

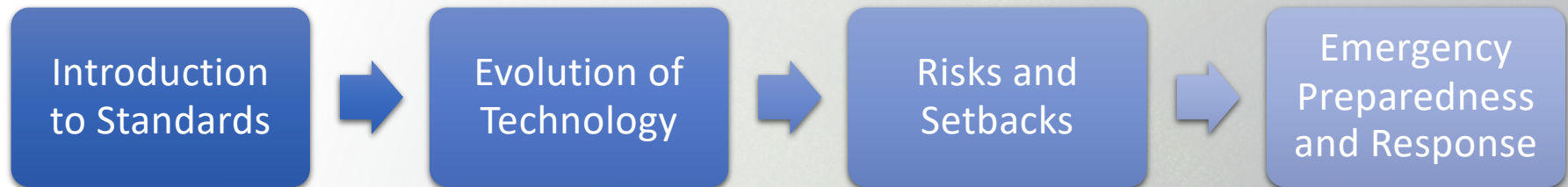


# Safety Standards for BESS Interconnection

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Presented by  
*Hydro One & Fire & Risk Alliance*

# Agenda



Robert Reinmuller

Quyen Diep

Ajay Garg

Farooq Qureshy

Hemant Barot



Team

## Team

Anthony  
Natale

Derek Post

Noah Ryder

Jeffrey Reetz



**FIRE & RISK**  
★ ★ ALLIANCE ★ ★





# Anthony Natale

- **CERTIFICATIONS:**

- Fire Instructor I, II - ProBoard Certified New York State
- Incident Command System Instructor FEMA Cert E-449
- Incident Command System 100, 200, 300, 400, 700 & 800a
- All Hazards Liaison Officer – FEMA Certification
- Incident Management Level 3 New Jersey DFS
- HazMat On-Scene Incident Commander New Jersey DFS
- Hazardous Material Technician II (120 hr.) FDNY
- Firefighter 1 New Jersey DFS
- Advanced Exterior Industrial Brigade - NFPA 1081 Texas A&M
- Interior Structural Industrial Brigade NFPA - 1081 Texas A&M
- Refrigeration Operating Engineer FDNY
- Underground Storage Tank System Operator NYS DEC
- NFPA 18 Technical Committee
- NFPA 855 Technical Committee



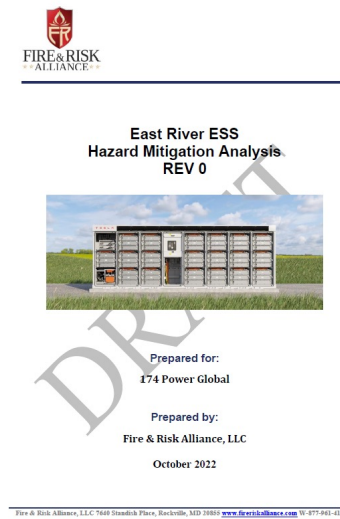
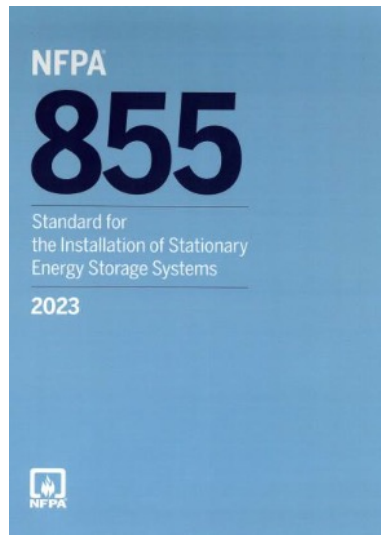
A 3D perspective rendering of a server rack system housed within a white container. The rack is filled with various server units, including control panels and storage bays. A blue wireframe outline traces the top and side edges of the rack structure. A small red dot is positioned on the top surface of one of the server units. The container has the word 'well' printed in red on its side. The background is solid black.

