



**Pacific  
Northwest**  
NATIONAL LABORATORY

# Safety & Reliability Overview

OE Peer Review  
October 2023

**Matthew Paiss**  
Technical Advisor

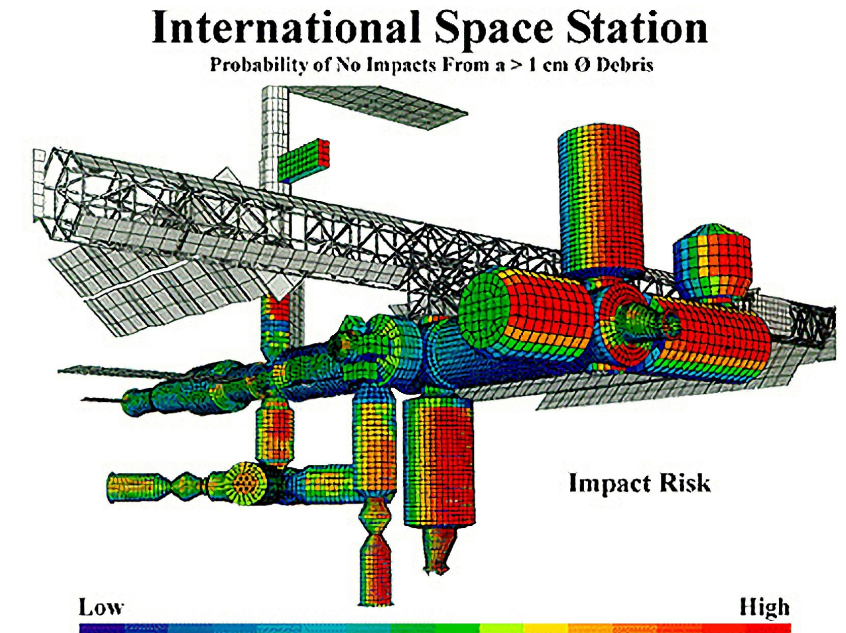
U.S. DEPARTMENT OF  
**ENERGY** **BATTELLE**

PNNL is operated by Battelle for the U.S. Department of Energy



## What comes first, Safety or Reliability?

- Reliability of sub-components has led to a number of failures.
- Safety standards may increase reliability concerns (deflagration prevention systems relying on sensors, motors, etc.)
- Grid controls, interoperability, and BMS/ESMS will play a key role in reliability





# Battery Safety is a Systems Approach

- Chemistry
- Cell QC
- Integration
- BMS
- Communications
- HVAC
- Fire Protection
- Explosion Control
- Workmanship

