

Designing Safe Energy Storage Projects

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Agenda

- 1 Energy storage fire safety
- 2 Permitting package
- 3 Site design guide
- 4 Fire alarm systems
- 5 Fire safety testing
- 6 Education



Speaker Intro: Chris Groves

- Leads Wärtsilä's product roadmap related to ESS fire and safety compliance, testing, and R&D
- Wärtsilä spokesperson on NFPA's ESRC (Energy Storage Research Consortium), supporting industry-relevant fire protection issues and identify related research needs
- Participates in NFPA 855 Technical Committee meetings and task groups including: Fire Detection & Suppression, Explosion, Barge, and HF production/Toxins
- Provides input on UL 9540 & UL 9540A technical committees



Energy Storage Fire Safety

Comprehensive design and approach to safety—de-risking the total cost of ownership throughout the project lifecycle

- Two large-scale fire tests showing no propagation from unit-to-unit
- Industry-leading **permitting package** and support
- Advanced (addressable) **fire detection** and alarm systems
- **UL 9540A** unit-level test-compliant energy storage solution
- **NFPA 69** compliant system, active ventilation for explosion protection
- Extensive R&D and **product testing** to further enhance our knowledge and improve product performance
- Prioritising **education** of customers, first responders, and communities

Wärtsilä's No.1 commitment is ensuring that our energy solutions are built with safety at the forefront.



Industry-Leading Permitting Package

Hazard Mitigation Analysis

Completed by a third-party specialty fire and risk engineering firm, compiling all our reports. GridSolv Quantum meets the Hazard Mitigation Analysis criteria as outlined in relevant local and international fire codes.

Emergency Response

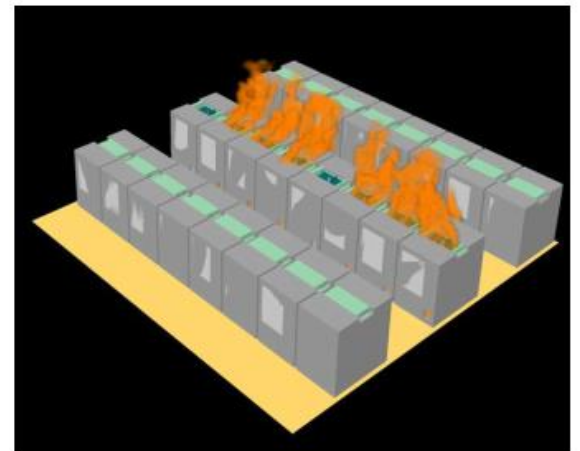
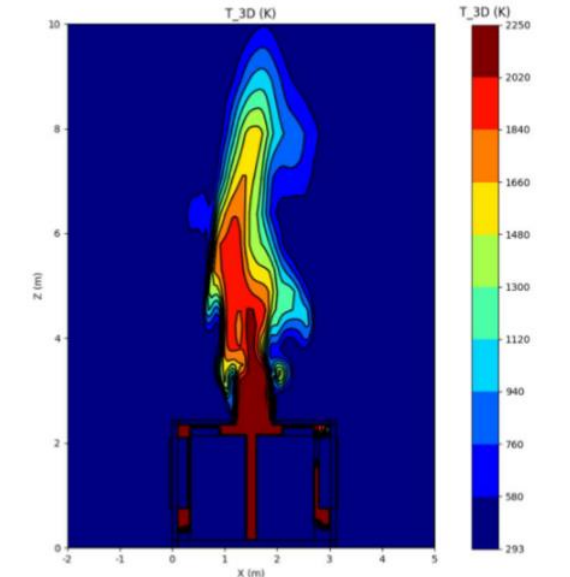
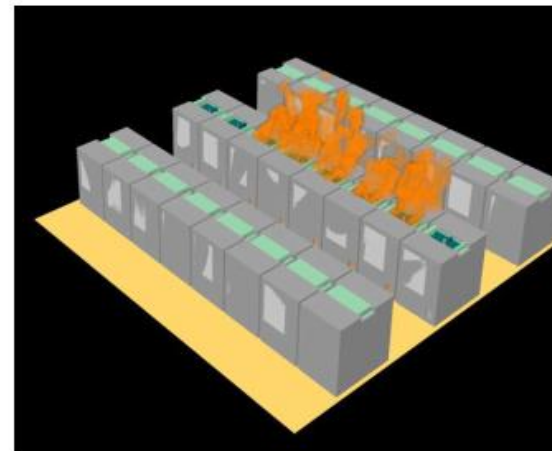
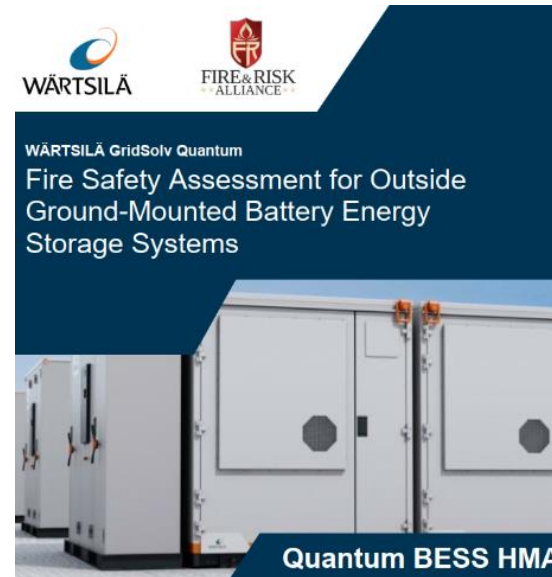
Generic template easily made site specific.