# Overview

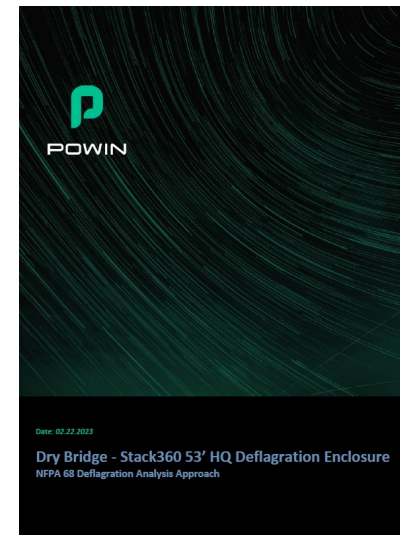
Section 1

# Introduction

## *Develop Fire Protection & Risk Assessment Standard*



|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|
| UL 9540A Report<br>Cell Report                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Ed.<br>2019-12-2                                                                                           |
| UL 9540A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                            |
| CELL TEST REPORT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                            |
| Test Method for Evaluating Thermal Runaway Fire Propagation<br>in Battery Energy Storage Systems (AACD)                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                            |
| Project Number.....                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 4789764715                                                                                                 |
| Date of issue .....                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 2021.04.27                                                                                                 |
| Total number of pages .....                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 39                                                                                                         |
| UL Report Office .....                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | UL-CCIC Company Limited Guangzhou Branch                                                                   |
| Applicant's name .....                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Contemporary Ampere Technology Co., Limited                                                                |
| Address .....                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | No.2 Xiangqiang Road, Zhangwan Town, Jiaocheng District<br>Ningde, Fujian, 352100 CN                       |
| Test specification:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 4th Edition, Section 7, November 12, 2019                                                                  |
| Standard.....                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | UL 9540A, Test Method for Evaluating Thermal Runaway Fire<br>Propagation in Battery Energy Storage Systems |
| Test procedure.....                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 7.1 – 7.8                                                                                                  |
| Non-standard test method .....                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | N/A                                                                                                        |
| Copyright © 2021 UL LLC All Rights Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                            |
| General disclaimer:<br>The test results presented in this report relate only to the sample tested in the test configuration noted or<br>list of the attachments.                                                                                                                                                                                                                                                                                                                                                               |                                                                                                            |
| UL LLC did not select the sample(s), determine whether the sample(s) was representative of production<br>samples, witness the production of the test sample(s), nor were we provided with information relative to<br>formulation or identification of component materials used in the test sample(s).                                                                                                                                                                                                                          |                                                                                                            |
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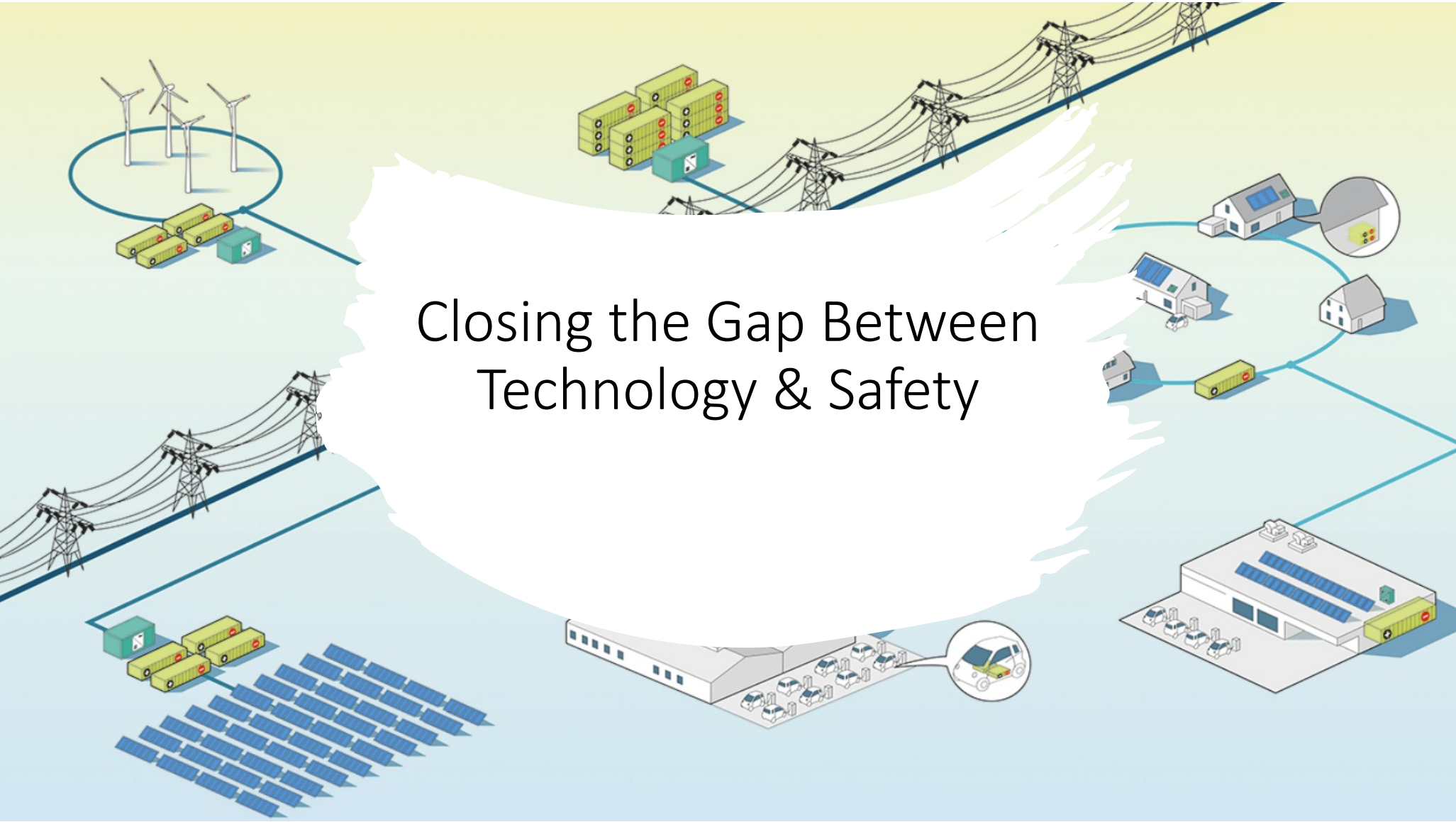






