Appendix J

Fire & Safety Documentation

U.S. Codes and Standards for Battery Energy Storage Systems

U.S. Codes and Standards for Battery Energy Storage Systems

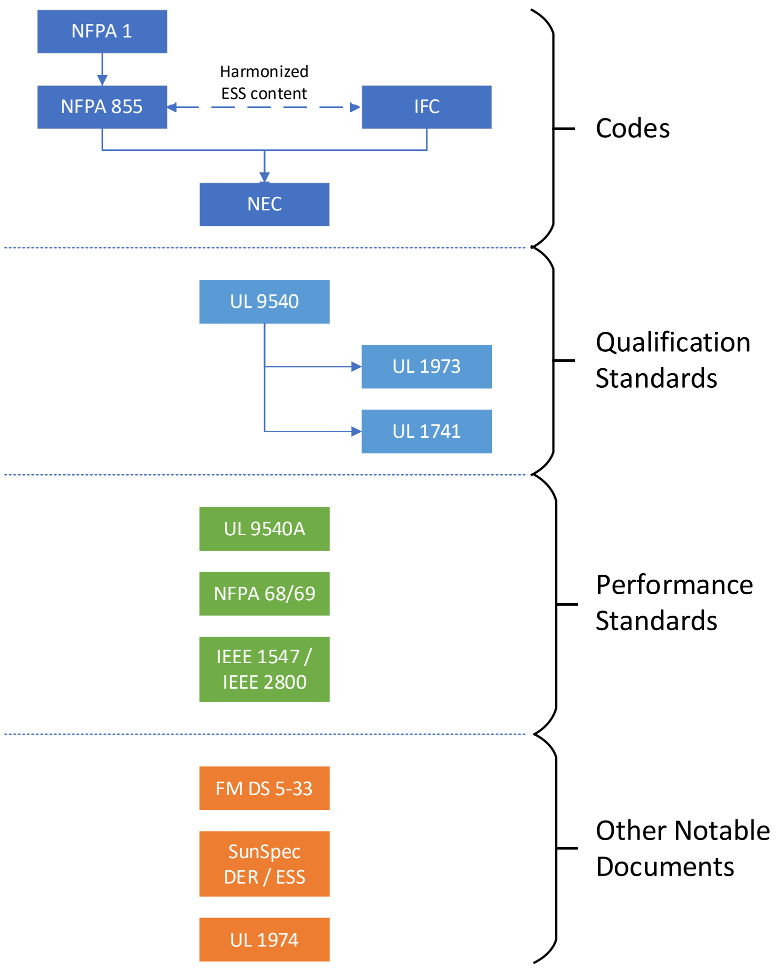
Introduction

This document provides an overview of current codes and standards (C+S) applicable to U.S. installations of utility-scale battery energy storage systems. This overview highlights the most impactful documents and is not intended to be exhaustive. Many of these C+S mandate compliance with other standards not listed here, so the reader is cautioned not to use this document as a guideline for product compliance.

This guide provides a graphic to show the hierarchy and groupings of these C+S, followed by short descriptions of each. Annex 1 summarizes some significant changes in the 2023 edition of one of the most important standards, NFPA 855, and Annex 2 provides a more detailed bibliography of the featured documents.

Graphic Overview

The following figure covers the main C+S and groups them by their applicability.



Codes

A variety of nationally and internationally recognized model codes apply to energy storage systems. The main fire and electrical codes are developed by the International Code Council (ICC) and the National Fire Protection Association (NFPA), which work in conjunction with expert organizations to develop standards and regulations through consensus processes approved by the American National Standards Institute. For these model codes to be enforceable, they must be adopted, in whole or in part, by states or local jurisdictions. This process generally results in a lag in adoption.

Below are the most relevant codes that apply to stationary energy storage systems:

NFPA 1 Fire Code[B7]. Covers the hazards of fire and explosion, life safety and property protection, and safety of firefighters. Chapter 52 provides high-level requirements for energy storage, mandating compliance with NFPA 855 for detailed requirements, effectively elevating the latter to the status of a code.