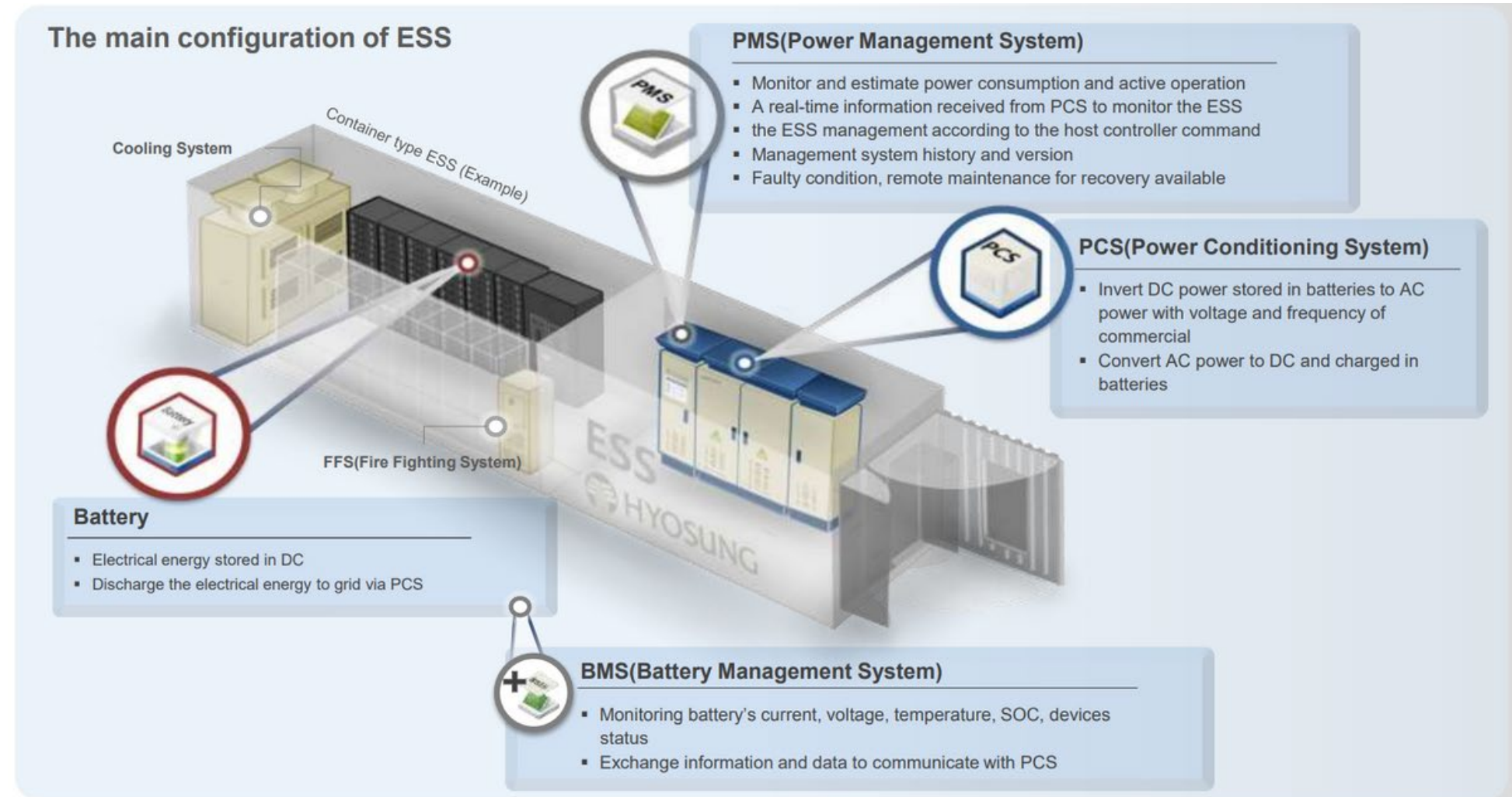
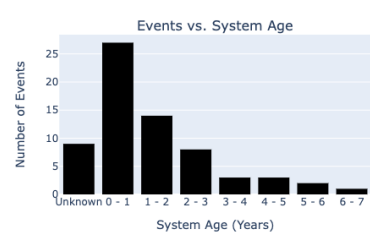
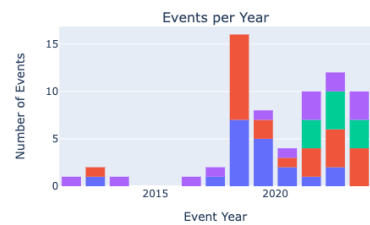
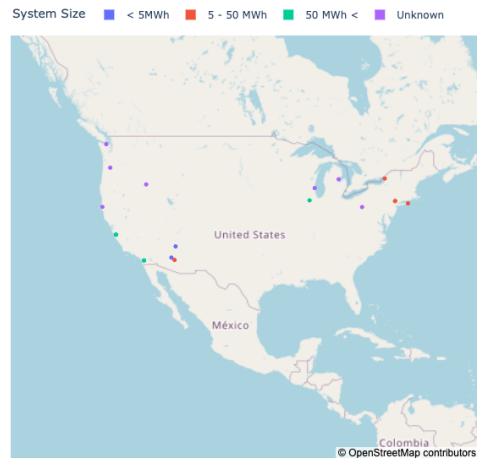


Image source: Hyosung Heavy Industries

# EPRI Failure Database

Site back online 48 hrs after event



- 10 BESS fires in 2023
- Failures due to liquid leaks & water ingress
- Failures during commissioning
- Residential ESS remains area of high risk due to price/quality demands.