# Interconnection Safety Standard





# Closing the Gap Between Technology & Safety



# No Risk to Transmission Assets from BESS Failure

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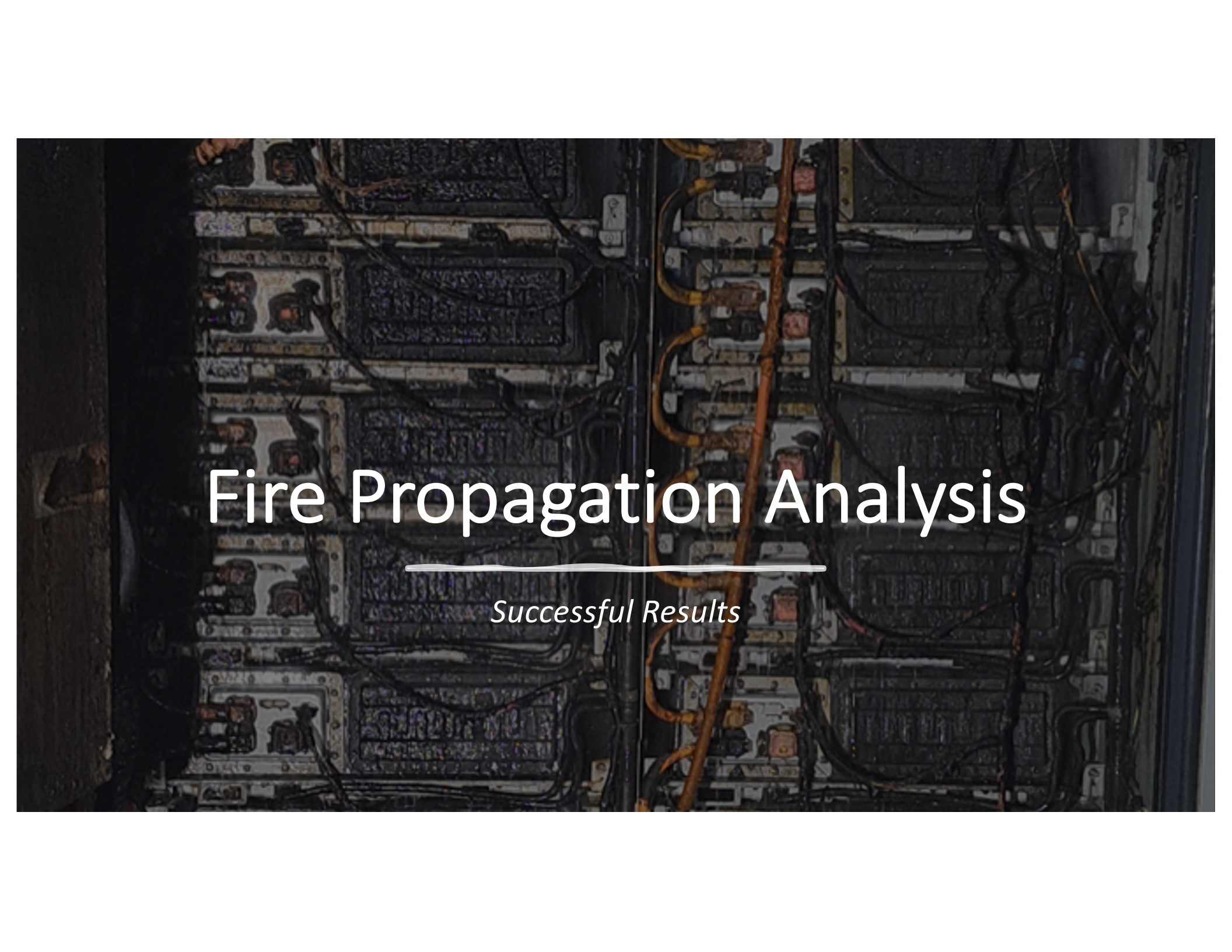




# Requirements

## Section 2





# Fire Propagation Analysis

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*Successful Results*



# NMC VS LFP

## LI-ION TECHNOLOGY

# Battery Chemistry

---

*Nickel Manganese Cobalt*

*Vs*

*Lithium-Iron Phosphate*

# Manageable Hazards

NMHC

LFP



# Nickel Manganese Cobalt (NMC)



**NMC vs LFP**

**Nail Penetration Test**

**wattsonic**  
Life's Innovation



# Nickel Manganese Cobalt (NMC)



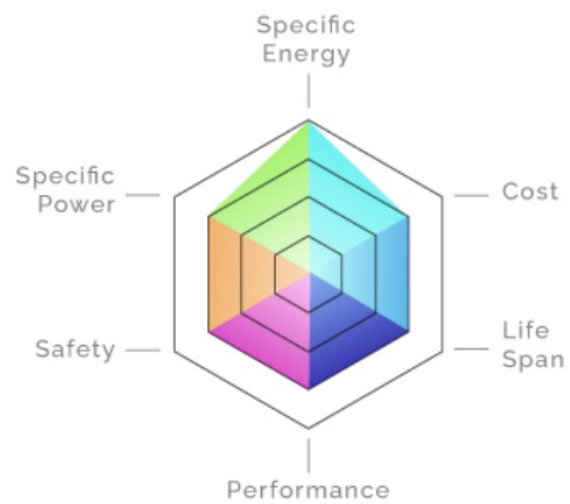
**NMC vs LFP**

**Nail Penetration Test**

**wattsonic**  
Life's Innovation

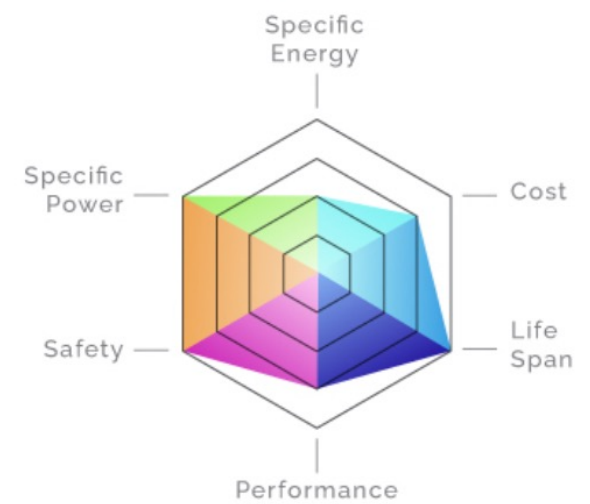
## LITHIUM NICKEL MANGANESE COBALT OXIDE

NMC



## LITHIUM IRON PHOSPHATE

LFP



# UL 9540A Test Hierarchy



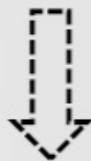
Cell Level Test



Module Level Test



Unit Level Test



Installation Level Test

- Whether cell can exhibit thermal runaway
- Thermal runaway characteristics
- Gas composition (flammability)
- Propensity for propagation of thermal runaway
- Heat and gas release rates (severity/duration)
- Flaming/deflagration hazards
- Evaluation of fire spread
- Heat and gas release rates (severity/duration)
- Deflagration hazards
- Re-ignition hazards
- Effectiveness of fire protection system(s)
- Heat and gas release rates (severity/duration)
- Deflagration hazards
- Re-ignition hazards



# Module Test

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No Fire  
Propagation  
Beyond the  
Module



# Hazard Mitigation Analysis (HMA)



## **Hazard Mitigation Analysis for Outside Ground Mounted Battery Energy Storage Systems: Dry Bridge BESS Facility, Chesterfield County, Virginia**

*DRAFT REPORT | REV0 | June 8, 2023*





The background image shows a long, low-profile industrial building with a white and grey facade. The building features a series of large, dark, rectangular panels, likely for explosion mitigation. A prominent green door is visible on the right side. The APS logo is mounted on the upper part of the building. In the foreground, there are several large, tan-colored storage containers or boxes. The ground is covered in gravel, and the sky is clear and blue.