Virtual and in-person training available.

Community Risk Assessment

Smoke and toxic gas modelling.

Other site-specific risks.

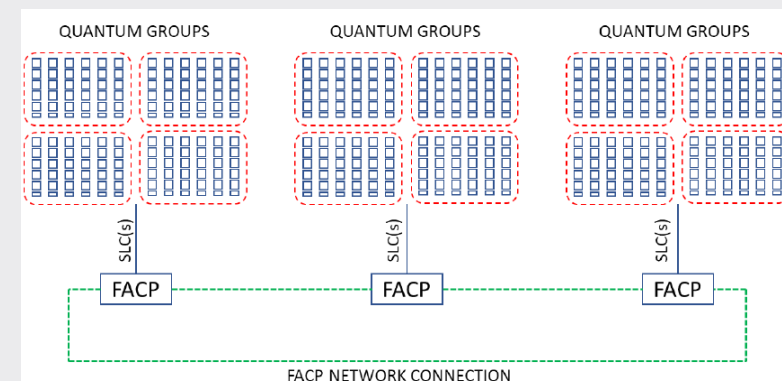
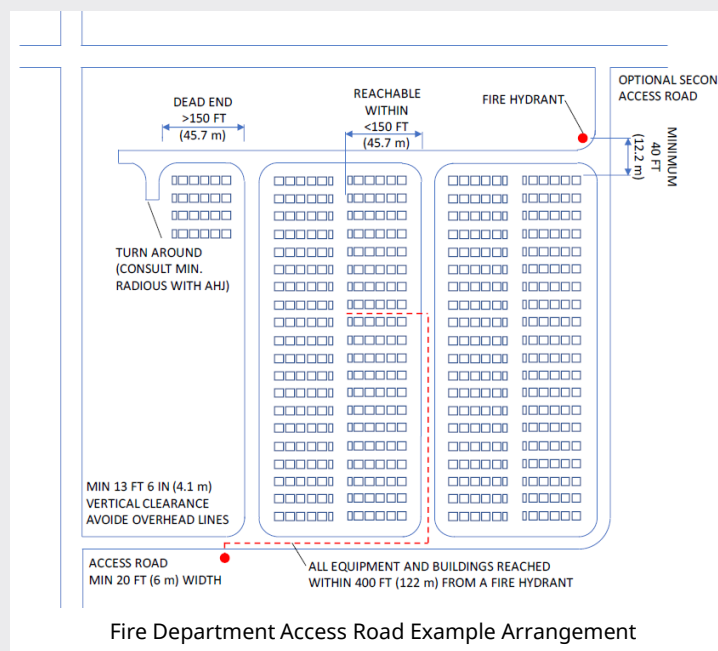
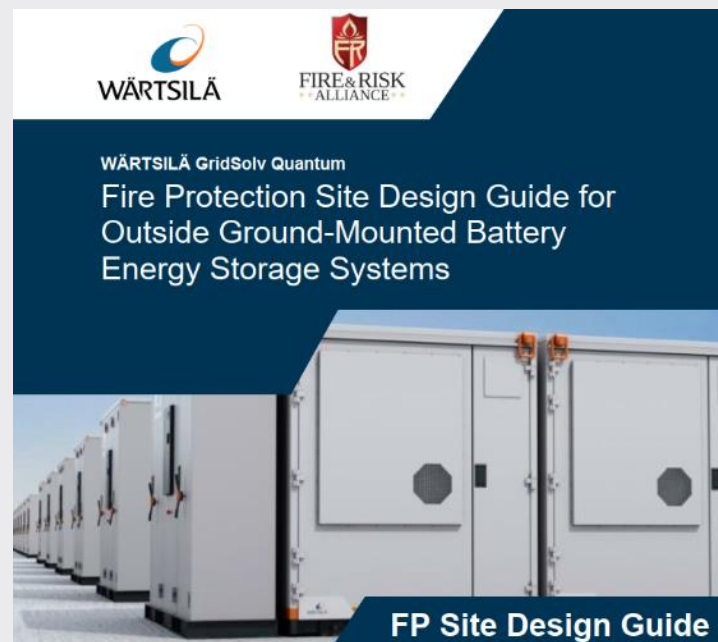


