Energy Storage Safety Codes, Standards, & Regulations (CSRs)

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Presented to the California Energy Commission – Webinar Series

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Sandia Energy Storage Program

Cyber Security

Enabling secure ES deployment/grid

ES demonstration project data collection & system analysis sofware (QuESt)

Analytics

Dedicated labs for development of future, lower cost, better performing ES electonics

Power Electronics

Sandia demonstrations are a key part in advancing DOE's mission of an equitable, carbon-free, and secure grid of the future

Demonstration Projects

Expansion of SNL's existing battery expertise to new and novel materials

Materials Research

Safety & Reliability

Safety research on batteries
Fire safety for fielded systems

Education of PRC's and other State/Federal Entities

Policy & Outreach

Sandia Energy Storage Program Thrust Area

SNL ES4SE Deployment Project: Albuquerque Publics Schools Atrisco HS BESS + solar

DEMONSTRATION TEAM

Sandia's Demonstration Projects

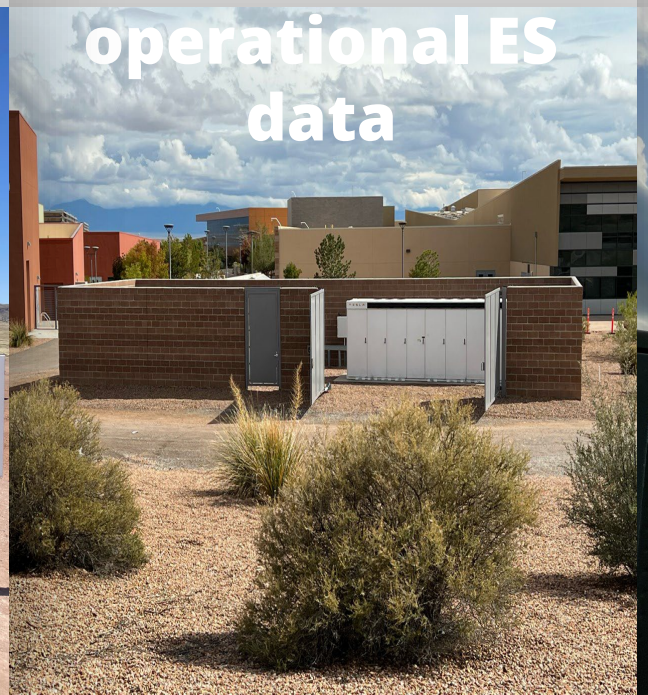
We facilitate the early adoption of energy storage technologies in support of the U.S. Department of Energy's (DOE) goals of an equitable, clean, resilient, and secure grid of the future

1

Act as a bridge between R&D and commercialization

2

Validate technical models through collection of operational ES data



3

Inform Codes, Standards, & Regulations (CSRs) development and installation best practices

4

Increase public confidence by demonstrating ES and showcasing its range of benefits

Demonstration Projects Are a Foundational Element of the DOE/SNL Energy Storage Program

1985 - Exxon Research & Engineering Co. Zn/Br flow battery (Z30-A) successfully powered an experimental EV at Ford Motor Company

1986 - GNB sealed lead acid battery system test interfaced with wind turbines, Solar Energy Research Institute (SERI), Rocky Flats, CO

2005 - AEP/SNL cost-shared deployment of the first 'DESS'

2000's – SNL performs characterization/life-cycle studies on Li-ion

2009 - SNL/CEC PIER program flywheel ES demonstration project for 'rapid response' frequency regulation

Long Duration Energy Storage

Community based projects

Equity In Energy

ES cybersecurity

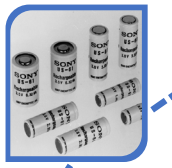
ES data & analytics

Mid-1970's – 1980's

Energy Storage Program early years, first use of cost-share demonstration projects to advance technologies

1990's

Major ES developments occur through SNL's cost-share deployment projects program



1992 - Cooperative Agreement placed by DOE/SNL to support the design, fabrication, and testing of the first modular "AC Battery" - PQ2000
R&D 100 Award in 1997

1994 - 4-yr, $2.8M, cost-share deployment program for VRLA battery improvement with GNB

1992 - SNL performs specialized evaluation of flooded lead acid batteries (C&D Charter Power Systems) in a 20MW BESS used for frequency regulation and spinning reserve in PR (PREPA).