Location	Energy (MWh)	Power (MW)	Module Type	Application	Installation	Event Date	System Age (yr)	State During Accident	Source
USA, ID, Melba	320	80	Powin Energy - Centipede		Substation	2 October 2023	0	Pre-operational	<a href="#">KTVB7</a>
Australia, Queensland, Bouldercombe	100	50	Tesla		Substation	26 September 2023	0.1	Operational	<a href="#">ABC News</a>
US, CA, Valley Center	560	140	LG Energy Solution		Rural	18 September 2023	1.6	Operational	<a href="#">Valley Road Runner</a>
France, Saucats, Barban	98	105			Rural	22 August 2023	0	Pre-commissioning	<a href="#">dayFREuro</a>
US, NY, Chaumont	15	5		Solar Integration	Rural	27 July 2023	0.4	Operational	<a href="#">7 News WWNYTV</a>
Taiwan, Taichung City, Longjing District			LFP			4 July 2023			<a href="#">United Daily News</a>
US, NY, Warwick	17.9	4	Powin Energy	Energy Shifting, Backup	Substation	27 June 2023	0.1	Operational	<a href="#">Convergent Energy and Power</a>
US, NY, Warwick	36	8	Powin Energy	Energy Shifting, Backup	Substation	26 June 2023	0.1	Operational	<a href="#">Convergent Energy and Power</a>
US, NY, East Hampton	40	5		Resiliency, Utility Peak Reduction	Substation	31 May 2023	4.8	Operational	<a href="#">East Hampton Star</a>
US, PA, Millvale			SimpliPhi Power (LFP)	Solar Integration	Urban	30 January 2023		Operational	<a href="#">WTAE</a>

Showing 1 to 10 of 67 entries

Previous 1 2 3 4 5 6 7 Next



# Safety Efforts

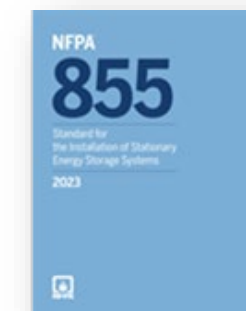
- International Fire service support
  - Australian SARET
  - EU ESS Safety Conferences
- Energy Storage Safety & Reliability Forum
- Educational Outreach
- Code & Standards Development



