The importance of fire safety in Australia’s booming energy storage industry

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Agenda

1 Introduction

2 Permitting

3 Site design

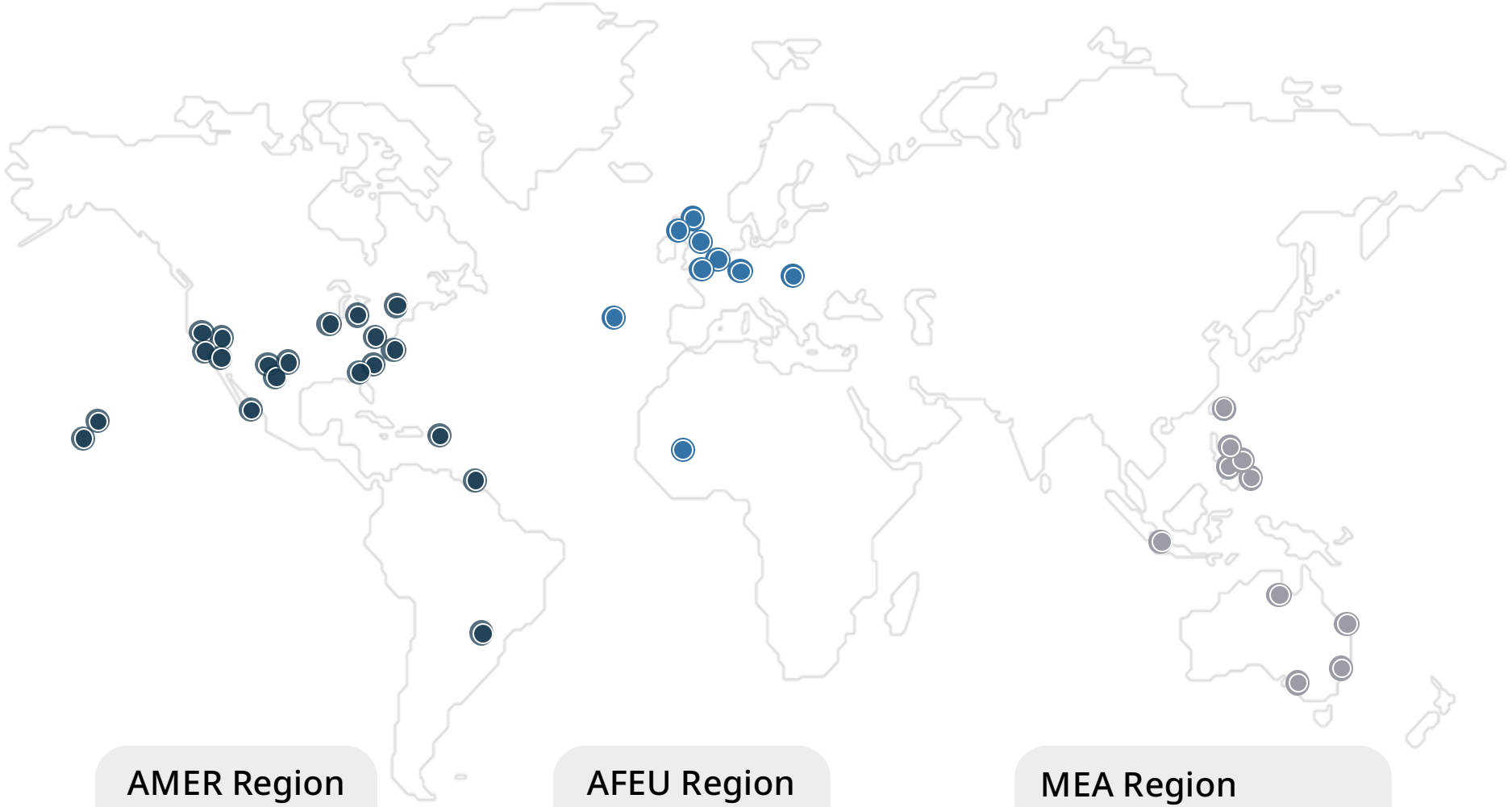
4 Fire testing

5 Education

Speaker intro: Ali Asadi

- **Electrical Systems Engineer (MIEAust, CPEng, NER)**
- **Extensive experience in utility-scale battery energy storage systems (BESS)**
- **Part of Wärtsilä Energy Storage's delivery team in the APAC region**
- **Successful involvement in BESS projects:**
  - Torrens Island (SA): 250 MW / 250 MWh
  - Eraring stage 1 (NSW) : 460 MW / 920 MWh
  - Bungama (SA): 150 MW / 300 MWh
- **Engineering background in Oil & Gas and Power Plant Industries**

A globally recognised energy storage solutions provider



AMER Region
Americas
2.5 GW
8 GWh