2000 - 2010

Growth period for ES on utility systems with new technologies being piloted

2010 - 2020

Major growth in the deployment of both FTM and BTM ES

Microgrid projects grow in scale and scope with several deployments in rural and remote communities including Alaska and Hawaii

2013 – SNL in partnership with Base Camp Integration Lab (BCIL-US Army) preforms functional testing on multiple ESS being evaluated for use in military FOB's

2017 - Sterling Municipal Light Dept. installs first utility scale ESS and largest system in New England.
-2017 Grid Edge Award winner by Greentech Media
-Finalist for the 5th Annual Energy Storage North America (ESNA) Innovation Awards

2020 - Future

Demonstrate and validate the equitable use of resilient, and secure energy storage systems on and off the grid through deployment projects

Current Sandia ES Demonstration Projects

U.S. Energy Storage Installation Codes, Standards, & Regulations (CSRs)

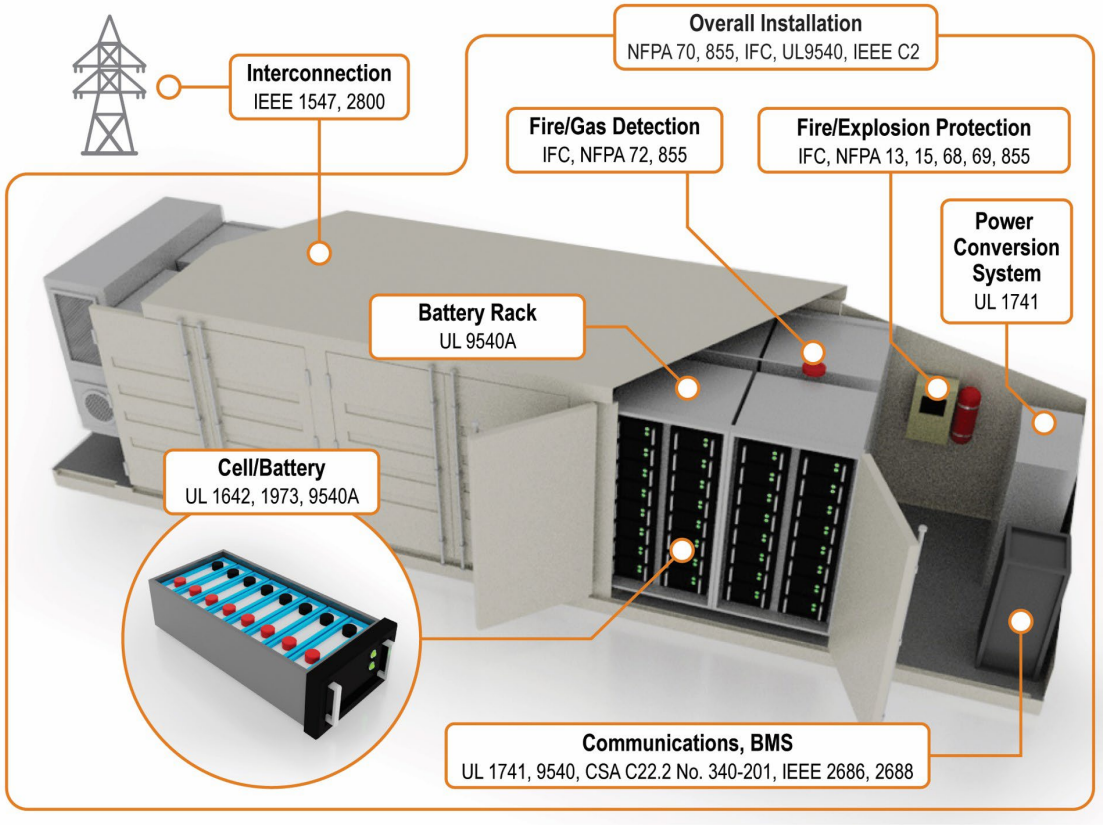
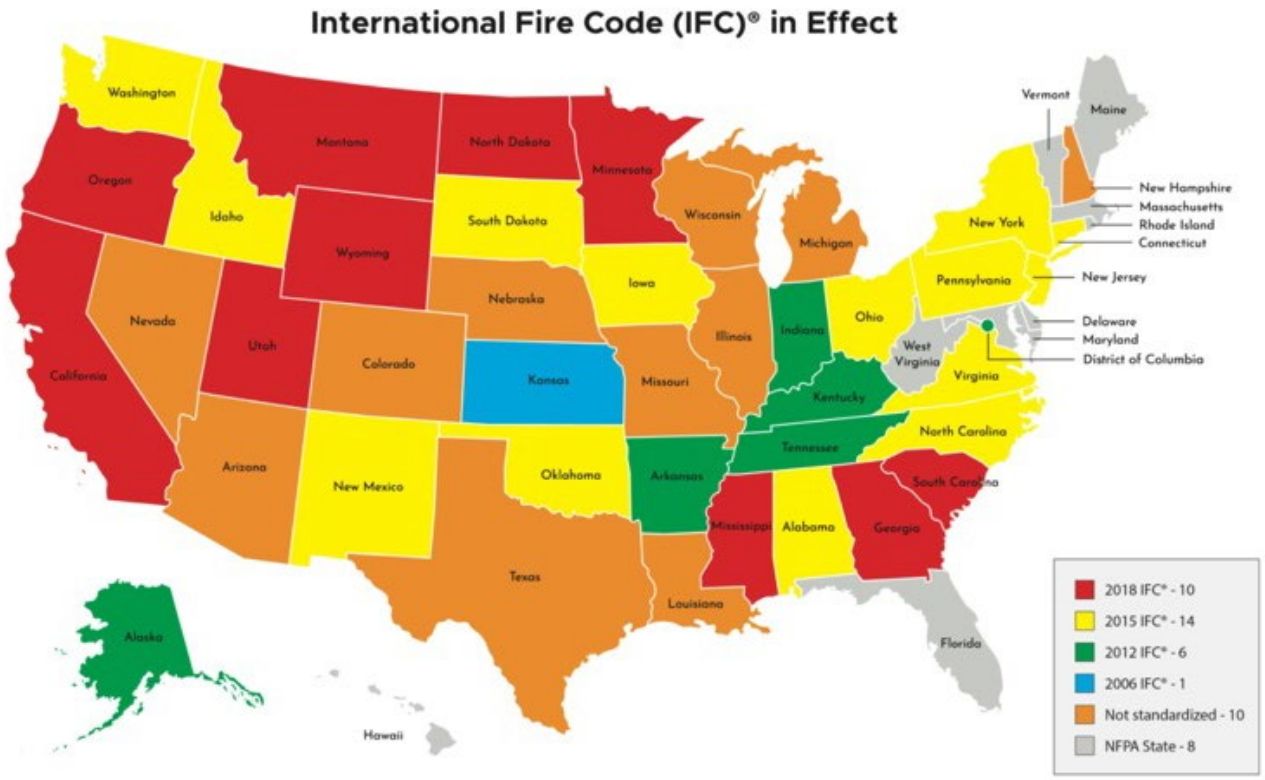
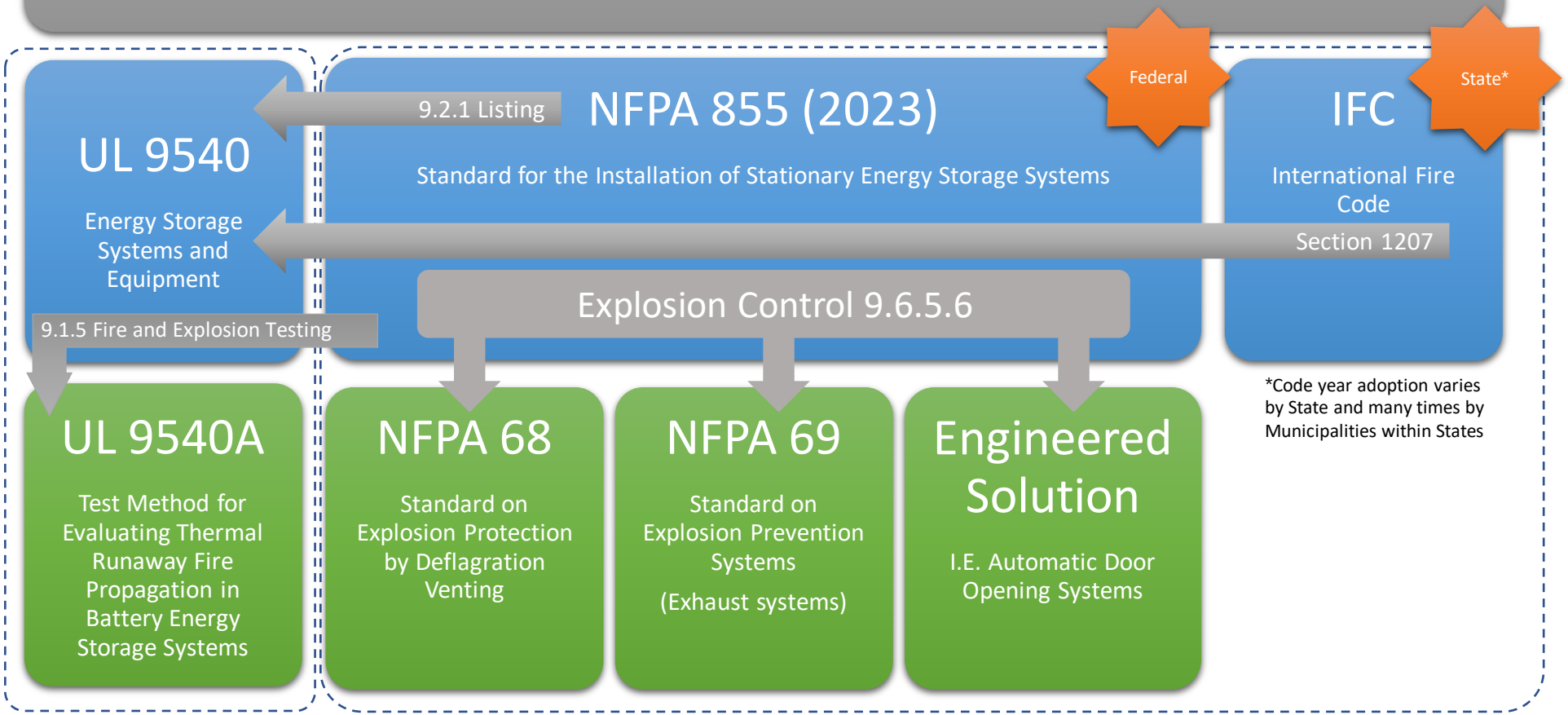


