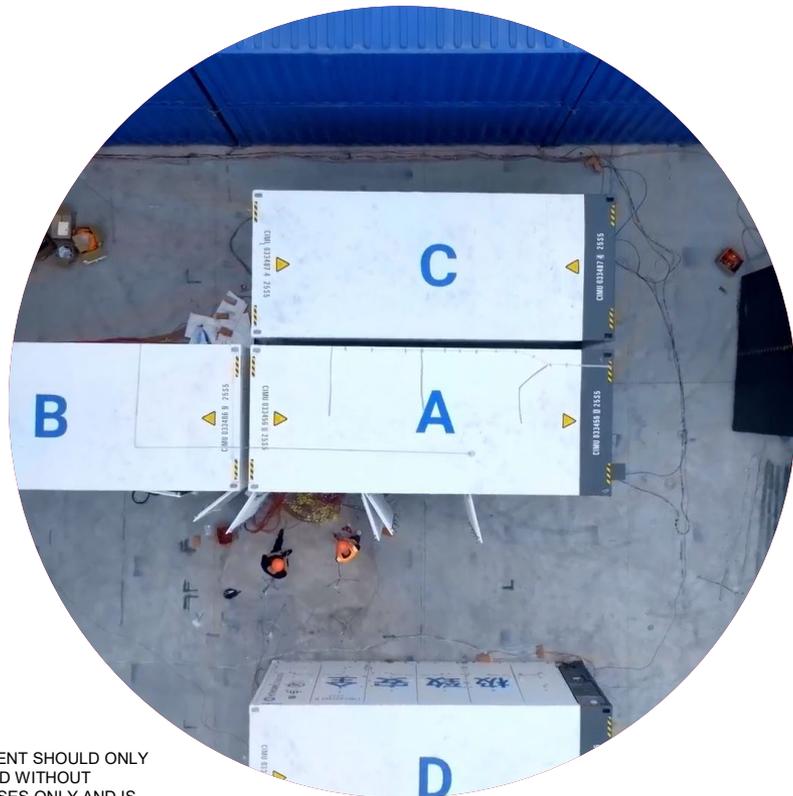
[hithium@hithium.com](mailto:hithium@hithium.com)