Site Design Guide

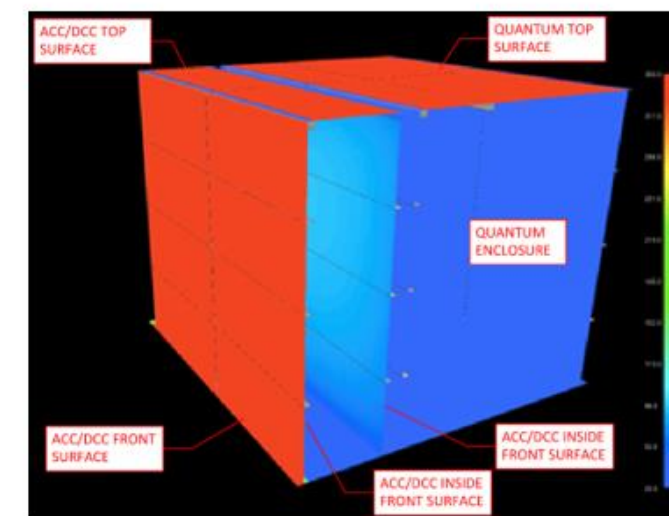
We have developed a site design guide to be utilised by developers to design their sites according to the latest code requirements, industry best practices, and product offerings.

Content:

- Fire protection site design
- Detection and alarm systems
- Fire suppressions systems
- Explosion protection systems
- Review and acceptance of fire protection systems



Multiple Networked Addressable FACP With Multiple SLC Loops



ACC/DCC and Quantum Enclosure Heat Transfer Analysis

Fire Alarm Systems

Addressable system

- Intelligent system that offers a wide range of data inputs, allowing customised notification and controls
- Allows facility managers and fire responders to pinpoint exact device/unit in alarm/trouble

Conventional system

- Information provided only about specific circuit loops (zones)
- Simple, easy to use and most economical approach
- Requires additional equipment to monitor and aggregate signals

Fire Command System

- Aggregated information from fire alarm system
- Located upwind and at a safe distance from BESS
- Should include Emergency Response Plan and Site Contacts

UL 9540A Testing

Wärtsilä has completed two series of UL 9540A testing for our Gridsolv Quantum Product

- In both tests the system has **passed** the performance criteria and thermal runaway was contained within the initiating module

- ✓ **No flaming** was observed outside the units
- ✓ Surface temperatures of modules within the target ESS units **do not exceed cell venting temperature**
- ✓ Surface temperatures on target walls **do not exceed 97°C above ambient**
- ✓ **No explosion hazards** observed including deflagration, detonations, or accumulation of battery vent gases
- ✓ Heat flux in the center of the means of **egress did not exceed 1.3 kW/m²**



Controlled Wärtsilä burn tests

Large-Scale “Bespoke” Tests

Now UL 9540A results are industry leading, but what happens in a worst-case scenario like a lightning strike or multi-cell thermal incident?