# Explosion Mitigation

*APS, Surprise AZ - April 19<sup>th</sup>, 2019*



*No Provisions for NFPA  
68/69 Compliance*





NFPA 68





NFPA 69



# NFPA 68 or NFPA 69 Analysis

Powin Stack 360 53-ft Dual-Duct Roof C1D1 Exhaust Fan Explosion Prevention Analysis

**Powin Stack 360 53-ft Dual-Duct  
Roof C1D1 Exhaust Fan Explosion  
Prevention Analysis**

**SUPPORTS NFPA 69 ANALYSIS**

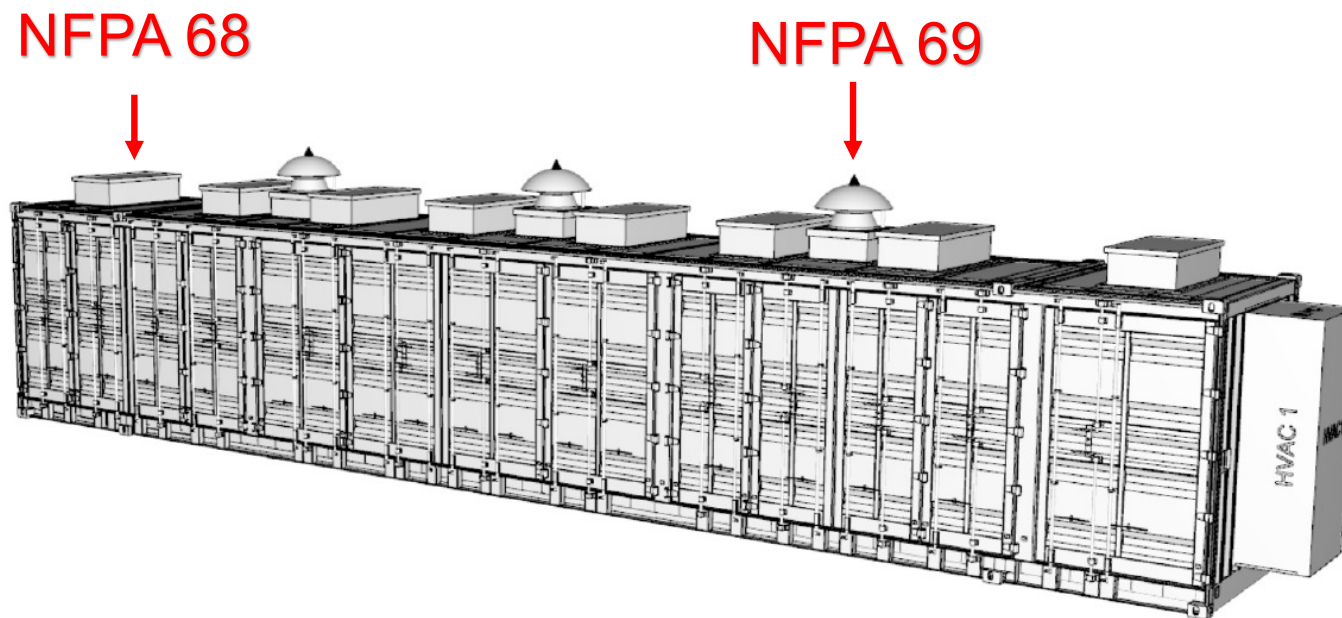
Date: 02.22.2023

**Dry Bridge - Stack360 53' HQ Deflagration Enclosure**  
NFPA 68 Deflagration Analysis Approach

## Number of Cells Required to Reach LFL

| <i>Event Description</i> | <i>Number of Cells involved</i> | <i>Failure Mode</i>                                  | <i>Average gas release rate (g/s)</i> | <i>Total Duration (min.)</i> | <i>Assumptions</i>                     |
|--------------------------|---------------------------------|------------------------------------------------------|---------------------------------------|------------------------------|----------------------------------------|
| Single module failure    | 9                               | Cell overheating or power surge affecting one module | 1.65                                  | 14.5                         | Propagation to all cells in one module |

