An Engineering Approach to Risk Management

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2017 ESS Safety Forum
22-24 February 2017, Santa Fe NM
Risk Management

- **Application**
  - Purpose of installation

- **Assess Hazard**
  - Risk event, e.g., fire
  - Natural hazards

- **Acceptable loss / damage**
  - Equipment damage
  - Business interruption
Risk Management

- Passive Protection
  - Site design
  - Equipment design

- Active Protection
  - Fire protection system
  - Fire service

- Human Element
Fire Protection Options

- Water based
  - Sprinklers, water spray/mist, hybrid
- Gaseous
  - Chemical agents, inert gas, hypoxic
- Wet Chemical
  - Gel, foam, compressed air/foam, wetting agents
- Dry Chemical
  - Dry agents, aerosol
Selecting a Protection System

What is the goal of the protection system?

- Limit the fire spread to:
  - Battery, module, rack, container, etc.
- Building constraints, e.g., room integrity
- Associated damaged
  - Hazard gas release, water contamination, building damage
  - Replacement or equipment down time
2017/18 Research Goals

- Determine sprinkler guidance for ESS within commercial occupancies
  - Sprinkler protection is most prevalent
- Is existing building protection adequate?
  - Large-scale sprinklered fire tests
- Establish the range of ESS fire hazards
- Collaborative effort with NFPA / PIRG
FM Global Research Campus
Scenario-based FMEA

- FMEA conducted on typical system
- Component failure
  - Failure progression at different stages
  - Evaluate impact of failure
  - Identify mitigation measures
FMEA Scope

- Commercial applications
  - Li-ion based ESS
  - 100 kW to 1 MW
- 25 scenarios identified
- Categories
  - Design, Maintenance, Operation
Sample Scenario

Cell Overcharge / High Temp.

Impact Description

- Cell damage; replace
- ESS outage

Mitigation Measures

- Cell protection
- BMS response

Cell temperature / pressure increase

- PRV operates
- Venting of gases
- Cells damaged; replace
- Extended outage

Spread of thermal effect to adjacent cells

- Multiple cell thermal runaway
- Extensive damage
- Extended outage

System level fire

- Toxic gas release
- Large fire
- ESS unrepairable

- Battery design
- Venting of gases
- Hazardous liquid restriction

- Passive and active fire protection

Spread of thermal effect to adjacent cells

- PRV efficacy
- HVAC design for heat dissipation and renewal
Available Guidance


- Protection
  - Electrical
  - Fire
- Hazards
  - Thermal runaway
  - Electrical fire
- Site design
- Operation & maintenance
- Human factors
- Terminology
Thank You

Available literature: