

DESTINATION 2050

Designing Safe Energy Storage Projects

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POWERGEN.COM



Agenda

1. Permitting Package
2. Large Scale Fire Safety Testing
3. Education



Speaker Introduction: Mishaal SyedNaveed

- Leads Wärtsilä Energy Storage & Optimisation's **product roadmap related to ESS fire and safety compliance, testing, and R&D**
- Member of Technical Committees
 - **UL 9540 / UL9540A**
 - **C801** - Testing Protocol for Evaluating Effectiveness of Detection & Suppression Systems for Battery Failure Events
 - CESA
- Former FPE for a major US-based Utility
- Licensed Professional Engineer (P.E.) in Fire Protection
- B.S. Fire Protection Engineering & M.S. Energy Systems Engineering



Site Design Guide (SDG)

- Fire codes may tell you *what* to do but it doesn't necessarily tell you how to do it.
- Utilised by customers to design sites according to the latest code requirements, industry best practices, and product offerings.
- Key Points:
 - Two entrances that consider wind direction and staging areas
 - Roads that can support fire trucks and have adequate clearances
 - Aggregating fire alarm signals to fire command centers
 - Water availability (hydrants/water tanks)
 - Equipment clearances to oil filled equipment, switchgears, lot lines, etc.

5.7 Example Fire Protection Site Design

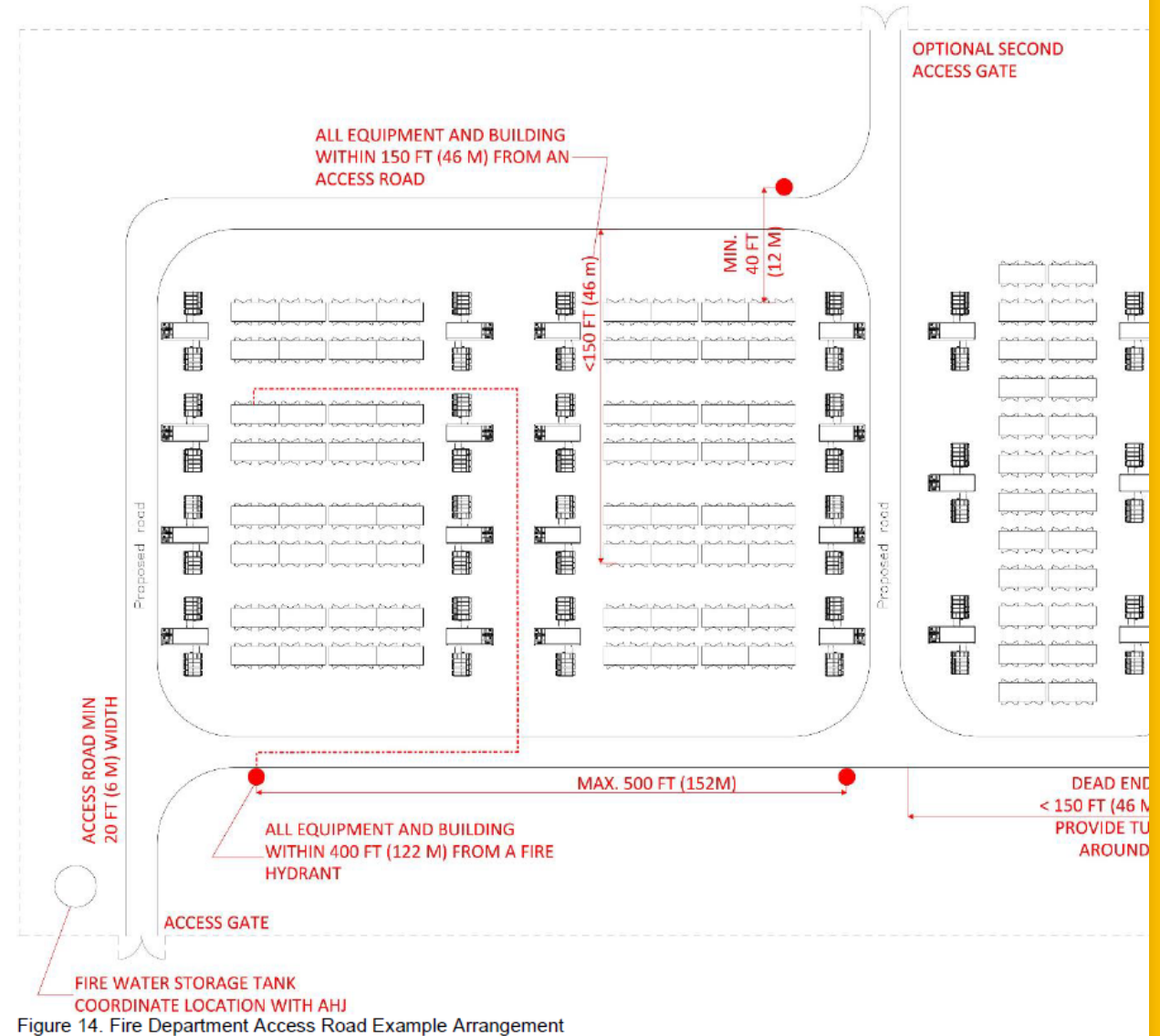


Figure 14. Fire Department Access Road Example Arrangement

Hazard Mitigation Analysis (HMA)

- Ensure clients are doing a site-specific HMA that meets the criteria laid out in NFPA 855. Annexes included:
 - Heat Flux Analysis
 - Consider unit to unit spacing
 - Spacing to oil filled equipment
 - Local wind speeds
 - Ventilation Analysis (NFPA 69)
 - FLACS (NFPA 68)-Partial volume analysis
 - New requirement in NFPA 855
 - FMEA

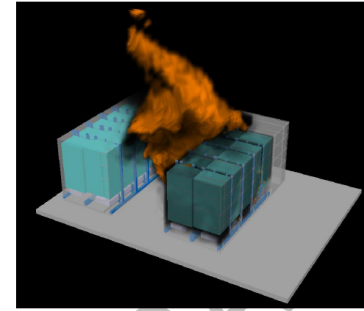


Figure 9: Flaming Event Inside the Initiating Quantum (Scenario 1 - 30mph wind speeds)

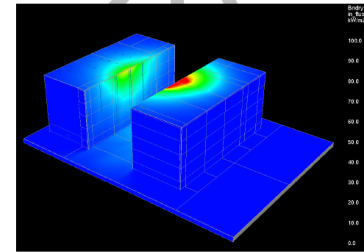
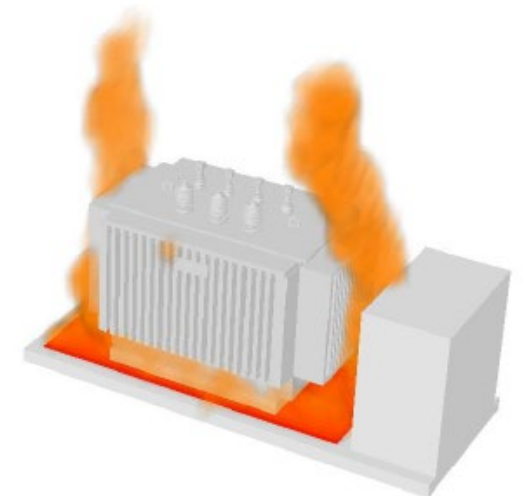
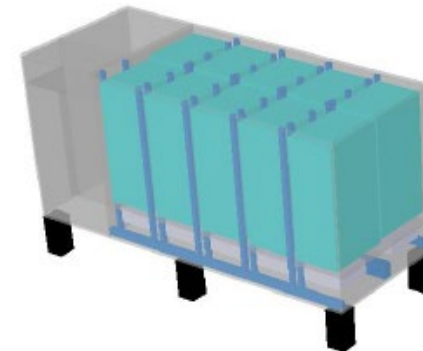
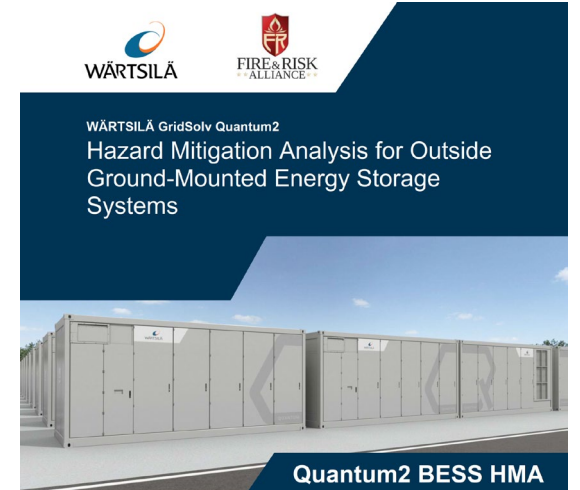