NFPA 70 National Electrical Code (NEC) [B10]. Covers practical safeguarding of persons and property from hazards arising from the use of electricity. Since 2017, Article 706 has provided specific requirements for Energy Storage Systems, applying to all ESS over 1 kWh.

NFPA 855 Standard for the Installation of Stationary Energy Storage Systems [B11]. Provides minimum requirements for mitigating the hazards associated with energy storage systems. NFPA 855 requirements apply to the design, construction, installation, commissioning, operation, maintenance, and decommissioning of energy storage systems.

International Fire Code (IFC) [B6]. With a similar scope to NFPA 1, the IFC includes ESS-related content in Section 1207 that is largely harmonized with NFPA 855.

Qualification Standards

The relevant codes for energy storage systems require systems to comply with and be listed to **UL 9540** [B19], which presents a safety standard for energy storage systems and equipment intended for connection to a local utility grid or standalone application. This document applies to the complete system and in turn requires that the major components be qualified to their own standards, the most important of which are **UL 1741** [B15] for the power conversion system and **UL 1973** [B16] for the battery. Energy storage management systems and battery management systems (BMS) are also subject to qualification, and the main applicable standards are **UL 991** [B14] and **UL 1998** [B18].

Performance Standards

Arguably the most important performance standard is **UL 9540A** [B20], covering large-scale fire and propagation testing. This test method (there are no pass/fail criteria) involves the sequential testing at the cell, module, unit (typically, a representative battery rack), and installation levels. There are 'off-ramps' that allow higher-level tests to be avoided based on lower-level test results. For example, all lithium-ion systems are subject to cell-, module-, and unit-level tests, but the installation-level test does not need to be performed if certain performance criteria are met at unit level. For example, for ESS used in large outdoor installations, the unit-level criteria are:

- No flaming beyond intended separation from exposures or excessive temperature rise at wall surfaces
- Module surface temperatures in adjacent units remain below the level at which cell venting occurs

- No explosion hazard
- Acceptable level of heating in the accessible means of egress

UL 9540A testing is required if: group (unit) energy exceeds 50 kWh; separation between groups is less than 3 ft (0.9 m); or stored energy exceeds the maximum value in Table 9.4.1 of NFPA 855 (600 kWh for lithium-ion). These deviations from the standard are subject to approval by the authority having jurisdiction (AHJ).

Section 9.6.5.6.3 of NFPA 855 requires design provisions for either explosion prevention in compliance with **NFPA 69** [B9] or explosion management according to **NFPA 68** [B8]. NFPA 69 compliance requires that the concentration of flammable gas generated from battery failure be maintained below 25% of the lower flammable limit (LFL), typically via system ventilation. NFPA 68 compliance requires a potential deflagration of battery gases to be managed via explosion venting panels or specially engineered system doors to maintain potential overpressures at safe levels. While NFPA 855 requires compliance with either NFPA 68 *or* NFPA 69, these standards are not mutually exclusive and battery systems may be designed to meet both standards.

Interconnection standards have been published by IEEE, with **IEEE Std 2800** [B5] applying to ESS connected at transmission and sub-transmission levels, and **IEEE Std 1547** [B3] for distributed energy resources (DER). IEEE recently published a new guide, **IEEE Std 1547.9** [B4] for using IEEE Std 1547 with energy storage DER.

Other Notable Documents

FM Global published its **Data Sheet 5-33** [B2] on lithium-ion ESS in 2017. There appear to have been relatively minor revisions in 2020 and none more recently. Unlike NFPA 855, the document includes minimum spacing and separation distances for BESS (or installation of structural fire barriers) that are prescriptive, rather than performance based.