Image courtesy of PNNL



Product Listing - Safety Standard/Code Relationship

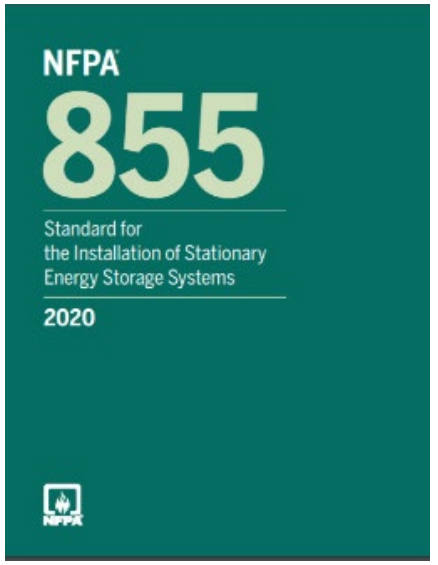


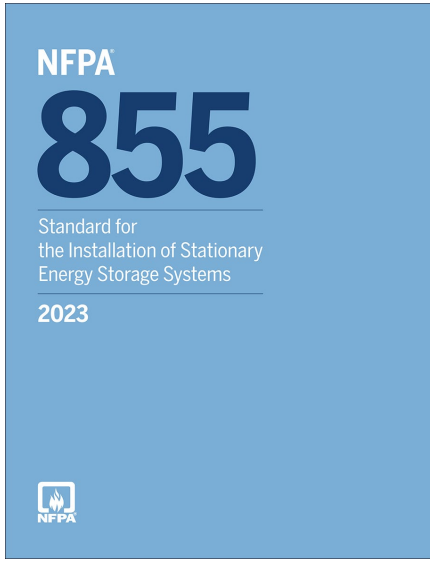
National Fire Protection Association (NFPA) 855

2020 NFPA 855 Standard for the Installation of Stationary ESS

- 1st Edition published (8/25/19)
- Scope reserved for next cycle based on appeal by utilities for exemptions
- Covers
  - Installation
  - Explosion Control
  - Commissioning
  - O&M
  - Emergency Response
  - Decommissioning

2023 NFPA 855 was approved as of 9/1/2022





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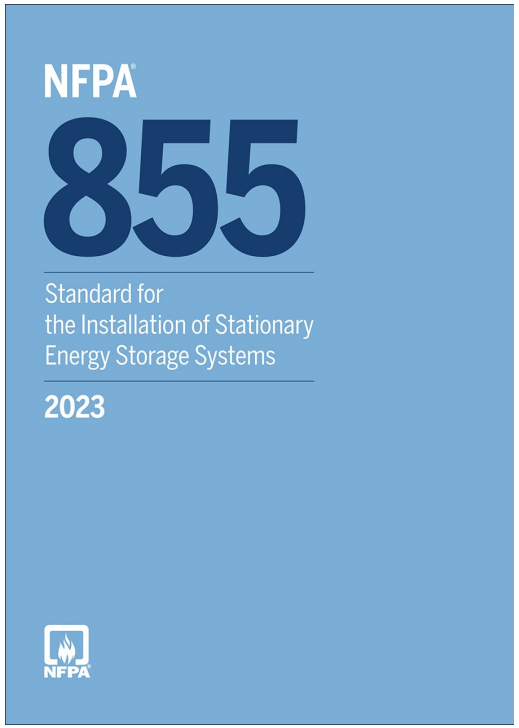
National Fire Protection Association (NFPA) 855

2023 NFPA 855 Standard for the Installation of Stationary ESS – *Significant Changes*

- Utilities are not exempt from this standard – although there are carve outs (exemptions) within certain sections
- Updated requirements for storage of Lithium Metal or Lithium-ion batteries
- System augmentation