# NFPA 855 Requires 1 Explosion Control Method







# Tesla Explosion Control

*22 Roof Vents w/ 12 Sparkers*

## FMEA Process

# Failure Modes & Effects Analysis



# Fire Risk Assessment

## Community Risk Assessment



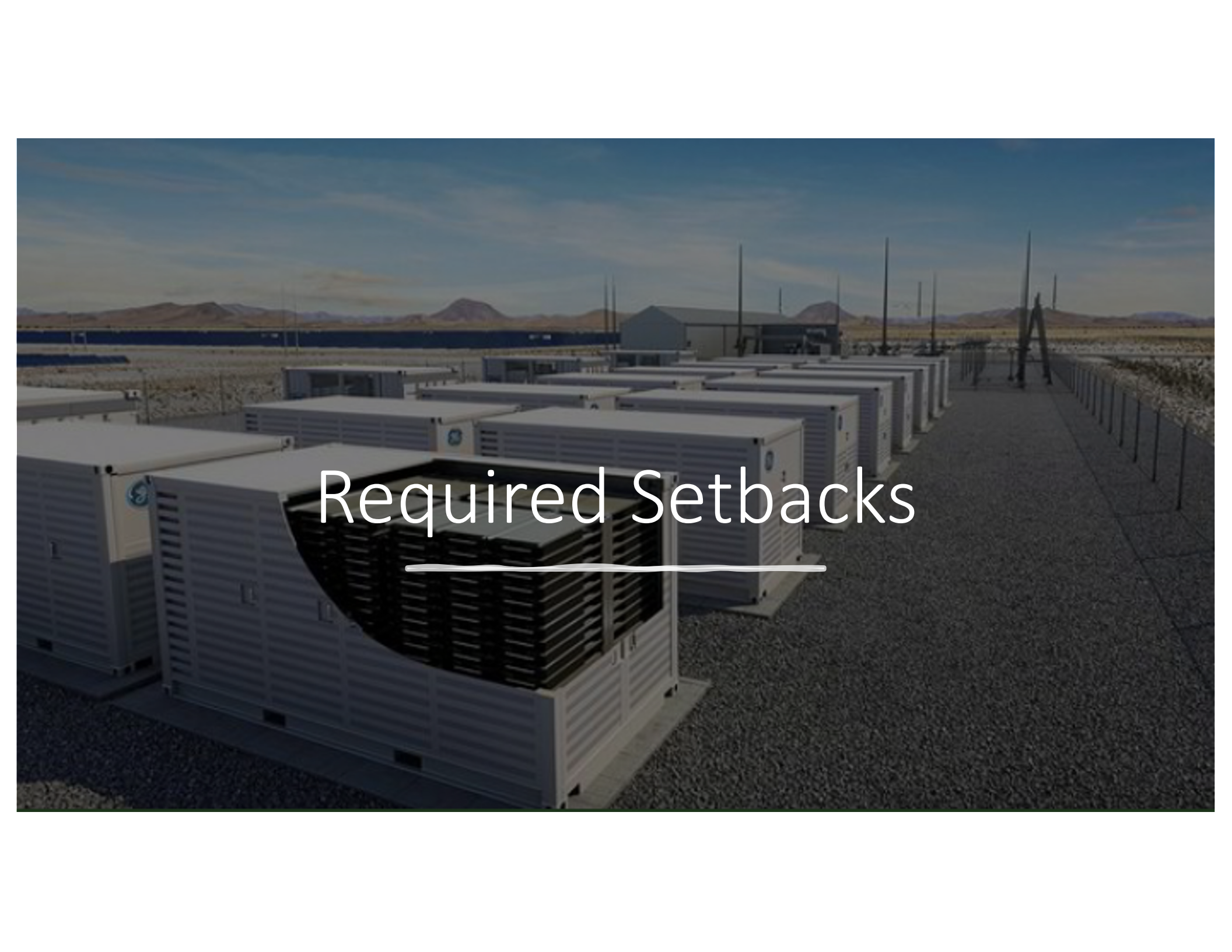
WÄRTSILÄ Quantum Cube

**Fire Safety Assessment for Outdoor Ground Mounted  
Battery Energy Storage Systems:  
Moccasin Pointe, La Porte, TX**

*REV3 | April 14, 2023*





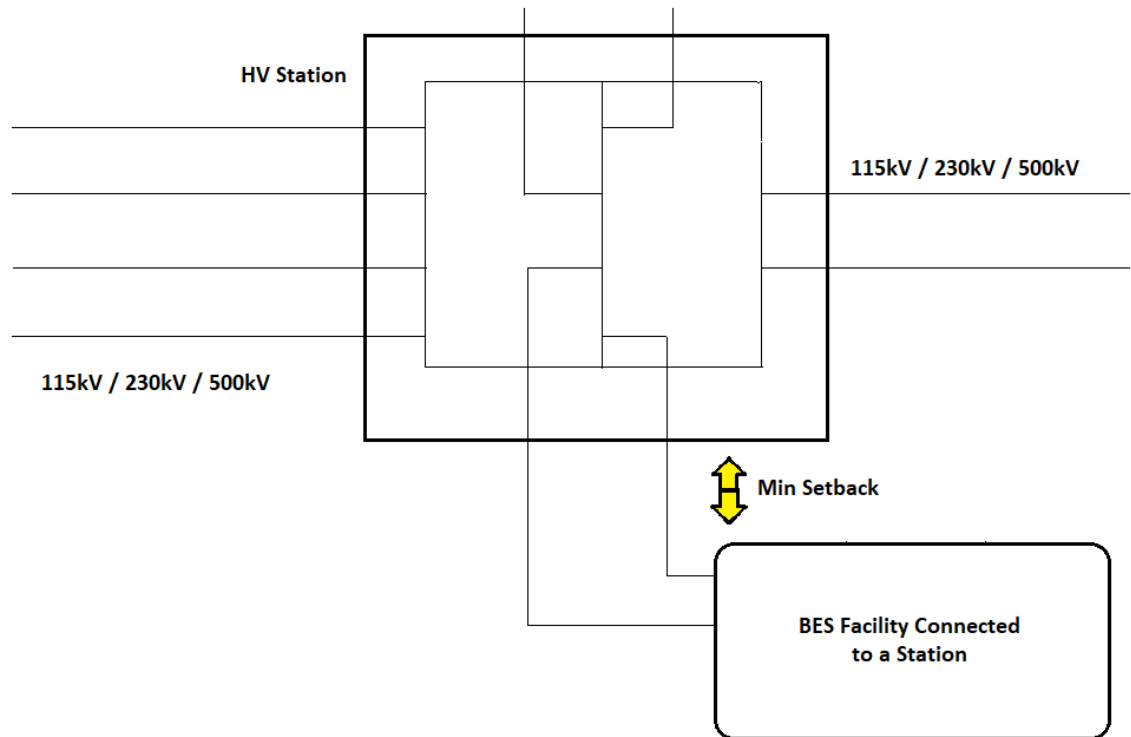


# Required Setbacks

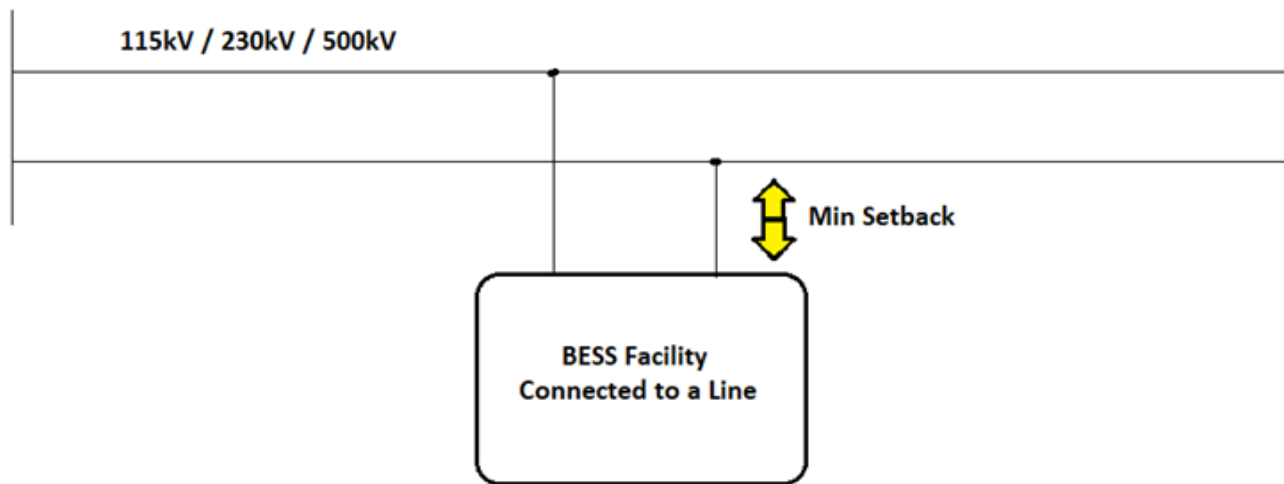


# Substation Setback

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# Transmission Corridor Setback





# Setback Table

---

| Item #                                                                                                                                                                                                                                                                                                                     | Hydro One Facilities                                                                    | Hydro One Setback Distance <sup>1,2</sup> |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|-------------------------------------------|
| 1                                                                                                                                                                                                                                                                                                                          | Hydro One – 500 kV Right of Way (ROW)                                                   | 150 meters                                |
| 2                                                                                                                                                                                                                                                                                                                          | Hydro One – 230 kV ROW                                                                  | 100 meters                                |
| 3                                                                                                                                                                                                                                                                                                                          | Hydro One – 115kV ROW                                                                   | 60 meters                                 |
| 4                                                                                                                                                                                                                                                                                                                          | Hydro One – 500 kV Substation                                                           | 300 meters                                |
| 5                                                                                                                                                                                                                                                                                                                          | Hydro One – 230 kV Switching Substation                                                 | 200 meters                                |
| 6                                                                                                                                                                                                                                                                                                                          | Hydro One 115kV Switching Substation or<br>Hydro One 230kV & 115kV step down Substation | 120 meters                                |