The SunSpec Alliance has established information models to assist in the integration of energy storage and other DER. The **SunSpec DER model** [B12] standardizes DER communication with utility SCADA (Supervisory Control and Data Acquisition) protocol IEEE Std 1815 (DNP3) for compatibility with IEEE Std 1547. The **SunSpec Energy Storage models** [B13] are based on Modbus protocol and are important for ease of ESS integration. Models for lithium-ion systems are complete, while those for other technologies are still under development. Another group working with SunSpec is the Modular Energy System Architecture (MESA) Standards Alliance.

For companies interested in second-life EV batteries in ESS applications, **UL 1974** [B17] covers the *process* of sorting and grading battery packs for repurposing, but not their *qualification*. The document does not cover the process for remanufacturing/refurbishing/rebuilding batteries, where repair or replacement of parts may be needed. Section 9.2.4.2 of NFPA 855 mandates that repurposing be carried out by a UL 1974-compliant company. Also, section 4.6.5 requires that reused equipment, such as second-life batteries, be 'reconditioned, tested, and placed in good and proper working condition and approved.' Approval would involve listing systems to UL 9540, which necessarily includes qualification of the battery to UL 1973. Since each integrator of such systems would most likely replace the vehicle BMS with one more suitable for ESS and would probably have to perform UL 9540A testing up to at least unit level, achieving the necessary codes and standards compliance could represent a significant financial burden.

Annex 1 – Significant Changes in the 2023 Revision of NFPA 855

This commentary is not intended to cover all changes in the 2023 revision of NFPA 855 but to highlight some changes that are likely to impact ESS designs and interactions between developers, integrators, and AHJs.

> **Important note**: While the 2023 document cannot generally be applied retroactively to existing installations, it allows an AHJ to request a hazard mitigation analysis for existing installations that are not UL 9540 listed, and to retroactively apply any portions of the new standard 'deemed appropriate to mitigate any hazards' identified as unacceptable. (See 1.4.2, 4.4.1, A.1.4.2)

- Details on firewalls, fire suppression, smoke or fire detection, gas detection, thermal management, ventilation, exhaust, and deflagration venting systems, if provided, are to be submitted to the AHJ for approval (see 4.2.1.1).
- Fire and explosion testing data are to be provided where required (see 4.2.1.3).
- There is a catch-all provision that empowers an AHJ to request a Hazard Mitigation Analysis 'to address a potential hazard … that is not addressed by existing requirements' (see 4.4.1).
- The device that manages charging and discharging within safe limits during normal operation (normally the BMS but could be the Energy Storage Management System) must be evaluated as part of the listing of the ESS (see 9.6.5.5. A.9.6.5.5)
- Chapter 14 previously covered storage areas for 'used or off-specification' batteries, and now covers 'lithium metal or lithium-ion' units, whether new or used. Areas are exempt if cells are <30% SOC. There may also be an exemption for areas with factory-assembled enclosures, although the text is unclear: 'Areas where new or refurbished batteries are installed for use in the devices, equipment, or vehicles they are designed to power.'

Annex 2 – Bibliography

The following documents are discussed in this overview. The date listed is the latest at the time of publication, but all are subject to periodic revision.

[B1] CSA C22.2 No. 340, Battery Management Systems (Draft), expected in 2023

[B2] FM Global Property Loss Prevention Data Sheet 5-33, Electrical Energy Storage Systems, January 2017, Interim Revision July 2020

[B3] IEEE Std 1547-2018, IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces

[B4] IEEE Std 1547.9-2022, IEEE Guide for Using IEEE Std 1547 for Interconnection of Energy Storage Distributed Energy Resources with Electric Power Systems

[B5] IEEE Std 2800-2022, IEEE Standard for Interconnection and Interoperability of Inverter-Based Resources (IBRs) Interconnecting with Associated Transmission Electric Power Systems

[B6] International Fire Code (IFC), 2021, International Code Council, Inc.