Washington State  
Department of  
**Commerce**

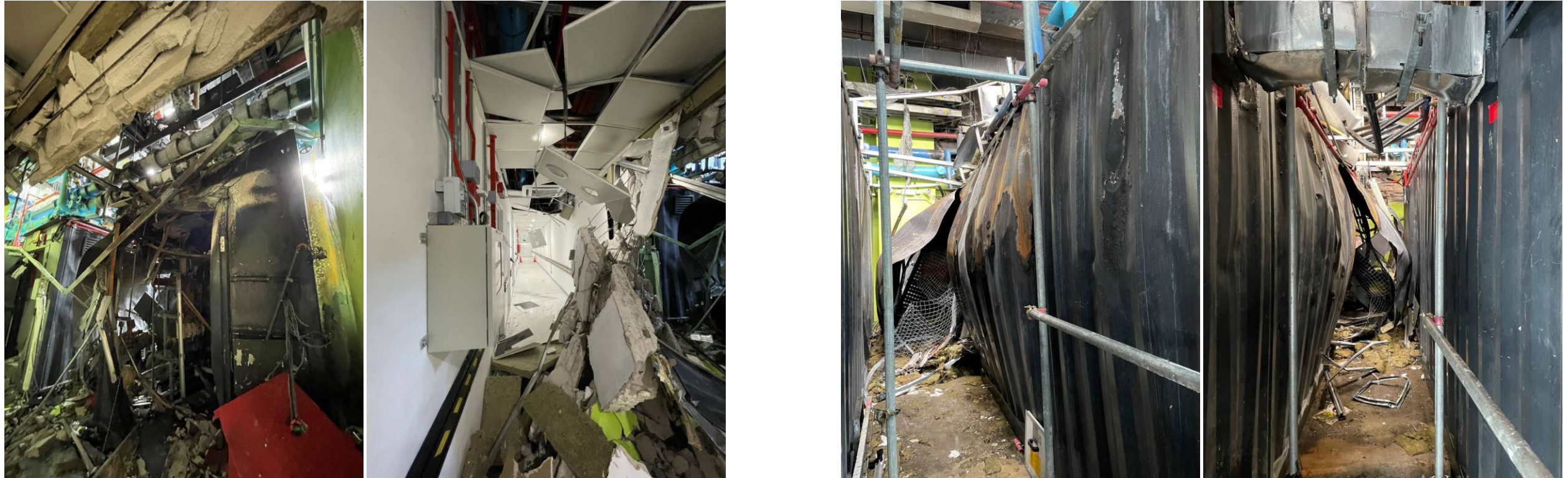


**NYSERDA**





# Reducing Explosion Risks is Key Gap



Deflagration in ISO enclosure installed indoors. Evidence of significant overpressure event in indoor installation in data center.

Deflagrations have resulted in 3 fatalities in China incident.



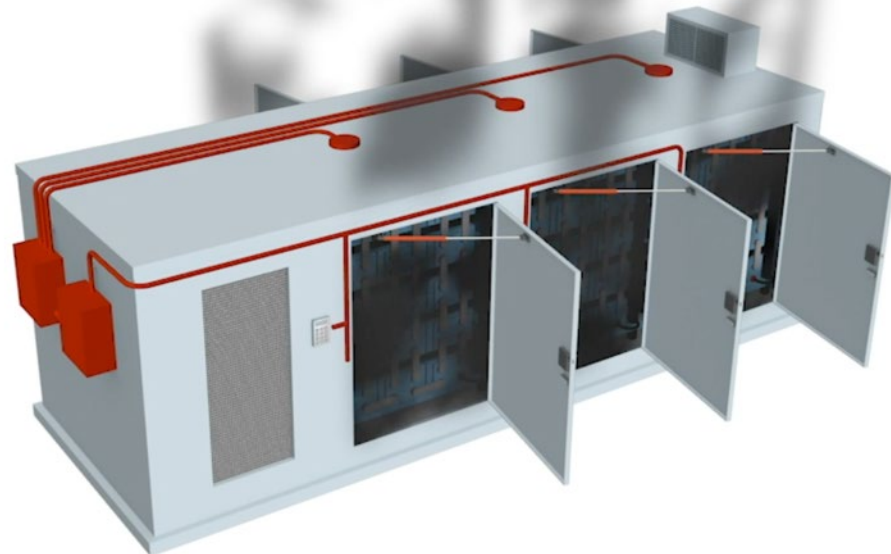
# Explosion Control Options

## Options for meeting requirement:

1. NFPA 68 – Deflagration Venting.
  - Blow-out panels to protect structure from explosion based on max gas production in module tests. **Possible deletion in 2026**
2. NFPA 69 – Deflagration Prevention.
  - Exhaust system designed to keep below 25% of LEL in area.
3. Engineered Cabinet – Based on Large Scale Fire Test has shown that no pressure waves will occur, and no projectiles can be ejected.



Courtesy: Fike Corp.



