



An Engineering Approach to Risk Management

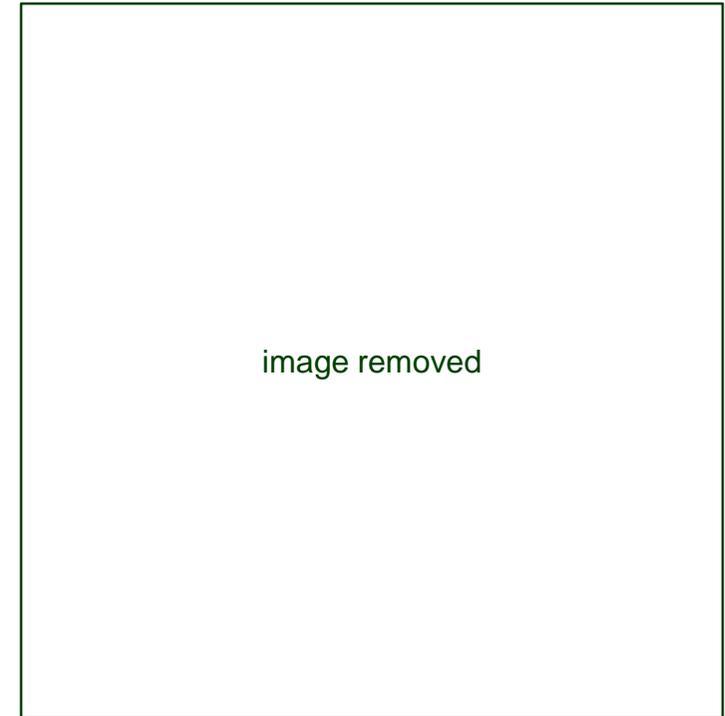
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2017 ESS Safety Forum
22-24 February 2017, Santa Fe NM