[B7] NFPA 1, Fire Code, 2021

[B8] NFPA 68, Standard on Explosion Protection by Deflagration Venting, 2018

[B9] NFPA 69, Standard on Explosion Prevention Systems, 2019

[B10] NFPA 70, National Electrical Code, 2023

[B11] NFPA 855, Standard for the Installation of Stationary Energy Storage Systems, 2023

[B12] SunSpec DER Information Model Specification 1.0, SunSpec Alliance, 2021

[B13] SunSpec Energy Storage Models, Draft 4, SunSpec Alliance, 2016

[B14] UL 991 Ed. 3, Standard for Tests for Safety-Related Controls Employing Solid-State Devices, 2004

[B15] UL 1741 Ed. 3, Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources, 2021

[B16] UL 1973 Ed. 3, ANSI/CAN/UL Batteries for Use in Stationary and Motive Auxiliary Power Applications, 2022

[B17] UL 1974 Ed. 1, ANSI/CAN/UL Standard for Evaluation for Repurposing Batteries, 2018

[B18] UL 1998 Ed. 3, Software in Programmable Components, 2013

[B19] UL 9540 Ed. 2, Energy Storage Systems and Equipment, 2020

[B20] UL 9540A Ed. 4, ANSI/CAN/UL Standard for Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems, 2019

Energy Storage & Safety

Energy Storage & Safety

Safety is a Critical Aspect of the Entire Electrical System, from Power Lines to Your Outlets

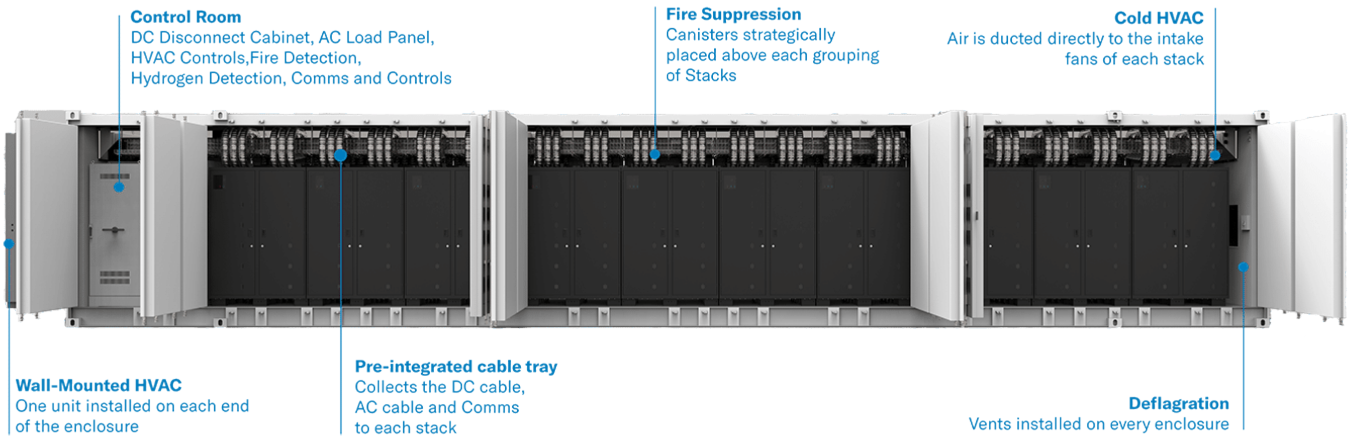
Safety is fundamental to all parts of our electric system, including energy storage. Each component of the electric system presents risks—from transformers and gas lines to power plants and transmission lines—and their safe operation is critical to provide the electricity that keeps our lights on, our refrigerators running, our homes air conditioned and heated, and our businesses operating. Energy storage is no different: with use of best practices and the proper design and operations, these facilities can mitigate risks and maintain safety while supporting reliable, clean electric service.