<http://hithium.com/en/>



# Large-Scale Fire Testing for Battery Energy Storage

What to expect with NFPA 855:2026 and upcoming UL 9540A publication



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# Introduction

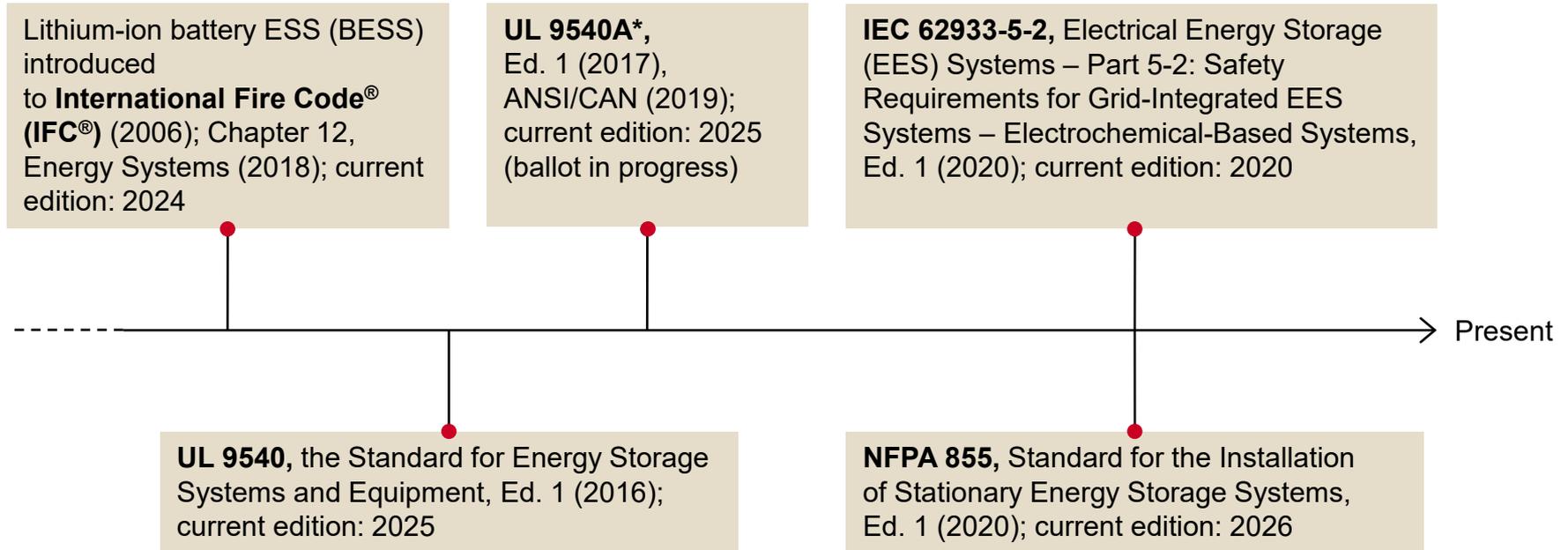


## LaTanya Schwalb

**Principal Engineer, Energy and Industrial Automation | UL Solutions  
Distinguished Member of Technical Staff, William Henry Merrill Society**

- Responsible for the development of technical requirements and interpretation of UL Standards for stationary batteries, energy storage systems, fuel cells and hydrogen generators
- Represents UL Solutions on technical committees for UL 1973, the Standard for Batteries for Use in Stationary and Motive Auxiliary Power Applications; UL 9540, the Standard for Energy Storage Systems and Equipment; and UL 9540A, Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems
- Member of NFPA 855 technical committee for energy storage systems; NFPA 850 for electric generating plants; NFPA 853 for fuel cells; NFPA 800, The Battery Code; and NFPA 2 for hydrogen technology
- Member of IEC technical committees TC 21/SC 21A for secondary cells and batteries; TC 105/MT 201, 301 and 401 for fuel cell technologies; TC 120/MT 7, 8 and Working Group 4 and 5 for electrical energy storage (EES) systems; and TC 31/WG 47 for cells and batteries in equipment for hazardous locations; member of Canadian Standards Association (CSA) technical committees for fuel cells and hydrogen generators using water electrolysis
- More than 20 years of experience in product safety certification

# Brief history of energy storage system (ESS) codes and standards

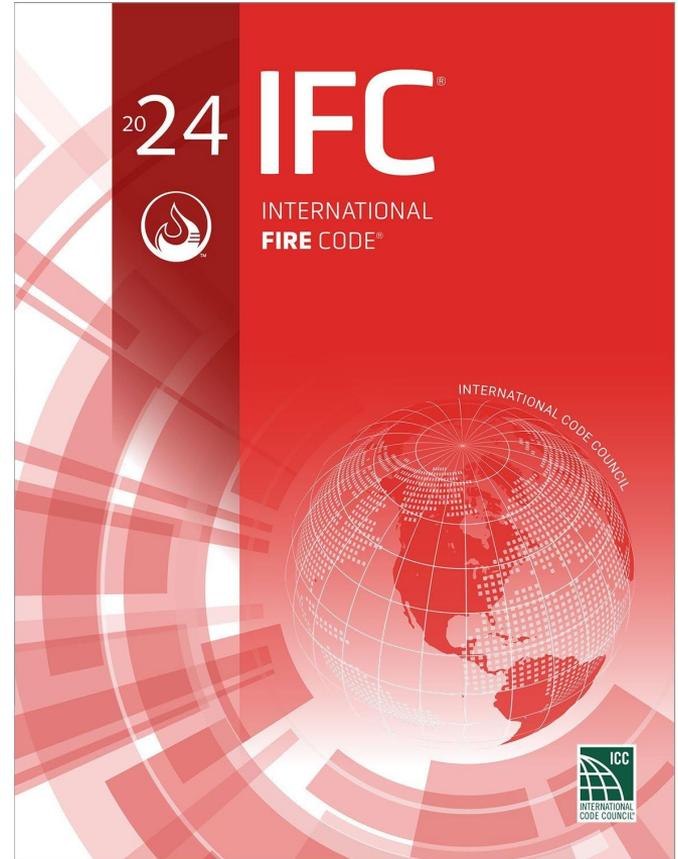


\*UL 9540A, Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems, Ed. 1

# Codes regulating ESS

## IFC 2024

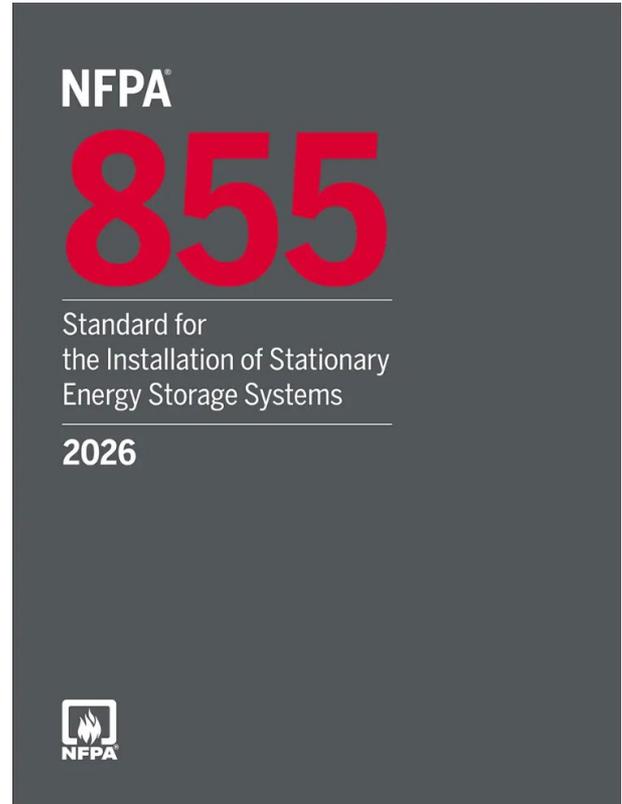
- **Chapter 1207.1.7**, Large-scale fire testing (LSFT) – Where required elsewhere in Section 1206, LSFT shall be conducted on a representative ESS in accordance with UL 9540A.
- **Chapter 1207.3.1**, ESS listings – ESS shall be listed in accordance with UL 9540.



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# Codes regulating ESS

- **9.2.1 Testing.** Where required, fire testing shall be conducted on a representative ESS in accordance with UL 9540A and **Large-scale fire testing** to collect data for gas production at a cell level, thermal runaway propagation potential at a module level **and thermal runaway propagation potential between ESSs.**
- Objective of LSFT – Demonstrate that a fire involving one ESS unit will not propagate to an adjacent unit.
- Additional guidance now provided in NFPA 855:2026, Annex G11



Reproduced from the National Fire Protection Association's (NFPA's) website, © NFPA (2025)

# ANSI/CAN/UL 9540A:2025

**UL 9540A:2025**, the Standard Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems

- Ed. 5, issue date March 12, 2025
- Binational Standard for Canada and the U.S.

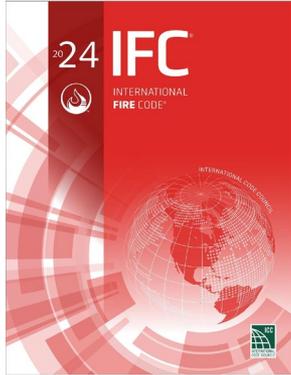
**Scope:** Determines the capability of a battery technology to undergo thermal runaway and then evaluates the fire and explosion hazard characteristics of those BESS

**Referenced in:** NFPA 855, International Code Council (ICC) IFC, ICC International Residential Code (IRC), UL 9540



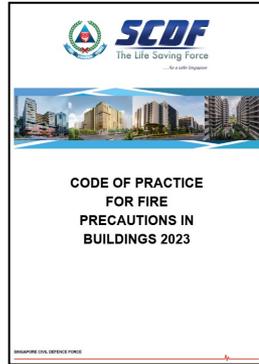
# Global recognition of UL 9540A

## U.S.



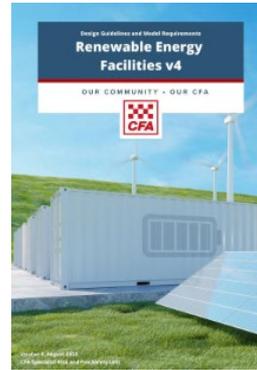
Referenced in IFC, which is the mandatory fire code for 41 states in the U.S.