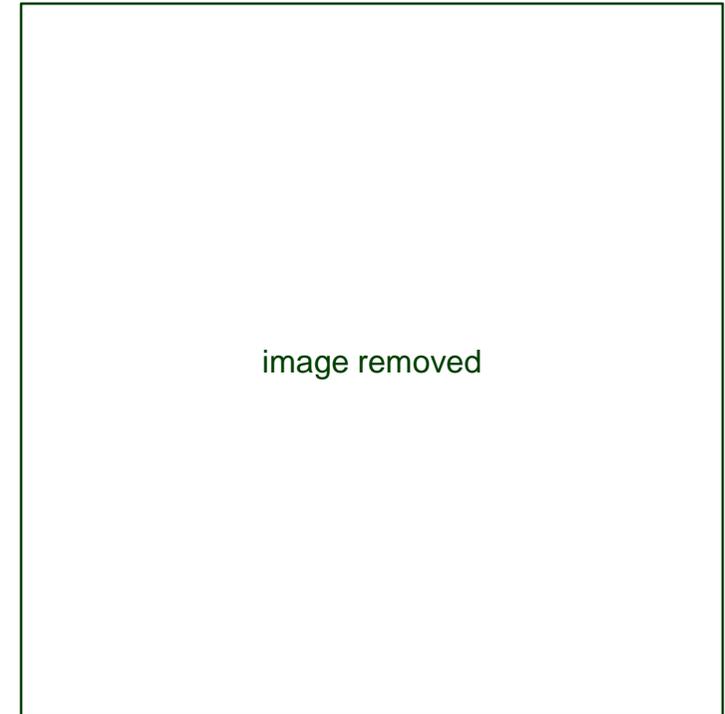
Risk Management

- 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

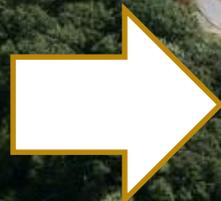
2017/18 Research Goals

- 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



Scale



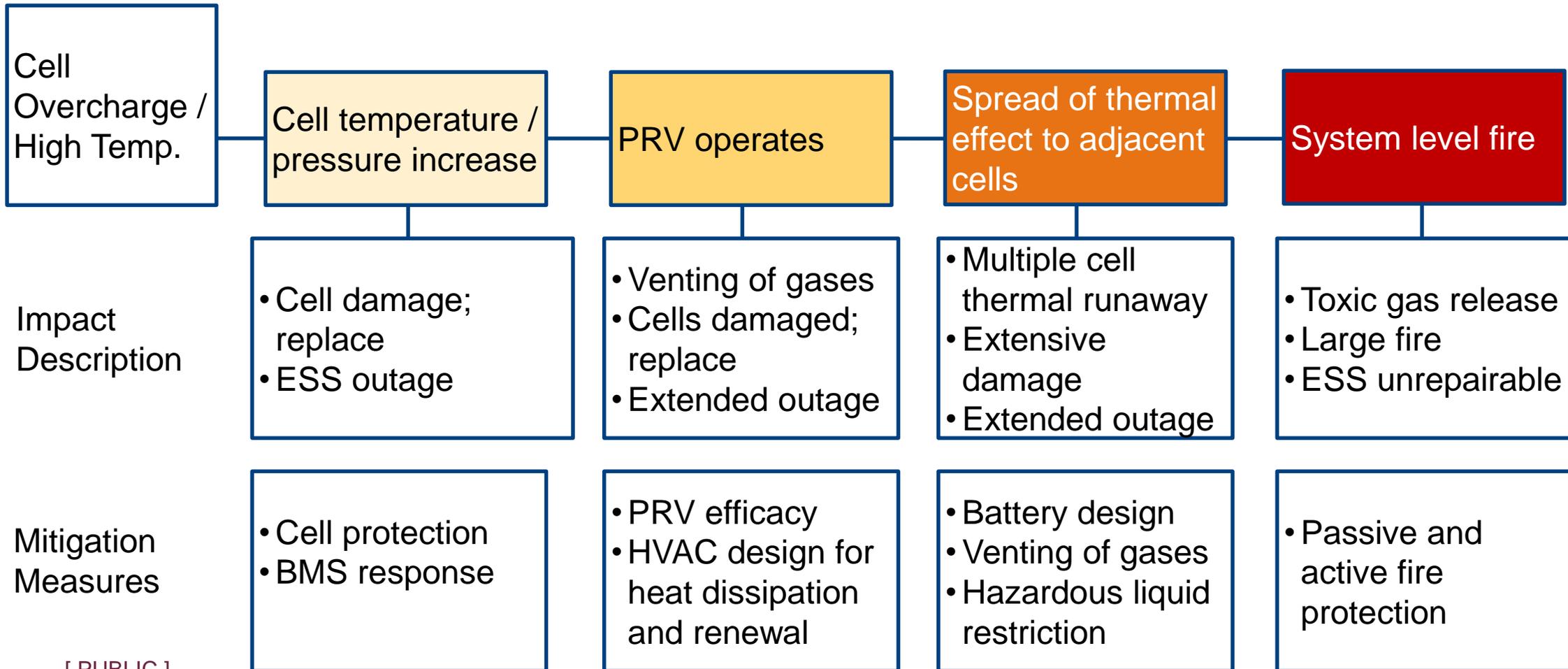
Scenario-based FMEA

- 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



Available Guidance

FM Global Property Loss Prevention Data Sheet 5-33,
“Electrical Energy Storage Systems,” 2017

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

Thank You

Available literature:

- FM Global Property Loss Prevention Data Sheets 5-33, Electrical Energy Storage Systems, 2017. Accessible at <http://www.fmglobal.com/research-and-resources/fm-global-data-sheets>.
- B. Ditch, "Development of Protection Recommendations for Li-ion Battery Bulk Storage: Sprinklered Fire Test," FM Global Technical Report, 2016. . Accessible at <http://www.fmglobal.com/research-and-resources/research-and-testing/research-technical-reports>.
- B. Ditch and J. de Vries, "Flammability Characterization of Li-ion Batteries in Bulk Storage," FM Global Technical Report, 2013. Accessible at <http://www.fmglobal.com/research-and-resources/research-and-testing/research-technical-reports>.