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Energy Storage Systems
Design Challenge

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ESS Design Concept for in High-Rise Bldg.

- Items we will cover
  - Hazards
  - Suppression
  - Detection & Notification
  - Liquid Runoff
  - Long Duration Events
  - Products of Combustion
  - Compartmentation
  - Feasibility
Hazards

- Thermal runaway
- Toxic gas production
- Leakage of hazardous materials
- Stranded energy in damaged batteries
- Electrical shock to emergency responders
Suppression Options

• Limited scientific data on the proper way to address extinguishment

• Fire Ignition
  • In adjacent equipment
  • Within cells
Suppression Options

• Fire tests show cooling of cells during suppression is critical to terminating the production of flammable gases

• Quick-response sprinklers
  • Effective with large volumes of water
  • Cheap
  • Water may not reach modules containing cells on fire
Suppression Options

• Gaseous suppression
  • Difficult to install in large area
  • Does not cool – which is critical for thermal runaway fires
• Expensive
• Hybrid system
Hybrid System

- Proposed Standard NFPA 770
- Victaulic Vortex
  - Hybrid System Using Water and Nitrogen
  - Small droplets for cooling (sub 10 micron)
  - Nitrogen displaces oxygen
  - Room Integrity is No Issue
Hybrid System

• The goal is fast suppression of incipient fires
  • The risk to ESS is an external or internal fire
  • Long duration events required to achieve self-sustaining thermal runaway
• Gap analysis – How similar are ESS fires to electrical or data installations, which are well researched topics
• Gap analysis – How do fires that start within cells develop
Victaulic Vortex

Photo courtesy of Victaulic
Hybrid System

• No need for assurance of tight room integrity
• Allows continuous ventilation
• No costly clean-up or equipment replacement
• Quick system recharge, minimal downtime
• Green design that is safe for the environment and personnel
Suppression Approach

- Victaulic Vortex
  - Limited testing for ESS
- Have redundant sprinkler system
  - In case Vortex fails
- Protect building structure
Sprinkler System

• 100 gpm per 100 sq ft of fire footprint
• Overview of a Year of Battery Fire Testing by DNV GL for Con Ed, NYSERDA and FDNY
• Nick Warner - NFPA 855 Technical Committee Finding
Sprinkler System

- Racks are 15 sq ft
- Two fusible link sprinklers centered over each rack at 15 gpm
  - or between
- Dedicated waterflow switch and control valve
Detection Approach

• For Hybrid System
• Air Sampling—Type Smoke Detector
  • Activates hybrid suppression
  • The goal is fast detection, fast suppression
• Use high temperature switches within ESS control equipment
Detection Approach

• Automatic battery disconnect emergency stop at sprinkler activation (not hybrid system)

• Manual emergency stop for battery outside of room
Notification Options

- Evacuate fire floor and two floors above
Handling of Liquid Runoff

• 12 ft deck to deck
• Modules are 7 ft 6 in high
• Create 2 ft high concrete berm
  • Leak detection & annunciation
• Contain water runoff
  • No floor drainage due to hazards
• Prevent water damage
• Prevent contamination
• Easy cleanup
Handling of Liquid Runoff

- Racks on raised floors, or
- Racks on 2 ft high stands directly over concrete floor
  - Limited accessibility for egress
Handling of Liquid Runoff

- 2 ft berm in 625 sq ft room creates 1,250 ft³ or 9,350 gallons
- 100 gpm per 100 sq ft of fire footprint
- Racks are 15 sq ft, assume 100 gpm or one handheld hose line
- About 1.5 hours of water containment
Long-duration event

• Concrete berm also helps with manual suppression
• Stops spread of stranded energy outside or room
• Submerging batteries after they burned is effective at cooling the batteries and neutralizing the thermal threat
Handling of Products of Combustion

• ESS fires similar to plastic fires of comparable mass (NFPA 855 Technical Committee Finding)
  • Still unknown high hazards
• Dedicated HVAC units going into automatic 100% exhaust upon sprinkler activation
• Manual button for 100% building exhaust with dedicated exhaust duct and isolation dampers for bypass
Compartmentation

• 2-hour fire barrier around room
• Minimum 3 feet separation is recommended, which is provided
• Option 1: Consider sub-dividing room or provide fire curtains between racks
  • Need gap analysis for further consideration
  • Fire tests do not show spread between racks
Feasibility

• Except for Hybrid system, most of our design is standard practice
Questions?

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