Battery Energy Storage Uses Technologies We Rely on Each Day

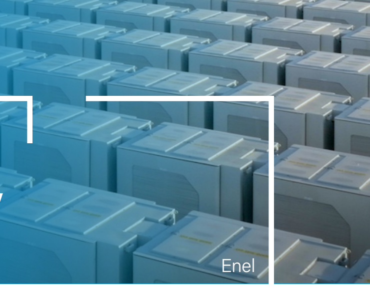
Batteries are present in every part of our lives, from mobile phones to laptops to electric vehicles – even toothbrushes and lawn mowers. Energy storage projects that power the electric grid, homes, and businesses utilize the same core technology as the battery that powers the phone in your pocket, just at a larger scale.

Energy Storage Systems are Regulated & Held to National Safety Standards

Because we rely on batteries in so many ways, the technologies have some of the most well-established safety features. On top of that, all energy storage projects must meet rigorous codes and standards to be permitted to operate – just like any other part of the electric system. Every battery technology that is installed on the electrical grid comes from a certified source. Every energy storage project integrated into our electrical grid is required to comply with national fire protection standards that are frequently updated to incorporate the best practices for hazard mitigation tools and strategies. State and local governments ensure energy storage facilities are installed and operated in compliance with their current standards.



Best Practices For Energy Storage Safety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Energy Storage Projects Use Numerous Strategies to Maintain Safety

Energy storage facilities use established safety equipment and strategies to ensure that risks associated with the installation and operation of the battery systems are appropriately mitigated. At every stage, from manufacturing to installation to operation, battery technologies and storage facilities use a variety of strategies to keep them safe. These strategies can include:

- **Pre-Installation Standards and Testing:** All modern batteries are designed and manufactured to adhere to and pass standard safety tests prior to operation. These safety standards and performance tests help to ensure that the technologies deployed in energy storage facilities uniformly comply with the highest global safety standards.
- **Proper Temperature Management:** All energy storage projects have thermal management systems, such as fans, ventilation, and heating and cooling equipment to maintain safe operating temperatures for the batteries.
- **Sensors that Regulate Temperature:** All projects are equipped with sensors that track battery temperatures and enable storage facilities to turn off batteries if they get too hot or too cold. A Battery Management System manages the charging and discharging of batteries similar to the system in your phone or computer.
- **Safety Equipment:** Energy storage facilities include equipment and systems designed to detect and suppress fires, to vent gasses, and incorporate fire-proof barriers. This safety equipment includes well-established tools deployed at all types of facilities across our electrical system.


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- **System & Component Certification:** The Occupational Safety and Health Administration's (OSHA) Nationally Recognized Testing Laboratories (NRTL) provide screening, testing, and evaluation for battery energy storage technologies and components. Many energy storage technologies are also contained within certified enclosures designed to safely house them.
- **24/7 Monitoring by Trained Personnel:** Energy storage facilities are monitored 24/7 by trained personnel prepared to maintain safety and respond to emergency events.
- **Emergency Response Plans:** All energy storage operators develop and maintain emergency response plans to ensure that, if there were an event, it is handled safely and according to best practices. Energy storage developers work with local fire departments and first responders for training and to share information about risks, response plans, and safety measures.

Relying on these measures, energy storage facilities are operated with a safety record consistent with the other technologies we rely on every day for electric service.

Battery Energy Storage Safety
Frequently Asked Questions (FAQs)

Battery Energy Storage Safety

Frequently Asked Questions (FAQs)