## ASEAN\*



- Referenced in the fire code and guidelines in **Singapore and Malaysia**
- Approved for adoption as a national standard in **Singapore and the Philippines**

## Australia



Referenced in the State of Victoria Country Fire Authority guidelines for renewable energy facilities and BESS

## IEC\*\*



- Referenced in IEC standards for LSFT requirements
- E.g., IEC 62933-5-2 for safety requirements for grid-integrated, electrochemical-based EES systems

# IFC/NFPA 855: Large-scale fire test (LSFT)

The code authority can approve installations based on LSFT results for the following reasons:

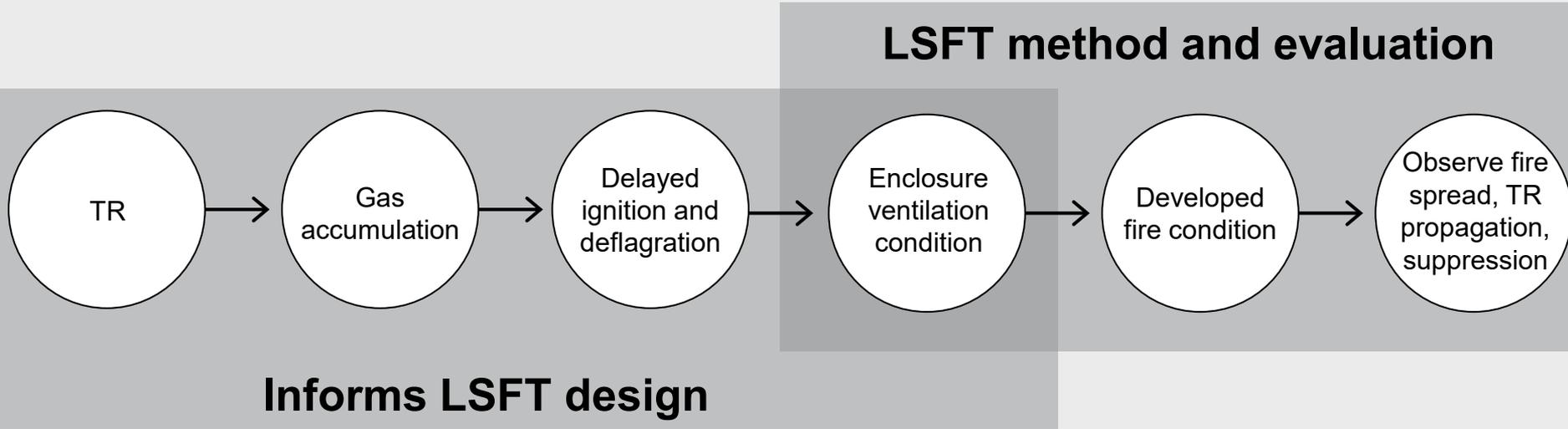
- **Increased BESS size**
- **Reduced spacing to adjacent BESS and/or walls**
- Increased maximum allowable quantity (MAQ) in a fire area
- Decreased separation to means of egress
- Decreased outdoor separation distances
- Justification of alternate sprinkler densities or fire suppression systems

# Objectives of LSFT

- Evaluate thermal exposure from a fire within one BESS to adjacent BESS for potential of fire spread to the batteries within the neighboring BESS
- Evaluate thermal exposure from a fire within one BESS to nearby structures
- Verify adequacy of manufacturer's proposed separation distances
- Determine whether a building's prescribed fire protection plan is adequate to control fire spread originating in batteries



# Revisions to UL 9540A Installation-level test solidify expectations for LSFT

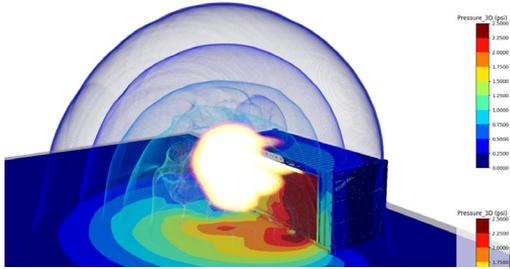


# Assumptions behind “developed fire condition”

- Conservative fire condition is not directly attributed to any one failure mode
- Cells undergo TR and flammable gas is ignited promptly.
- Thermal runaway propagation prevention (TRPP) systems are inoperable or overwhelmed by the failure mode.
- More ventilation in the enclosure will support fire growth.
- Post-deflagration fire scenario is the most challenging ventilation condition for an unattended BESS