Figure 10: Roof Exterior Incident Heat Flux (Scenario 1 - 30mph wind speeds)



Community Risk Assessment (CRA)

- Community Risk Assessment a.k.a. Fire Safety Assessment may be used to support specific project sites.
- The CRA evaluates the potential toxic gas, flammable gas, heat, and overpressure extents and any impacts to the site, the fire service, or the public.
- Plume models should be at a minimum based on UL 9540A module level results.
- Note that one may receive requests for additional modeling to consider gases such as HF

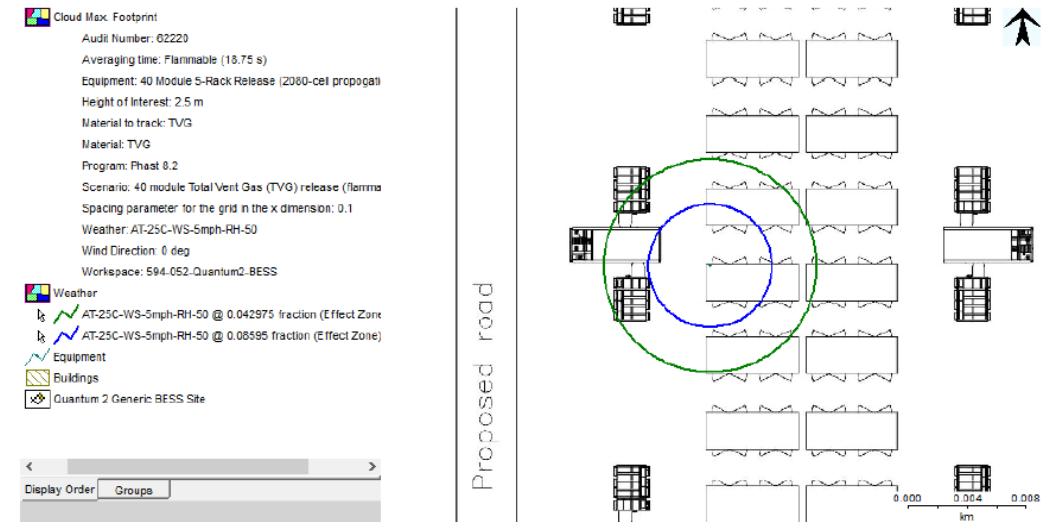


Figure 21 Map of horizontal extent of vapor cloud for LFL (8.595%) and 1/2 LFL (4.2975%)