AFEU Region
Africa, Europe
1 GW+
2 GWh+

MEA Region
Middle East, Asia, Australia
1.5 GW+
4.9 GWh+

14 GWh+
awarded, contracted, in deployment

130+
projects

15+
year track record
of growth & industry leadership

What is thermal runaway?

- Has a variety of causes:
  - Electrical safety system failures
  - Overcharge / over-discharge
  - Mechanical damage
  - Manufacturer’s defect
  - Operating environment outside specifications (too hot or cold)
  - Rodents, insects

- Produces several hazards:
  - Heat
  - Flames
  - Off-gassing of hydrogen and carbon dioxide (primarily)
  - Off-gassing of toxic gases
  - Deflagration / explosions

Fire mitigation measures need to be taken to ensure safe energy storage system performance

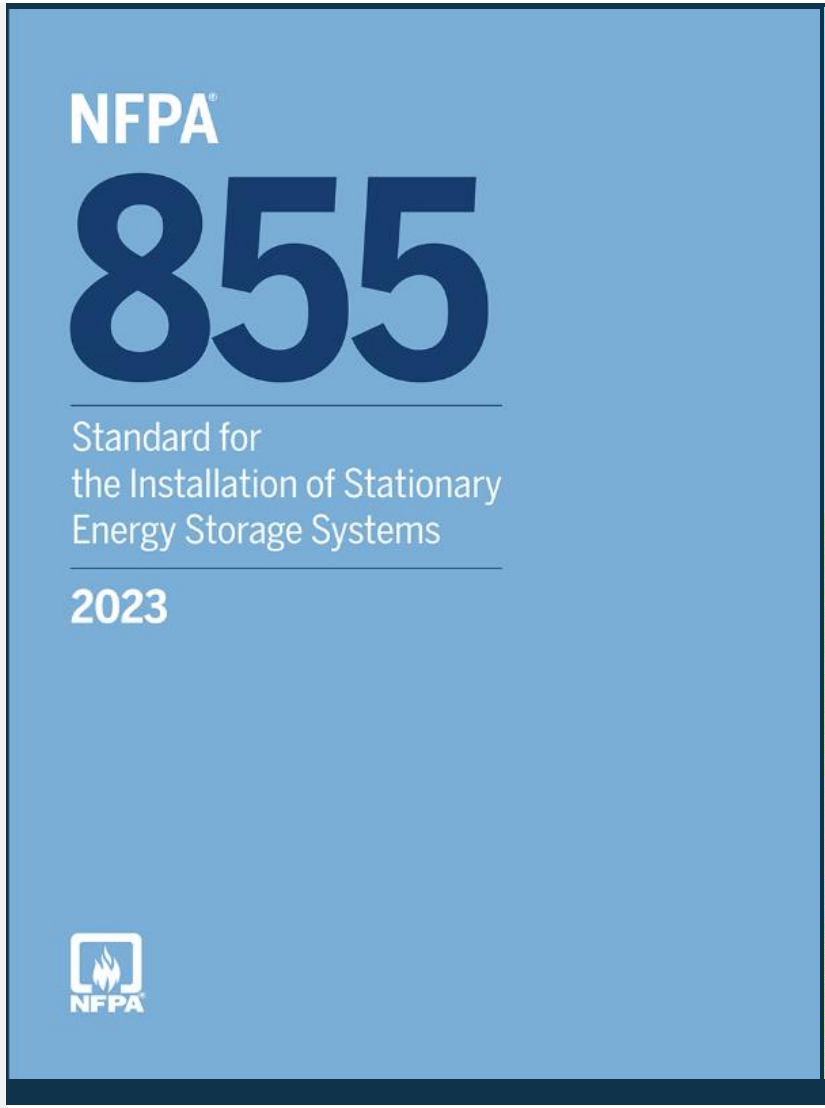
Typical battery energy storage (BESS) site layout