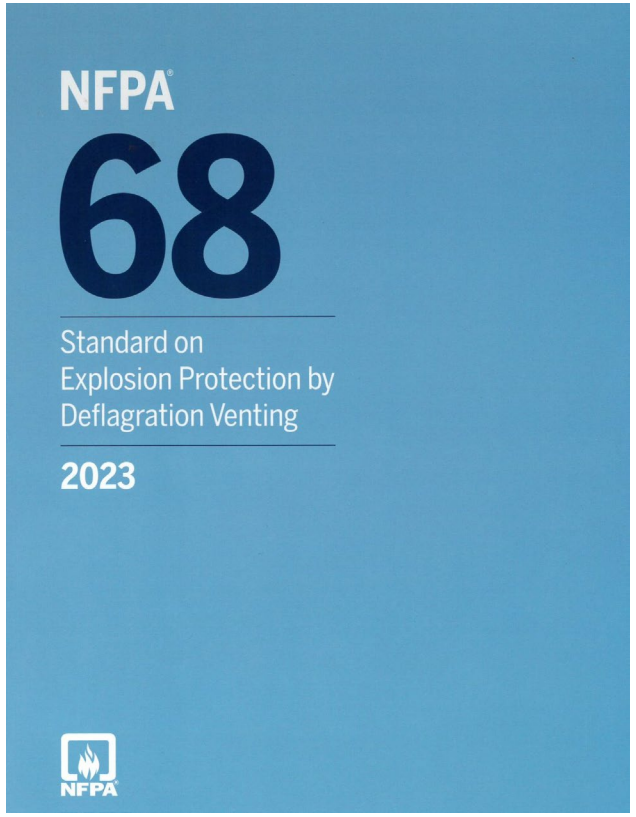
2026 NFPA 855 Standard for the Installation of Stationary ESS – *In Second Draft Stage*

- *Example of some of the Task Groups and content are:*
  - *Roof top PV and ESS, Charging Stations, ESS on Barges, 2nd Life Use, …*

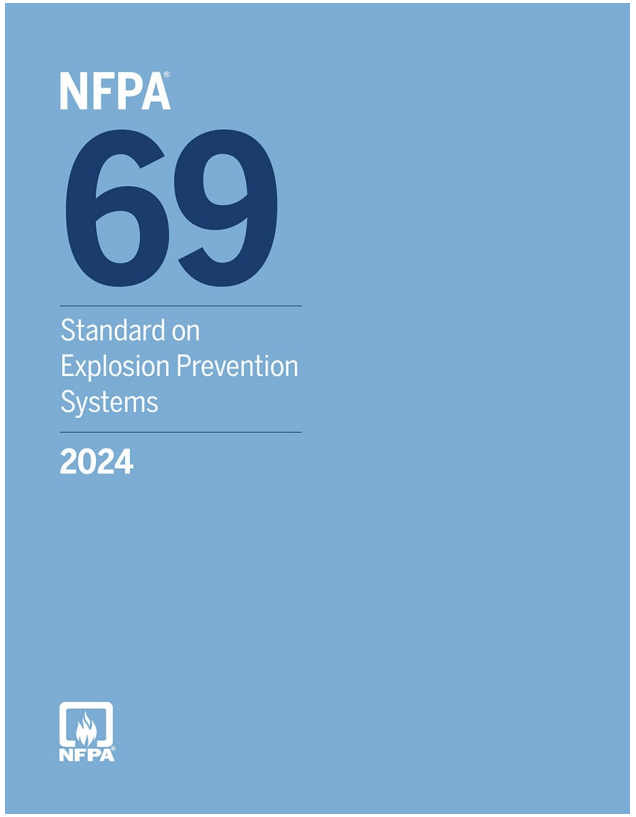
Lessons Learned & Examples

Many Manufacturers & Integrators don't understand NFPA 855 Requirements

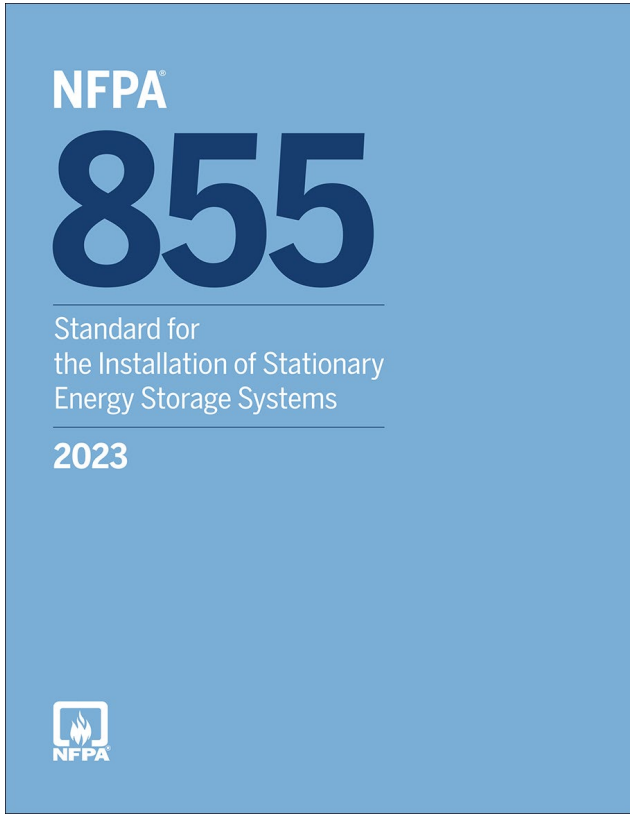
- Especially true as related to explosion mitigation



Option: Deflagration Venting (Blow out panels)