- Wärtsilä undertook two large-scale tests on our Gridsolv Quantum platform to get those answers
- In both tests we utilised a central cube as the initiator and a cube on either side representative of a site installation
- Utilising a pre-mixed burner, we ignited the battery modules until we had a sustaining fire

The data collected during the tests has been instrumental in:

- Permitting discussions
- Validating our unit-to-unit and row-to-row spacing is safe
- Creating accurate emergency response plans and fire fighter training

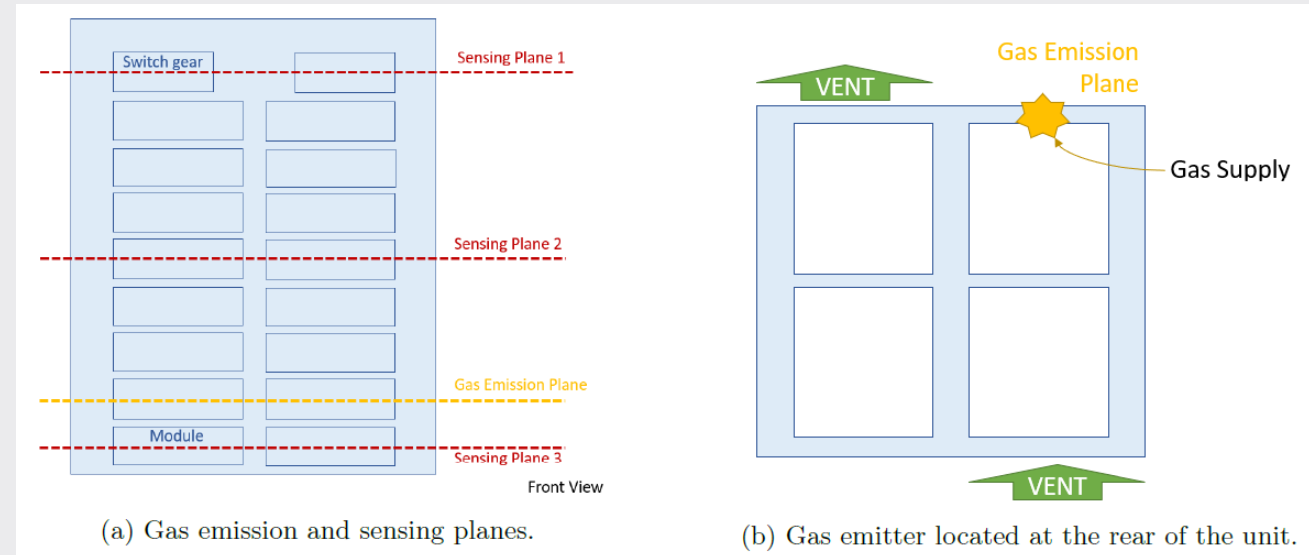


Controlled Wärtsilä burn tests

Large-Scale NFPA 69 Testing

- Extensive modelling to show that under a wide range of release conditions, GridSolv Quantum **meets the requirements** of **NFPA 855 & NFPA 69**
 - This included release in different locations, magnitudes, durations, and sensor locations
- This modelling was backed up by **two series of real-world tests**
 - Examined a variety of gas sensors and about a dozen fans to evaluate performance.
- The testing involved using both syn gas and a custom blend designed to replicate thermal runaway gases

We were able to ID which actual components worked the best and confirmed that the **fans chosen meet code requirements**. This allows us to provide a complete, robust package to the AHJs.



Gas supply plan

Education: Addressing the Gaps Between Manufacturers and Code Compliance



Wärtsilä ES&O is at the forefront of collaborating with stakeholders knowledgeable in fire science and safety at the product design level to address customer and AHJ concerns.



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



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



We encourage early and frequent discussions with AHJs.



We discuss with our customers on the importance of conducting a Hazard Mitigation Analysis (HMA), including a Fire Risk Assessment (FRA) and an Emergency Response Plan (ERP).



We are leading the industry by example and is committed to remaining at the cutting edge of product development, without sacrificing safety as a top priority.



Q&A



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