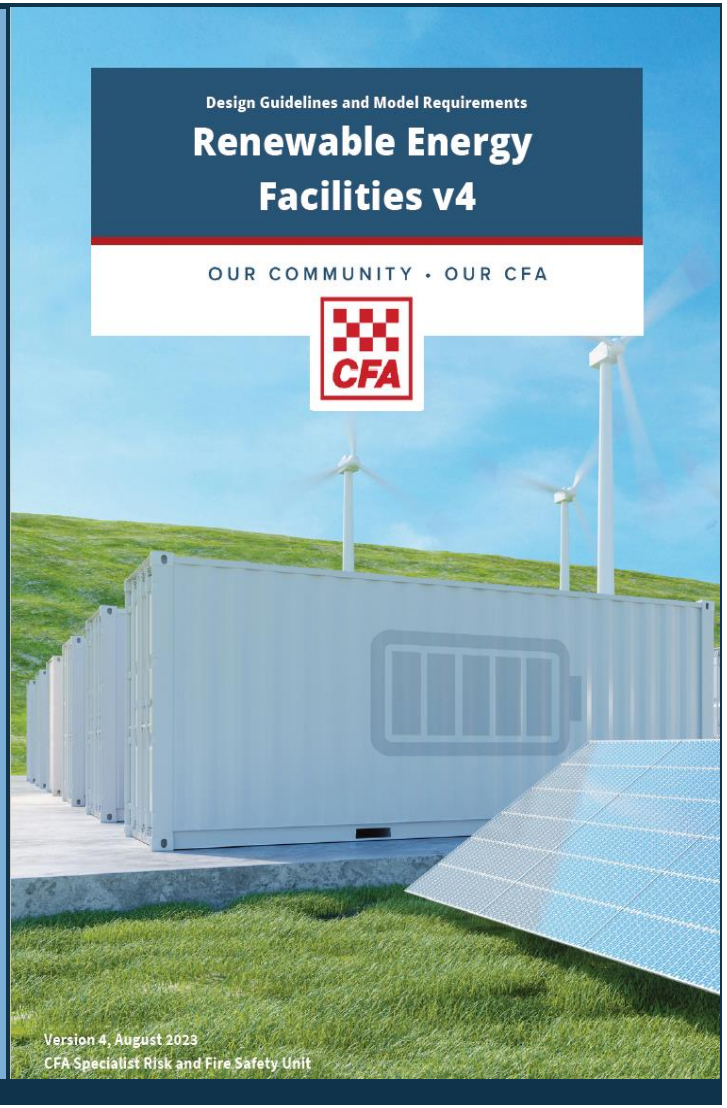
Millions of battery cells comprising a large-scale BESS

Safety improvements driven by code

Typical NFPA855 permitting submittals include:

- Community Risk Assessment (CRA/FRA)
- Hazard Mitigation Analysis (HMA)
- Design / Product listings
- UL 9540A testing
- Large scale fire testing
- Explosion control
- Commissioning plans
- Decommissioning plans
- Bushfire risk and mitigation
- Response preparation / Training