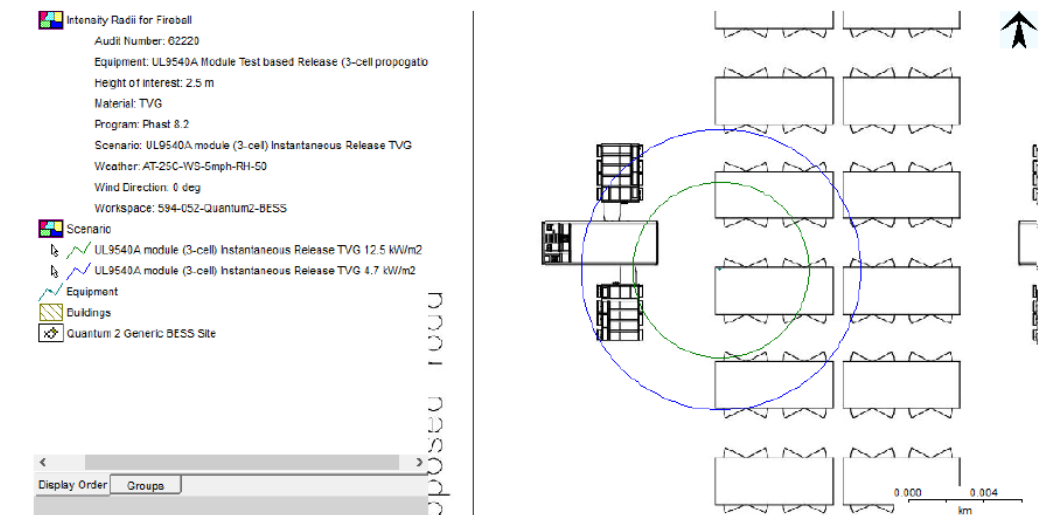


Figure 35. Thermal Radiation Levels for a Fireball for Scenario 1.4 (blue = 4.7kW/m²; green = 12kW/m²)

Emergency Response & Decommissioning Plans

- Majority of accidents happen during the hot commissioning phase of projects.
- Cold commissioning focuses on ensuring mechanically sound system functionality, while hot commissioning focuses on testing actual power generation and daily functional operation testing.
- Ensure a site-specific Emergency Response has been created and training provided to local first responders
- Additional updates in NFPA 855 will look to consider Construction Emergency Response Plan(CERP) & an Operations ERP for O&M and site personnel
- Initial training should happen virtually with the local AHJ before units arrive and in person after equipment is set.

Safe Staging:

The application of water for exposure control should be made from the terminal end of the container. Be mindful to observe the exclusion zone clearance in front of the doors which presents the primary hazard zone, Figure 19.

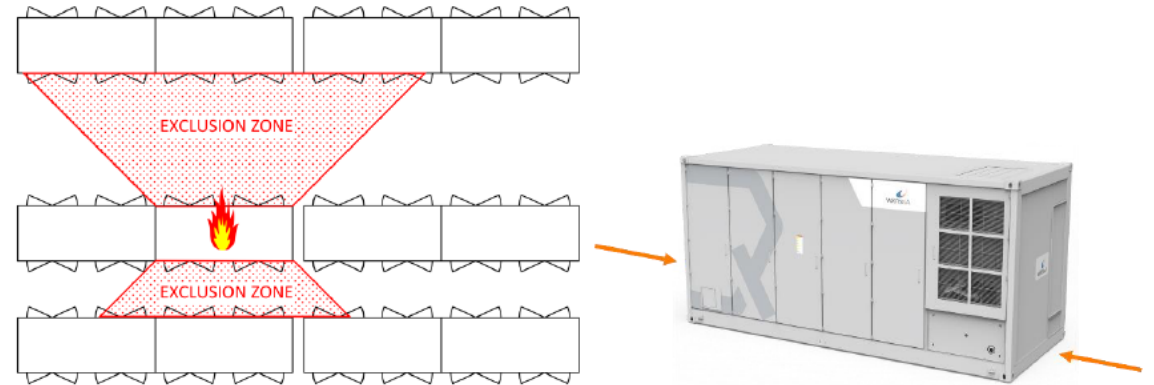


Figure 19. Safe Staging Exclusion and Safe Approach

Community Risk Assessment (CRA)