Option: Venting Solutions



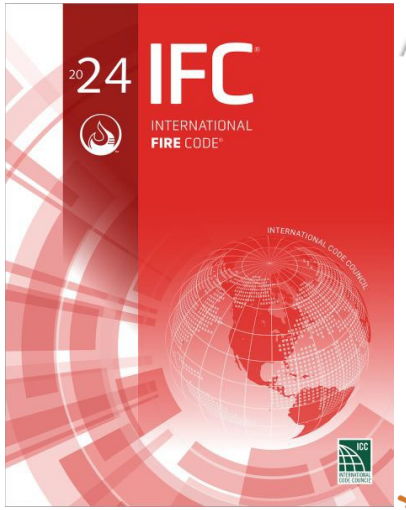
Option: "Engineered Solutions"

International Fire Code

2021 International Fire Code

- Section 1206
- Changes from 2018
  - Scope ads O&M, retrofit, commissioning, decommissioning
  - Exemption for telecom using Pb & NiCd @< 60 VDC
  - Suppression system based on 9540a
  - Dedicated/ Non-dedicated use buildings
  - Explosion control: NFPA 68 or 69

2024 International Fire Code

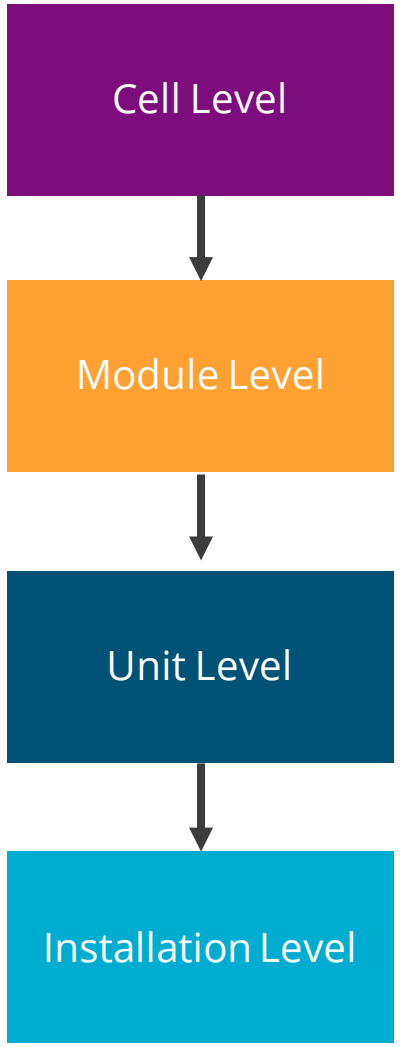


- Section 1207 – Electrical Energy Storage Systems (ESS)
  - Continued language alignment with NFPA 855 – Scope section of 1207 reads, "Material based on NFPA 855 2023 Ed."
- Future editions are expected to simply point to NFPA 855 as the default standard for installation of energy storage systems

UL 9540A Test Methodology

Evaluating/interpreting test results can be challenging

Credit: FM Global



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UL 9540A Cell Level Testing

Purpose:

Determine if thermal runaway can be induced,

If so, document thermal runaway methodology, instrumentation,

Determine cell surface temp at venting and thermal runaway,

Measure gas generation and composition.

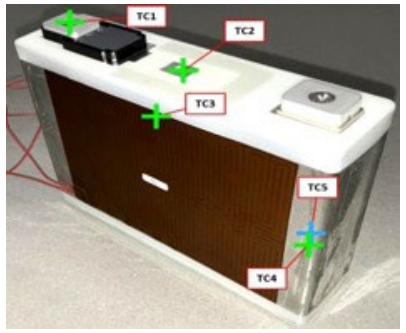
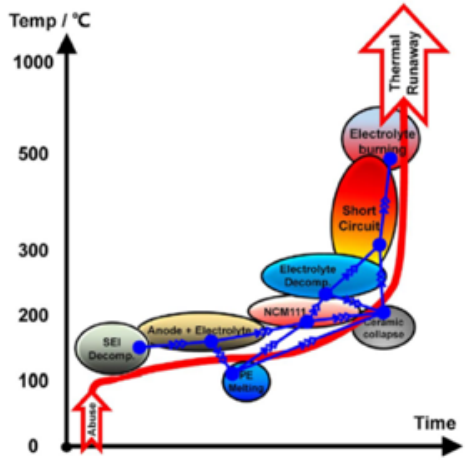


Image Credit: UL



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UL 9540A Module Level Testing