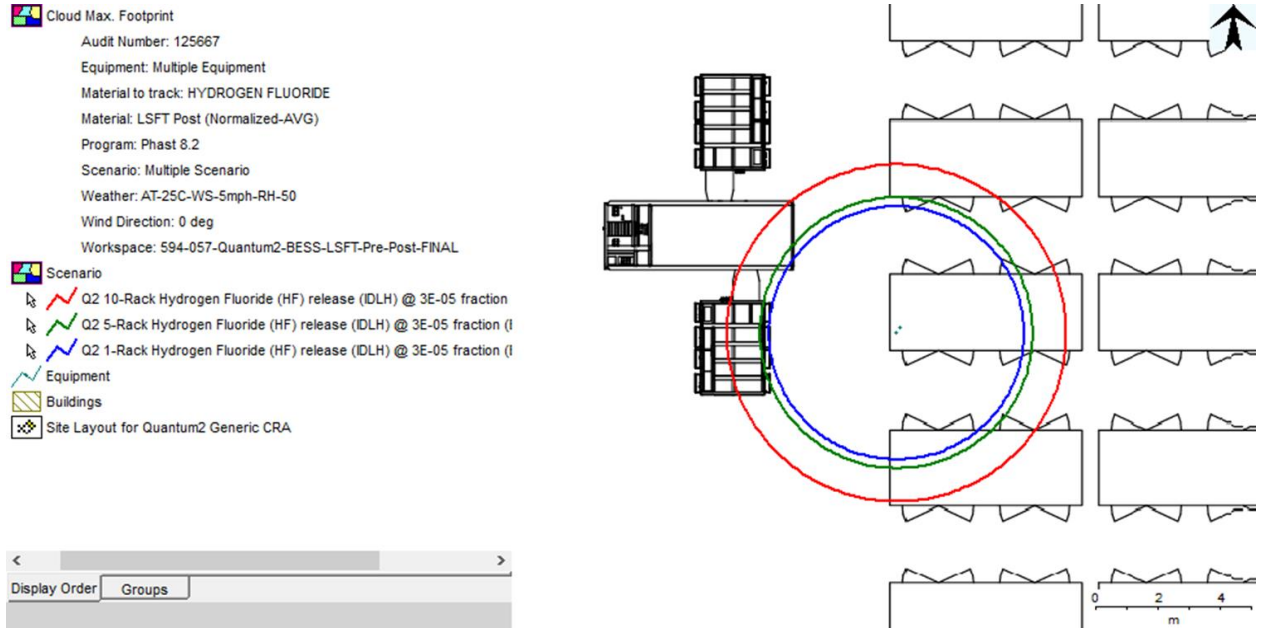


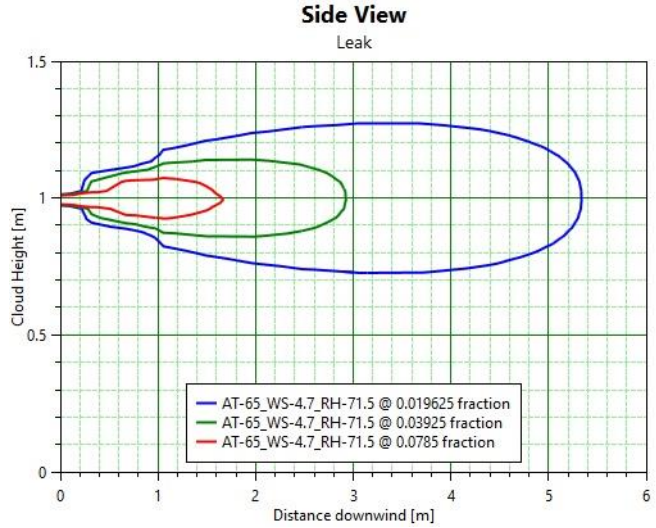
Community / Fire Risk Assessment

A Community Risk Assessment (CRA)—sometimes referred to as a Fire Risk Assessment (FRA)—may be used to support specific project sites.