| <p>1. All distances are from the edge of right of way or Hydro One station property line.</p> <p>2. For proponents that have acquired property rights or own the BESS property prior to January 1, 2023, and cannot meet the above distances, the layout must be discussed with Hydro One for assessment and approval.</p> |                                                                                         |                                           |

# Assessments



| Required Assessments                                                                                                                                                                                                                          | Up to 250m from Lines ROW | Up to 400m from Stations Property Line |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|----------------------------------------|
| <ul style="list-style-type: none"><li>• Hazard Mitigation Analysis (HMA)<ul style="list-style-type: none"><li>○ Code Review</li><li>○ UL 9540 Listing</li><li>○ UL 9540A Test Report</li><li>○ Fault Condition Assessment</li></ul></li></ul> | Required                  | Required                               |
| <ul style="list-style-type: none"><li>• Fire Risk Assessment (FRA)<ul style="list-style-type: none"><li>○ Community Risk Assessment</li><li>○ Air/Gas Dispersion Study</li></ul></li></ul>                                                    | Required                  | Required                               |
| <ul style="list-style-type: none"><li>• Fire Protection Design Documentation<ul style="list-style-type: none"><li>○ Passive Fire Protection System</li><li>○ Active Fire Protection Systems</li></ul></li></ul>                               | Required                  | Required                               |
| <ul style="list-style-type: none"><li>• Commissioning Plan</li></ul>                                                                                                                                                                          | Required                  | Required                               |
| <ul style="list-style-type: none"><li>• Emergency Response Plan</li></ul>                                                                                                                                                                     | Required                  | Required                               |



# Detection



Fire Strobe



Alarm Bell



Heat  
Detector



Smoke  
Detector



Combustible gas  
detector  
CO, H<sub>2</sub>, CH<sub>4</sub>



Fire Alarm  
Control panel

NFS-320

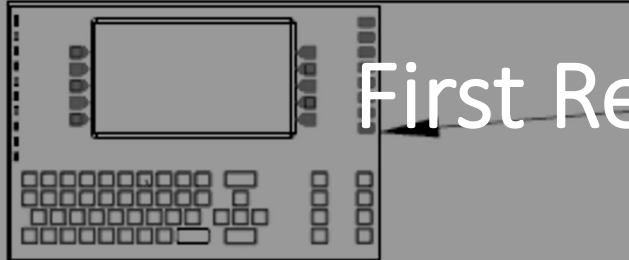
# FACP to Central Station Monitoring

 **NOTIFIER**  
by Honeywell

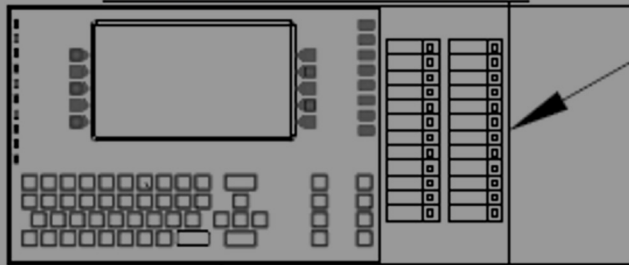
# First Responder Station

Gas Readings  
Purge Control  
FACP Data

## GAS LEVEL MEASUREMENT



## FIRE ANNUNCIATOR PANEL



14





A photograph of a large fire at a power plant or substation at night. Several firefighters in full protective gear are positioned around the burning area, directing high-pressure streams of water from their hoses onto the flames. The fire is intense, with bright orange and yellow flames and thick black smoke rising into the dark sky. The scene is filled with the complex infrastructure of the power plant, including tall metal support poles, cross-arms, and numerous high-voltage power lines. The ground appears to be covered in a layer of snow or frost. The overall atmosphere is one of a major emergency response in a high-risk industrial environment.