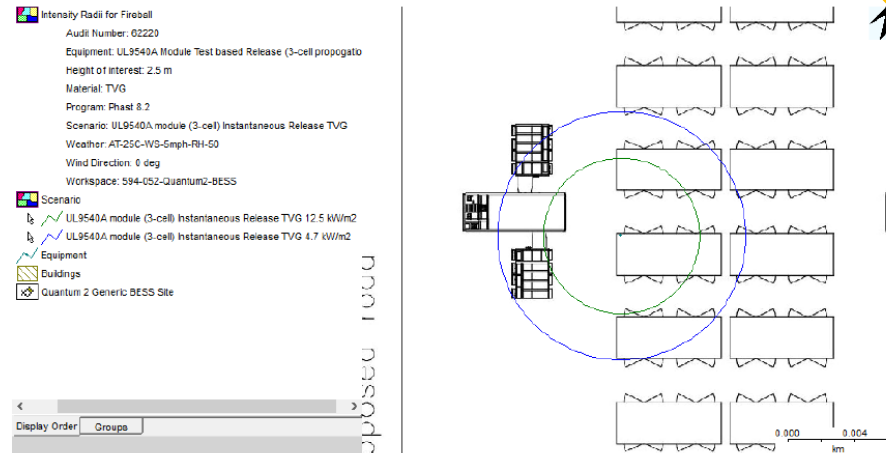


Figure 35. Thermal Radiation Levels for a Fireball for Scenario 1.4 (blue = 4.7kW/m^2 ; green = 12kW/m^2)

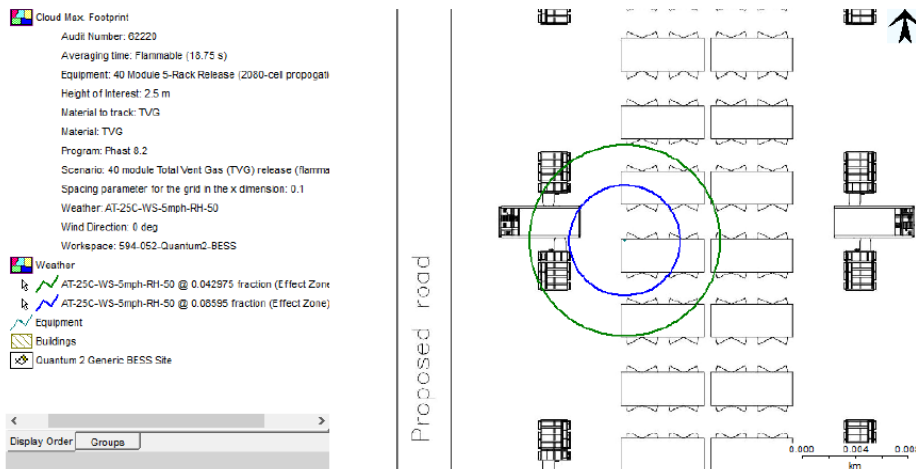


Figure 21 Map of horizontal extent of vapor cloud for LFL (8.595%) and $\frac{1}{2}$ LFL (4.2975%)

- No two manufacturer are the same. What are some things to look out for when evaluating a BESS supplier?
- Is the system listed to UL 9540 or other appropriate listings for the country its installed?
- Does the site require any special environmental conditions that have been evaluated in the listing?
Example: Seismic
- What are the IP ratings of the module and Enclosure?
- What explosion prevention systems are present?
Have they been evaluated by a third party?
- Did they pass the performance criteria at the unit level or where they required to perform an installation level test?
- What does their safety record look like?



Controlled Wärtsilä burn tests



Large Scale Fire Test (LSFT) – Controlled Burn Test

- There is currently no released Large Scale Fire Testing Standard however Wärtsilä ES&O has worked with industry leaders and AHJs to address growing concerns
- Initiated with **pre-mixed flame burner** until self sustaining
- Deflagration panel removed to simulate post deflagration fire (non ventilation limited)
- Conducted a controlled burn test that burned for over **5 hours** without intervention
- Conditions on adjacent enclosures or wood walls two and a half meters in front and rear of unit show **no risk of escalation** to other ESS units or rows and no damage to the wooden walls
- Heat Flux peaked at 13.3 kW/m²
- Module temperatures remained **below cell venting temperature**

Education: Bridging the Gap between the Manufacturer & End-User



Ensure testing aligns with industry best practices and addresses AHJ concerns.



Take a project-specific approach to fire safety, factoring in site layout, human and environmental conditions.



Maintain a fire safety-first mindset, regardless of project scope, contract, and independent of where the project site lives.



Encourage early and frequent discussions with AHJs, Developers, and Insurers.



Discuss with customers the importance of conducting a Hazard Mitigation Analysis (HMA), including a Community Risk Assessment (CRA) and an Emergency Response Plan (ERP).



Ensure you are working with manufacturers who maintain safety as a top priority.



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Q&A