# Enclosure ventilation condition



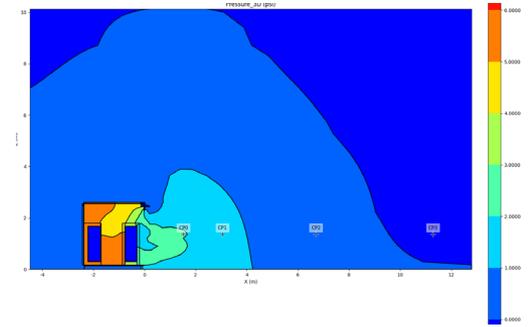
## Deflagration vents

- NFPA 68, Standard on Explosion Protection by Deflagration Venting, typically used for design in North America
- Includes prescriptive and performance-based approaches
- Determined by calculation, simulation or testing



## Alternative vent areas

- Testing used to determine post-deflagration ventilation condition
- Guidance in UL 9540A, Annex C (balloted)

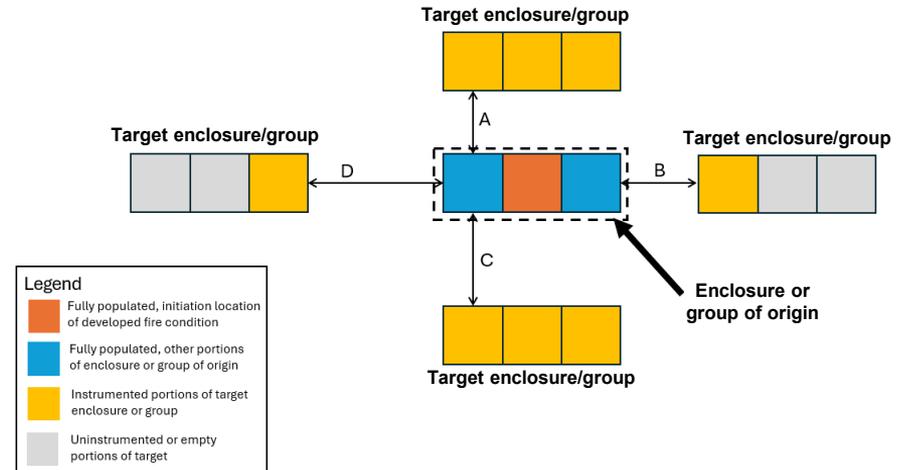


## Doors and vents

- Open both vents and door(s)
- Open doors often considered as upper bound on thermal exposure to BESS across aisle
- Includes commissioning and maintenance conditions

# What a test looks like: Outdoor enclosures

- Developed fire condition to consume at least one vertical group of modules, e.g., rack
- Separation distances
- Fire suppression systems allowed
- TRPP systems disabled in enclosure of origin
- Openings on enclosure of origin represent fire following deflagration
- Target instrumentation related to the completeness of the target enclosure



Source: UL Standards & Engagement (ULSE), UL 9540A ballot recirculation

# Measurements and data collection

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## Required for performance criteria

- Temperature in BESS of origin to monitor developed fire condition
- Temperature grid in target BESS – Criteria related to cell vent temperature
- Heat flux to structures, if nearby

## Optional

- Heat release rate
- Gas concentrations in the plume
- Battery management system outputs
- Survivability of communications or critical safety systems
- Additional heat flux or validation data for modeling

# UL 9540A LSFT Proposal

- Ballot introduced – June 27, 2025
- Consensus reached – Aug. 18, 2025
- **NFPA 855:2026 published – Sept. 9, 2025**
- Recirculation ballot opened – Nov. 7, 2025
- Recirculation ballot closed – Dec. 22, 2025 (consensus maintained)
- Second recirculation ballot opened – Feb. 7, 2026
- Second recirculation ballot closed – Feb. 23, 2026 (consensus maintained)
- Final publication – Q1 2026\*

\*Date is subject to change



Thank you

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## Q&A



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2:00 pm - 1:00 pm EDT, New York City

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NFPA 855 and large-  
scale fire validation of  
6.25 MWh BESS  
containers (Global  
focus)**

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