# Fire Suppression

*Changing Tactics*





Why Do We Extinguish Fires ?  
*Life Safety & Preservation of Property*



# What They Think & What Actually Happened

[Home](#) > [Future Tech](#) > [Electric Vehicles](#)

**TESLA'S CAR CRASH NEEDED 32,000  
GALLONS OF WATER TO PUT OUT THE  
FIRE**



# Thermal Runaway

*Vent Pressure  
100 psi*

---





Single Failure Loss





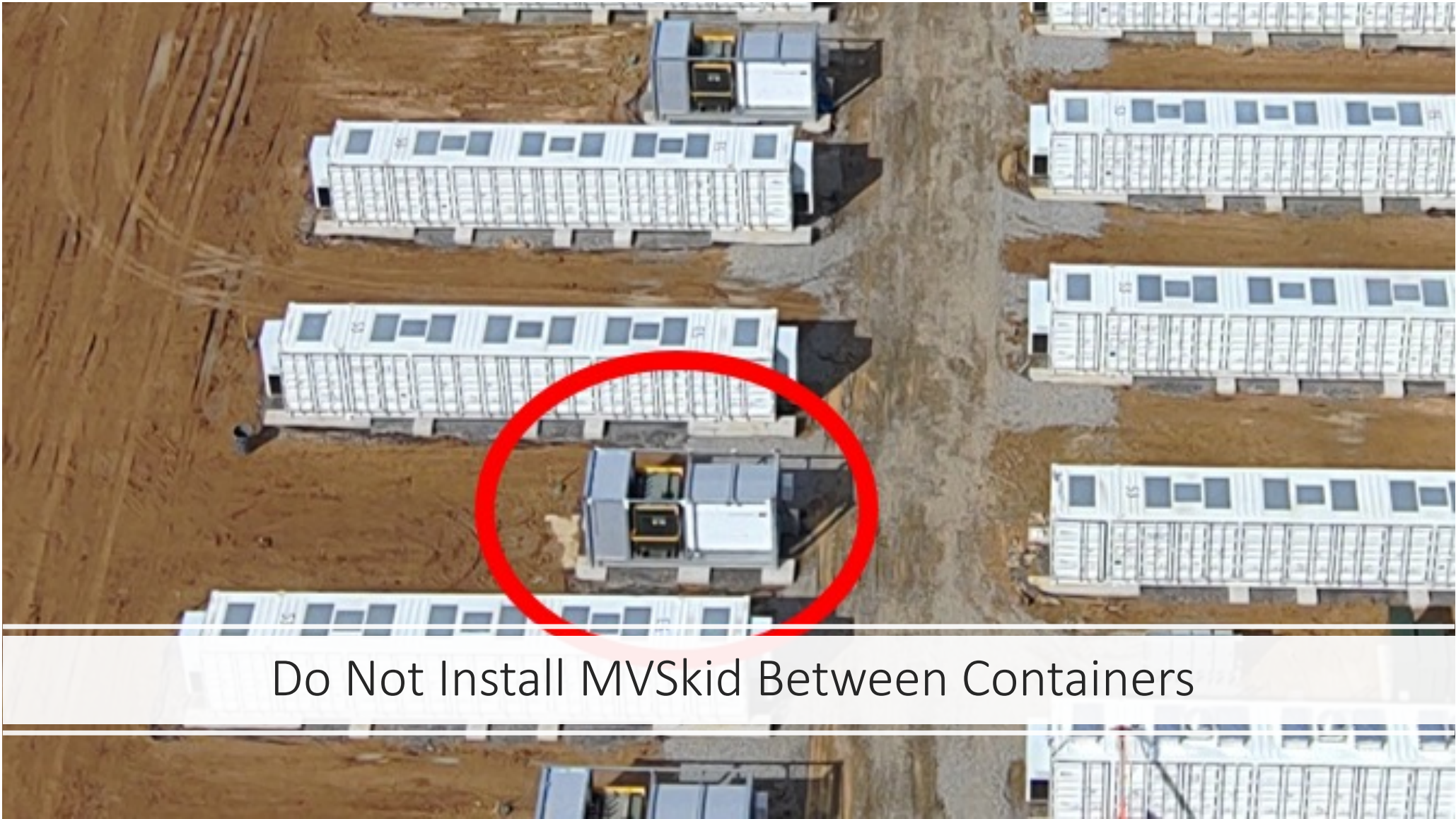
# Spatial Separation

**NFPA 855 3'**

**FM Global 20'**

**Utility Standard 25'**





Do Not Install MVSkid Between Containers







Vegetation Management



# Required Plans

**NFPA<sup>®</sup>**

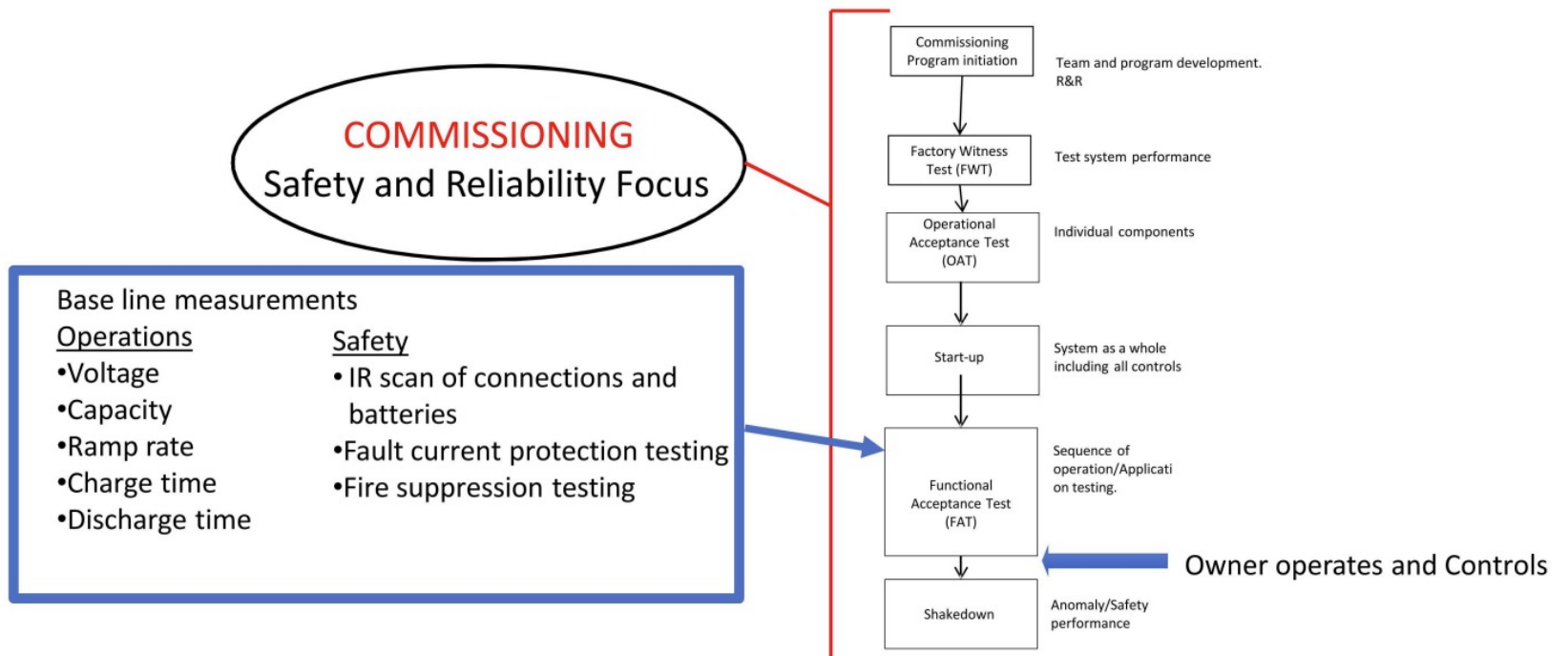
**855**

Standard for  
the Installation of Stationary  
Energy Storage Systems

**2023**

# Commissioning Plan

## 15 Commissioning / Testing Process details





# Operations & Maintenance Plan



## Megapack 2 Operation and Maintenance Manual

CONFIDENTIAL INFORMATION - SHARED UNDER NDA ONLY - REV 1.1

# Decommissioning Plan



## Wärtsilä GridSolv Quantum ESS Decommissioning Plan



### ESS Decommissioning Plan Rev\_0

REV\_0 | Date: May 1<sup>st</sup>, 2023

This plan has been developed to assist customers with end of useful life and post incident decommissioning of Wärtsilä's GridSolv Quantum energy storage system battery installations.

This generalized document and supporting material should be consulted prior to performing decommissioning on Wärtsilä GridSolv Quantum equipment.

**Approved By**  
Wärtsilä  
485 Springpark Place, Suite 1500  
Herndon, VA 20170

**Fire & Risk Alliance, LLC.**  
7640 Standish Place  
Rockville, MD 20855  
fireriskalliance.com  
1-877-961-4118

**Confidential**  
**Document No. 594-002 Wärtsilä BESS Decommissioning Plan**

**CONFIDENTIAL AND PRIVILEGED;** Attorney-Client Communication/Party Representative Work Product Self Critical Analysis/Self Evaluation Privilege Contains Mental Impressions, Conclusions and Opinions Respecting the Value or Merit of a Claim or Defense or Strategy or Tactics

# Emergency Response Plan



## Dry Bridge BESS

Chesterfield County, Virginia  