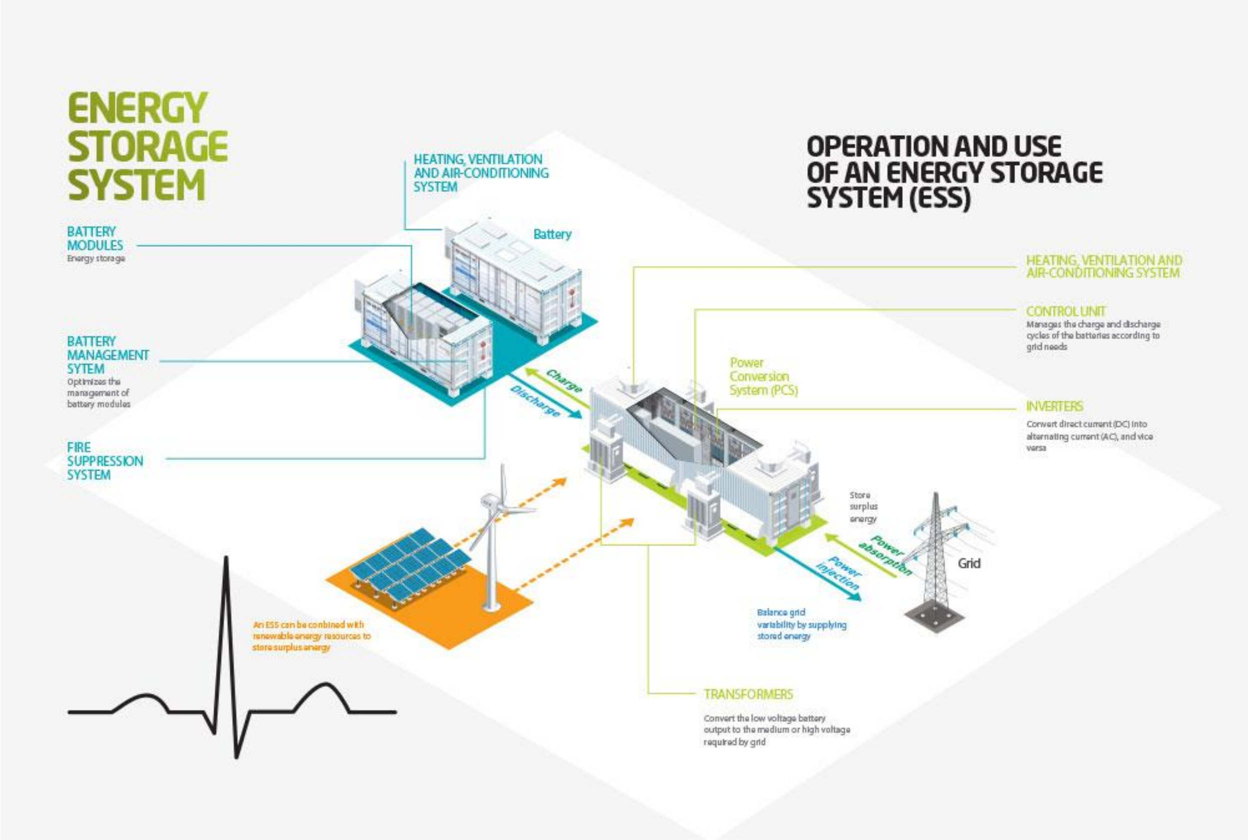
Why do we need batteries to support the electricity grid?

Energy storage fundamentally improves the way we generate, deliver, and consume electricity. Battery energy storage systems can perform, among others, the following functions:

1. **Provide the flexibility needed** to increase the level of variable solar and wind energy that can be accommodated on the grid.
2. **Help provide back-up power during emergencies** like blackouts from storms, equipment failures, or accidents.
3. **Lower costs** by storing energy when the price of electricity is low and discharging that energy back onto the grid during peak demand.
4. **Balance power supply and demand instantaneously**, which makes the electrical grid more reliable, resilient, efficient, and cleaner than ever before.

How are batteries arranged in an energy storage system?

Battery energy storage systems vary in size from residential units of a few kilowatt-hours to utility-scale systems of hundreds of megawatt-hours, but they all share a similar architecture. These systems begin with individual battery cells, which are electrically connected and then packaged in a battery module. Battery modules are aggregated with controls and other equipment and housed within racks, which in turn are built into an enclosure, such as a cabinet or ISO shipping container, or a building. One or more of these enclosures or buildings, along with necessary electrical equipment, comprise the battery energy storage facility that discharges to or charges from the electrical grid.