The report may evaluate the potential toxic gas, flammable gas, heat, and overpressure extents, as well as any impacts to the site, the fire service, or the public.

- Smoke and toxic gas modelling
- Heat flux analysis
- Other site-specific risks





Site design guide

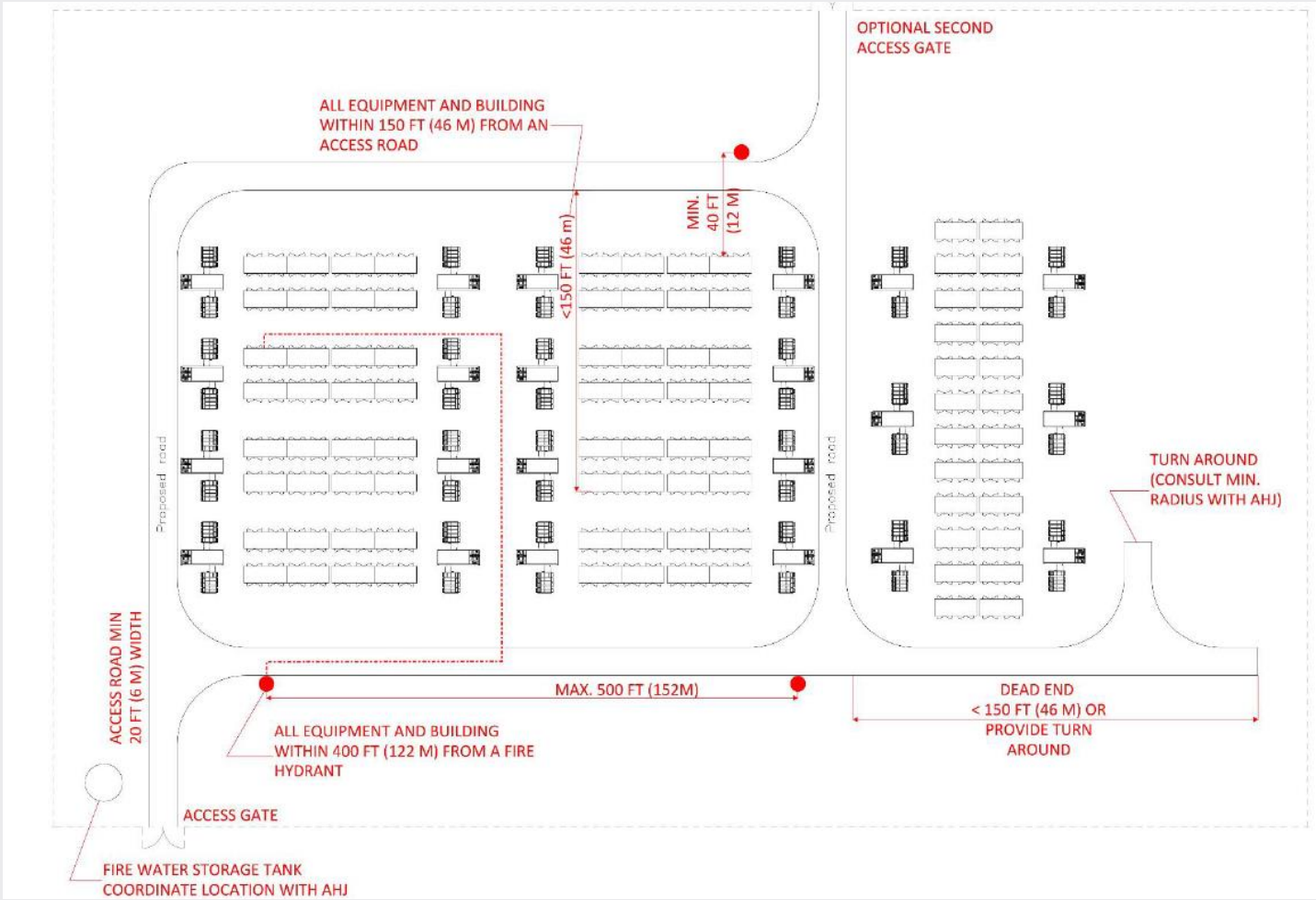
Fire codes may tell you what to do but they don’t necessarily tell you how to do it.