Battery Energy Storage System

*This plan has been developed to assist the local emergency responders with important safety and emergency response information concerning the Powin Stack 360E energy storage system.*

*This generalized document and supporting material should be consulted prior to any fire service personnel performing firefighting operations or entering the Dry Bridge BESS site.*

**Confidential**

**Document No. ERP-680-006**

## Emergency Response Plan Rev\_02

Approved By: Strata Clean Energy

Approved By: Dominion Energy

Draft Date: June 8, 2023

CONFIDENTIAL AND PRIVILEGED; Attorney-Client Communication/Party Representative Work Product Self Critical Analysis/Self Evaluation Privilege Contains Mental Impressions, Conclusions and Opinions Respecting the Value or Merit of a Claim or Defense or Strategy or Tactics.





# Fire Department Training

Hazards & Response Tactics for BESS Emergencies



# Design Documentation

- Recommended documents to be submitted to Hydro One:
- Hazard Mitigation Analysis (HMA)
  - Code Review
  - UL 9540 Listing
  - UL 9540A Test Reports
  - Fault Condition Assessment
- Fire Risk Assessment (FRA)
  - Community Risk Assessment
  - Air/Gas Dispersion Study
- Fire Protection Design Documentation
  - Passive Fire Protection Systems
  - Active Fire Protection Systems
- Commissioning Plan
- Emergency Response Plan
- Signed and Sealed Document Assembly- Self Certification Document



# Next Steps

Hydro One will post the Fire Protection Risk and Response Standard (FRRAS) on the [Transmission Connected Generator](#) page by 21<sup>st</sup> July 2023.

Your comments are expected before 4<sup>th</sup> August 2023

For any questions or comments, please email us with a Subject Line “BESS Setback Enquiry” to:  
[largeaccounts@hydroone.com](mailto:largeaccounts@hydroone.com)



Questions

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