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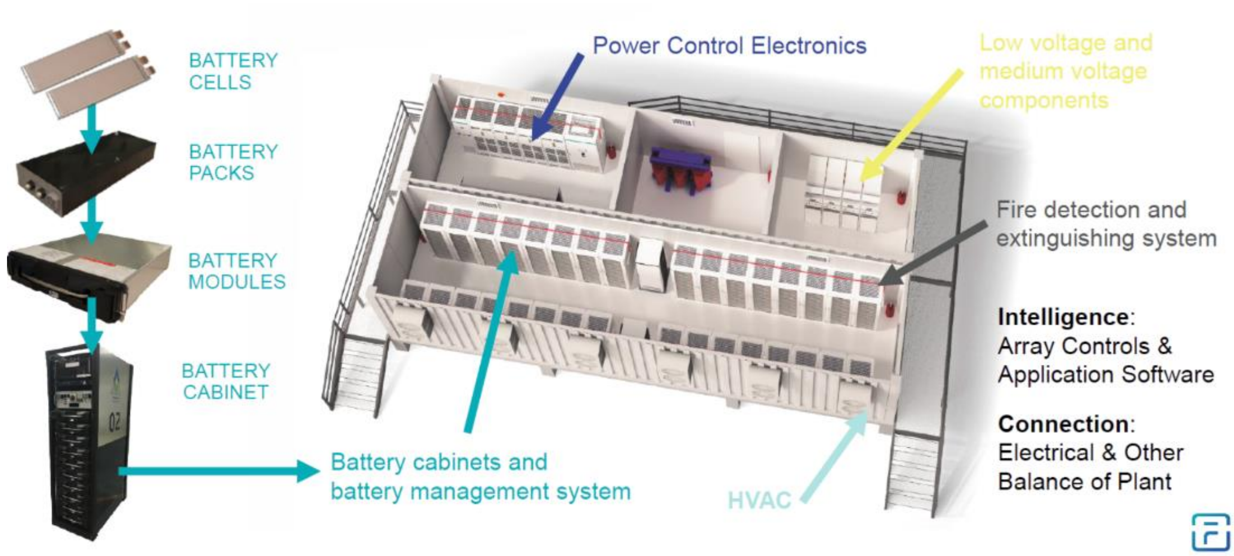


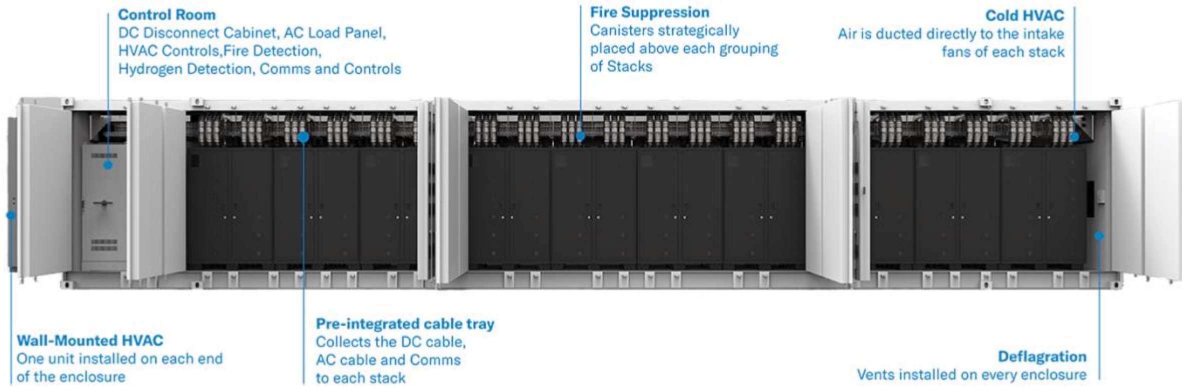
Image Source: Fluence

How are batteries connected to the electrical grid different from batteries in laptops and mobile devices?