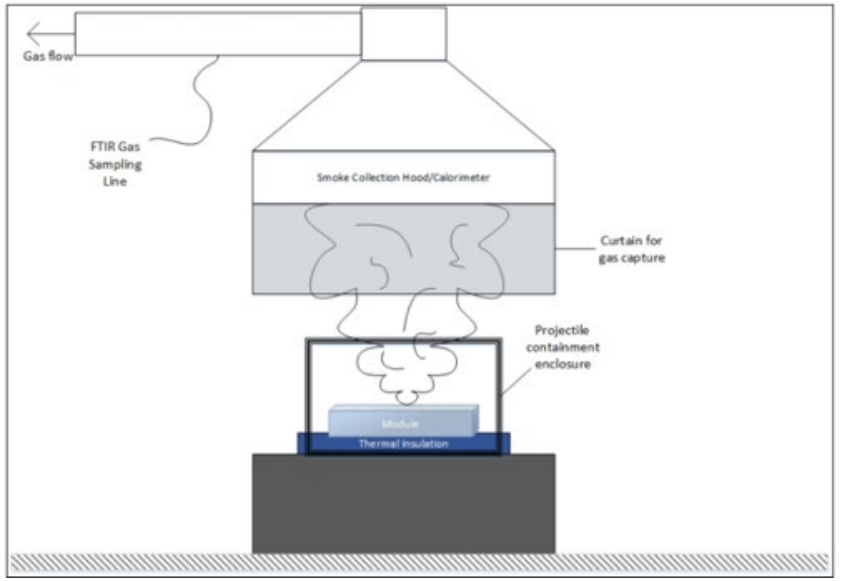
Purpose:

Evaluate thermal runaway propagation within a module,

Develop data on heat release rate and vent gas generation rate and composition,

Document fire and deflagration hazards.

Image Credit: UL



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UL 9540A Unit Level Testing

Document thermal runaway progression within the unit,

Document if flaming occurs outside the unit,

Measure heat and gas generation rates,

Measure surface temperatures and heat fluxes in target units,

Measure surface temperatures and heat fluxes on walls.

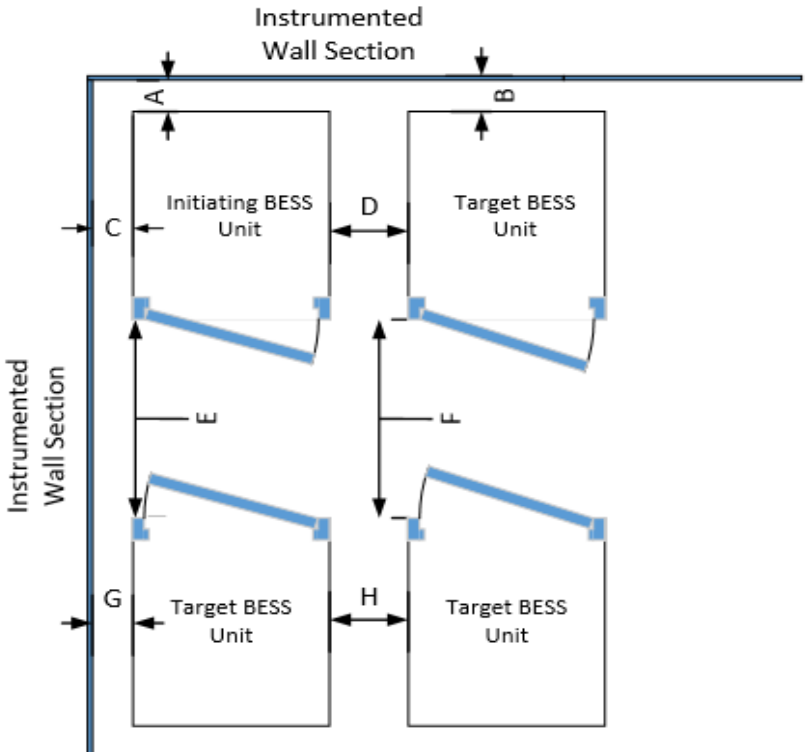


Image Credit: UL

UL 9540A Unit Level Performance

Acceptable results:

No flaming outside the unit under test *

No explosion hazard observed (incl gases <25% LEL)

Maximum temperatures on target units ≤ the vent temperature in the cell level test, and maximum surface wall temperature rise ≤ 97 °C (175 °F) above ambient.