We have developed a site design guide to be utilised by our customers to design their sites according to the latest code requirements, industry best practices, and product offerings.

More information: bess-sdk.com

Key points:

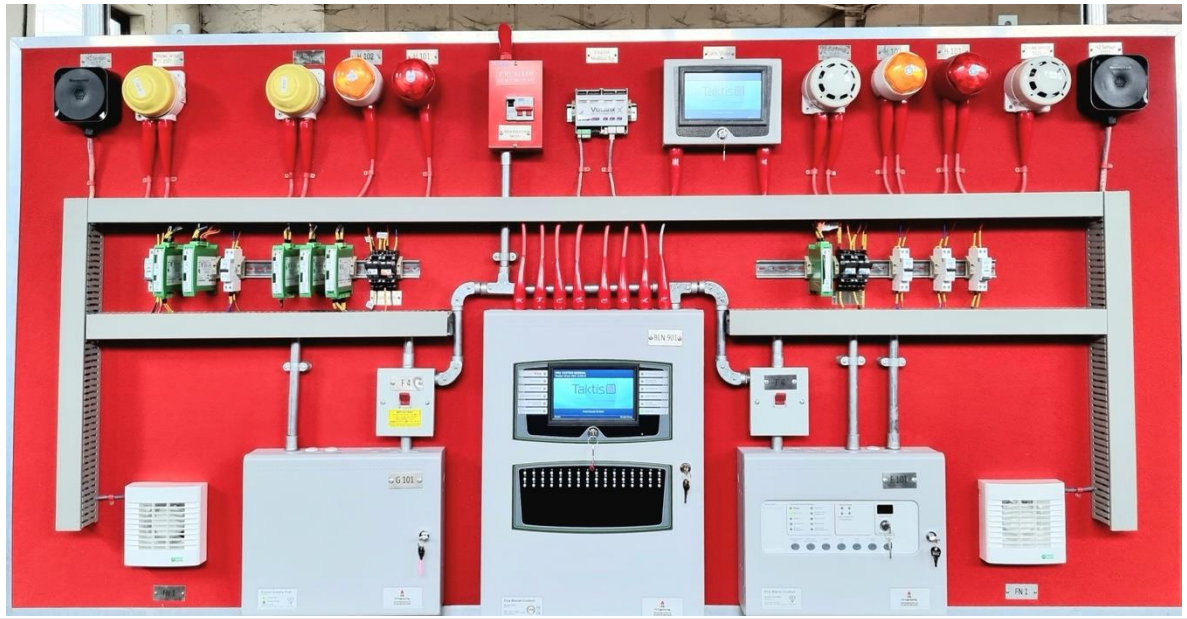
- 2 entrances that consider wind direction and staging areas
- Roads that can support fire trucks and have adequate clearances
- Aggregating fire alarm signals to fire command centers
- Water availability (hydrants/water tanks)
- Equipment clearances to oil filled equipment, switchgears, lot lines, etc.