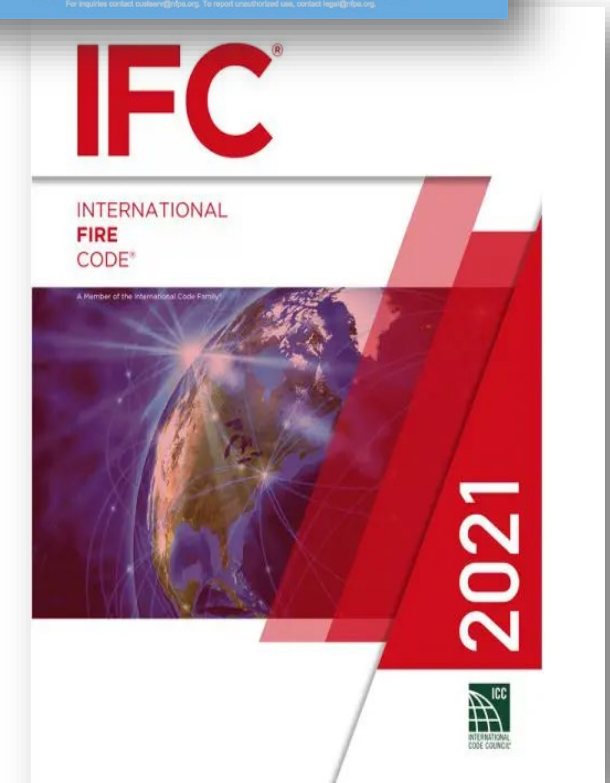
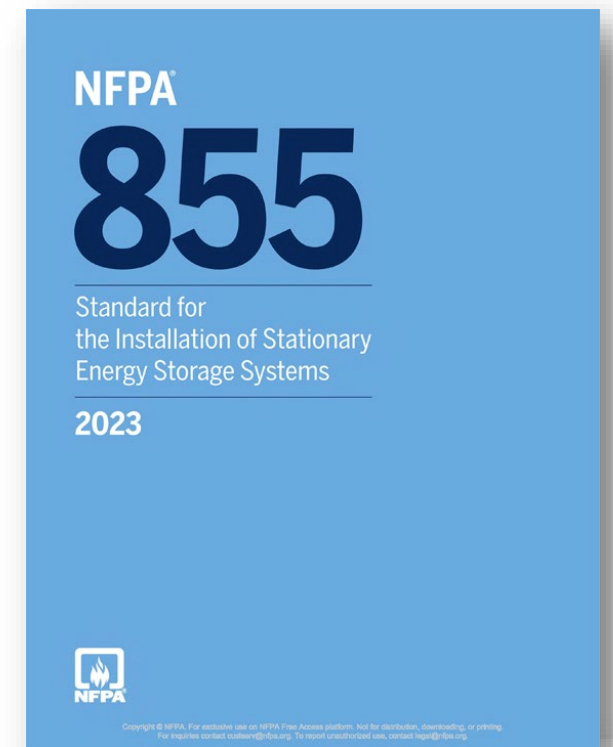
PNNL-SA-191544



Courtesy: LS-ES

# Codes & Standards Update

- NFPA 855-2026 is at 1<sup>st</sup> draft stage with over 300 proposals. Edition will be published in fall of 2025.
  - IFC 2024 will be published imminently. Work on 2027 edition may point to NFPA 855.
- Significant changes to include:
    - ✓ Deflagration prevention requirement (no passive venting).
    - ✓ More clarity around Hazard Mitigation Analysis (HMA).
    - ✓ Allowance of Pb-acid/NiCd to be listed to UL1973
    - ✓ Addition of remanufactured battery guidance
    - ✓ New chapter for Flow Batteries & ESS on barges.





# Acknowledgement

We acknowledge the support of Dr. Imre Gyuk and the OE Energy Storage Program for this work



U.S. DEPARTMENT OF  
**ENERGY**