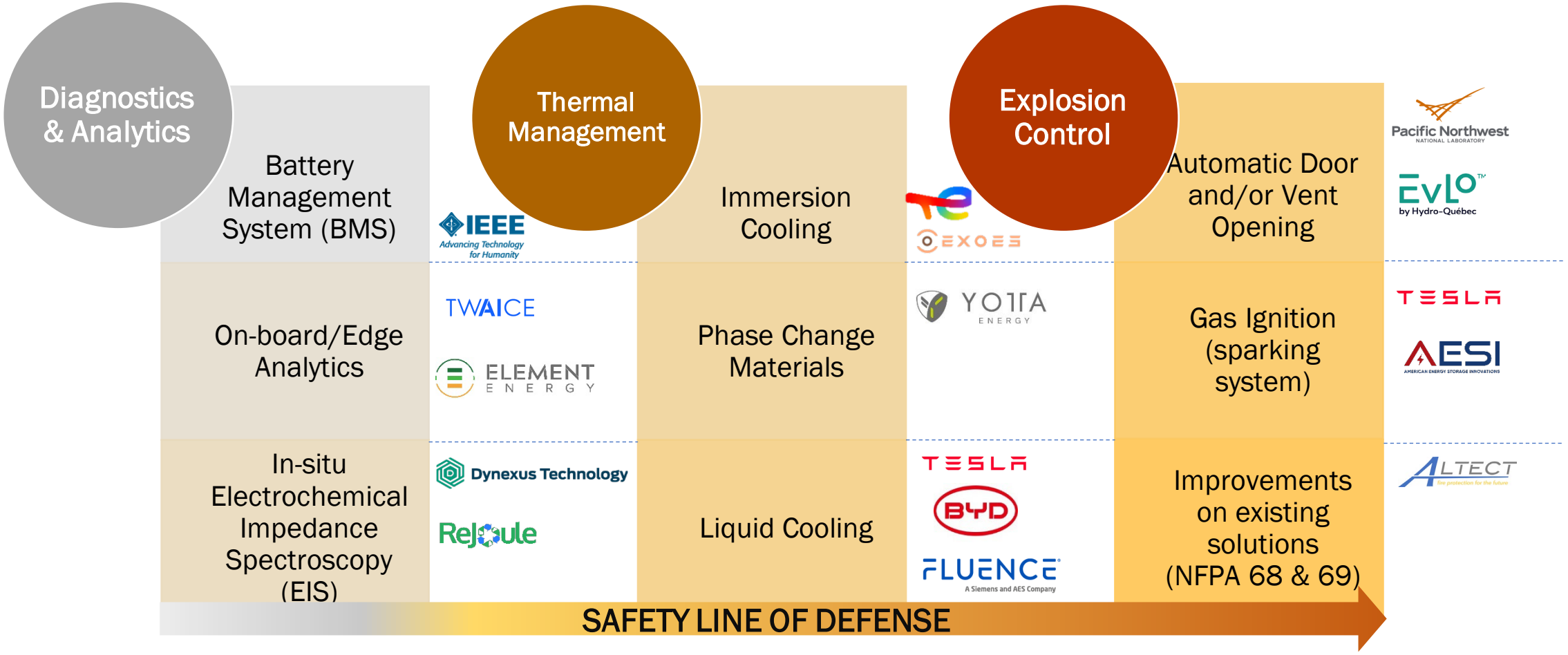
* If flaming is observed, the test will be conducted with a manufacturer recommended automatic sprinkler system or other fire protection system present.

Credit: UL

Three Primary ES Safety Focus Areas Identified

This is from a multi-lab proposal Sandia made to the DOE called, *"Multi-technology Energy Storage Safety (MTESS) At The System Level".*

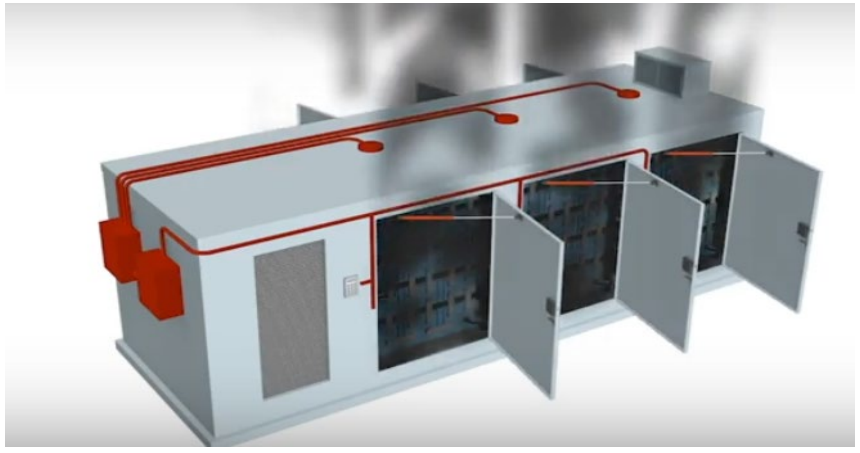
These safety solutions would predominately fall under the "Engineered Solutions" option within NFPA 855



Application of an "Engineered Solution"

PNNL Intellivent – Automatic Door Opening System

- Doors open in response to a signal from one or a combination of gas detection, smoke/heat detectors
- Deployed at PNNL Lab Site
- Field deployed on a joint Sandia/PNNL project
- Requires a UL9540A installation level test to become an accepted 'engineered solution'



Field Demonstration Project Site
Intellivent Installation

Considerations For CSR Compliant Energy Storage Systems

ESS deployments funded by CEC programs (either wholly or partially) should be required to comply with the most current Fire and Safety Codes/Standards* **(specifically NFPA 855)

Request for Proposals (RFP's) should include language specifying adherence to the most current Fire and Safety Codes/Standards regardless of the Code of Record at the deployment location*

Evaluate bid proposals and vendors closely to ensure they understand what is required and their proposed system design reflects the requirements and meets the intent of specified CSRs

*Exceptions should be made for first-gen or pilot projects where it is understood and known that the system may fail (within reason)

**My personal opinion

Thank You For Your Attention

Questions?

Additional questions/comments, contact: wtclark@sandia.gov

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