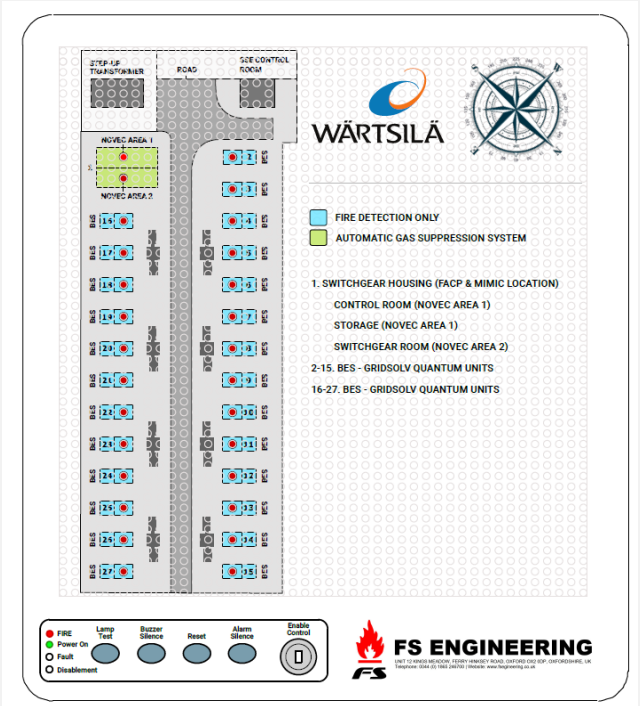


Example: Fire Protection Site Design / Fire Department Access Road Arrangement

Fire command centers and annunciation

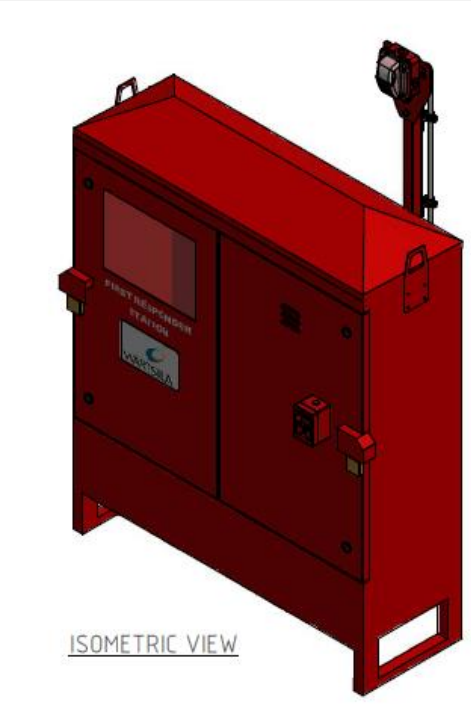
- Multiple panels shall be aggregated to a master or annunciator panel at a fire command center or other approved location
- All required annunciation means shall be located as required by the Fire Authority to facilitate an efficient response to the situation
- Alarm signals from detection systems shall be transmitted to a supervisory station





Fire command center

- Located upwind and at a safe distance from BESS
- Should include an Emergency Response Plan & site contacts



Suppression

Aerosol usage:

- Aerosol fire suppressions systems **do not offer suppression** by cooling and cannot stop a thermal runaway event once initiated
- The installation of an aerosol fire suppression system has the **potential to create a higher risk** of explosion by extinguishing a flaming fire that is consuming thermal runaway off-gas, leading to a buildup of unburned flammable gases

Water usage:

- Offensive fire suppression use **increases risks and complicates water containment** issues, including water intrusion on energised electrical components, which can cause short-circuiting and reignition hazards that may persist for several days
- The recommendation is **non-intervention**, with exposure protection as the appropriate response tactic
- Should a Fire Authority, Insurer, Developer, or Utility mandate the use of suppression, a **fixed water spray system should be installed** above the BESS enclosures

Large Scale Fire Testing (LSFT)

- There is currently no released LSFT standard, however, Wärtsilä has worked with industry leaders and fire authorities to address growing concerns
- UL 9540A results are current industry minimums but does not assess a worst-case fire scenario
- NFPA 855 2026 will require the following:
  - UL 9540A testing shall be conducted on a representative ESS
  - Large scale fire testing shall be conducted on a representative ESS
- Manufacturers should be able to demonstrate that in a reasonably worst-case scenario, **there will not be unit-to-unit or row-to-row propagation**
- Initiated with pre-mixed flame burner until self-sustaining
- Module temperatures remained below cell venting temperature and no cooling or suppression utilised

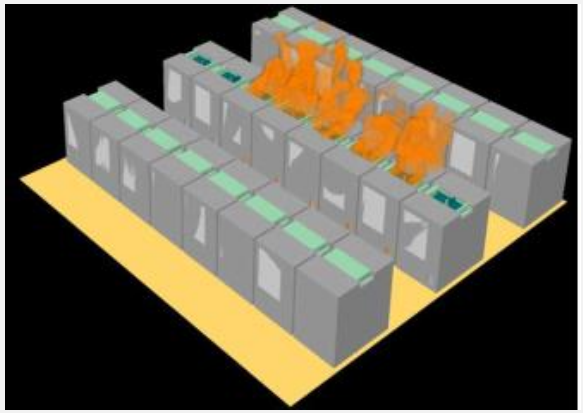
Controlled Wärtsilä LSFT test (2024)

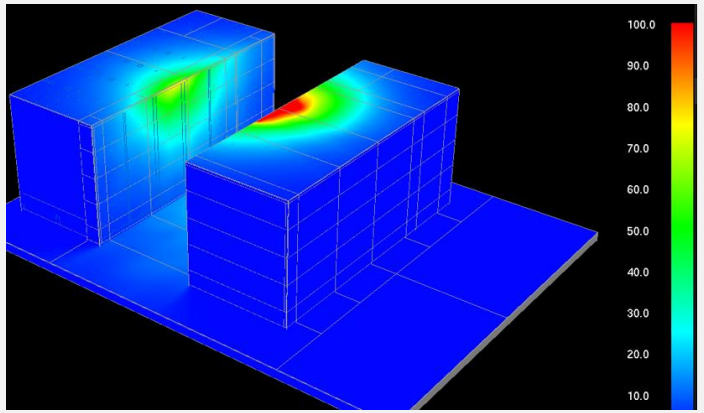
Risk informed site design, equipment separations

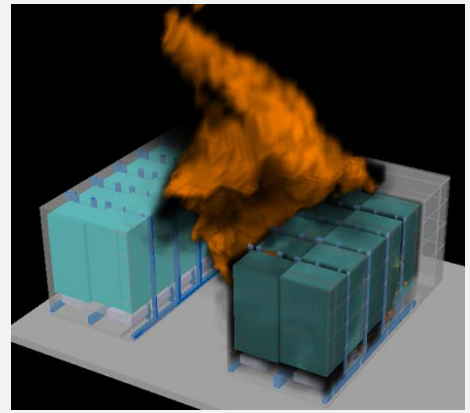
- Spacing between outdoor BESS enclosures shall comply with the following:
  - Be validated using LSFT
  - Be analysed using anticipated wind conditions for the site
  - Be reviewed by a registered design professional

- Analysis and LSFT conducted without suppression assumption

Wärtsilä Heat Flux Modeling with 80 kmh Wind Tilt (2022)







Stakeholder BESS evaluation

No two manufacturers are the same. What are some things to look out for when evaluating a BESS supplier?

- Documentation availability and evaluation by a registered design professional
- Long-term service agreements (LTSAs) throughout the lifecycle of the project
- Ensure no reliance on fire suppression for risk mitigation
- Fully tested and compliant explosion control systems
- UL 9540A results
- Large scale fire testing completed
- Utilising listed components
- Industry track record

Education: Emergency response decommissioning and training

- BESS emergency response plan and associated training shall be established, maintained, and conducted
- Emergency response plan shall, at a minimum, address the following:
  - Mitigation
  - Preparedness
  - Response
  - Recovery
- Personnel responsible for the operation, maintenance, repair, servicing, and emergency response for the BESS shall be trained in the procedures prior to its commissioning
- Refresher training shall be conducted by the ESS facility operations personnel at least annually

Education: Addressing the gaps between stakeholders

Work with manufacturers knowledgeable in fire science and safety at the product design level to address customer and Fire Authority concerns.

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

Lead the industry by example and commit to developing sites without sacrificing safety as a top priority.

Encourage early and frequent discussions with Fire Authorities.

Q&A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