Battery energy storage systems operate by converting electricity from the grid or a power generation source (such as from solar or wind) into stored chemical energy. When the chemical energy is discharged, it is converted back into electrical energy. This is the same process used with phones, laptops, and other electronic devices. However, while batteries in consumer electronics have a single function, those connected to the electrical grid -- which are much larger -- serve more complex functions. For instance, electrical grid batteries must be combined with power conversion devices to produce AC (alternating current) power. Batteries connected to the electrical grid can also have a different composition than those found in consumer electronics.

What is the risk of fire or explosion associated with battery storage systems?

Safety events that result in fires or explosions are rare. Explosions constitute a greater risk to personnel, so the US energy storage industry has prioritized the deployment of safety measures such as emergency ventilation to reduce the buildup of flammable gases. Such ventilation can reduce the effectiveness of fire suppression, so an increasing number of manufacturers have adopted a strategy of allowing fires in individual battery enclosures to burn out in a controlled manner, while also preventing the propagation of fire between enclosures. The rationale is that fire consumes any flammable gases as they are produced, thus preventing explosions. Additionally, allowing the battery to burn avoids problems with stranded energy and reignition, both of which have been issues with electric vehicle fires. The monitoring systems of energy storage containers include gas detection and monitoring to indicate potential risks. As the energy storage industry reduces risk and continues to enhance safety, industry members are working with first responders to ensure that fire safety training includes protocols that avoid explosion risk.



Do energy storage systems pose a risk to first responders?

Battery energy storage system operators develop robust emergency response plans based on a standard template of national best practices that are customized for each facility. These best practices include extensive collaboration with first responders and address emergency situations that might be encountered at an energy storage site, including extreme weather, fires, security incidents and more. They also address emergency response roles and highlight the importance of coordinating with first responders—particularly during planning—to ensure there is a complete and detailed shared understanding of potential emergencies and the proper safety responses. Emergency response plans also include contact details for subject-matter experts who can advise first responders on appropriate actions for each situation.

To learn more, read ACP's Energy Storage Emergency Response Plan Template.

Do battery energy storage systems pose a risk to the broader community?

In the rare case where fires do occur, they may be managed without endangering broader communities. A study for the New York State Energy Research & Development Authority states that, while battery fires emit toxic fumes, the average level of toxicity is similar to that of plastics fires involving materials such as sofas, mattresses, or office furniture. Depending on the size of the facility, authorities may close nearby roads and issue shelter-in-place advisories to local residents. The diverse system components that comprise the energy storage facility have chemical and fire smoke data that can be utilized to determine the risks for each facility. The code-required Hazard Mitigation Analysis will summarize how risks beyond the site boundary will be prevented.

A September 2022 fire in California presents a case study where a thermal event was resolved with minimal effect to the local community. Fire broke out in one battery enclosure (out of 256). The fire did not spread to adjacent units, and firefighters had been trained to allow the fire to burn while protecting nearby exposures. After some hours, shifting winds caused a nearby highway to be closed and residents were advised to shelter in place with their windows closed. The fire burned itself out in five hours, leaving no possibility of reignition. Approximately 18 hours after the fire broke out, the highway was reopened and the advisory lifted when air-quality sampling around the facility showed no detectable traces of airborne contaminants.

Are these batteries built to withstand extreme weather events?

Battery energy storage systems are currently deployed and operational in all environments and settings across the United States, from the freezing temperatures of Alaska to the deserts of Arizona. These systems are designed with associated heating and cooling systems to ensure optimal battery operations and life based on the environmental conditions at the installation location. Not only are battery energy storage facilities built to withstand disruptive weather events, but they can also help increase resiliency to extreme weather events, prevent power outages, and provide back-up power.

Do batteries leak or emit pollution?

In normal operation, energy storage facilities do not release pollutants to the air or waterways. Like all energy technologies, batteries can present chemistry-specific hazards under fault conditions. Batteries with free-flowing electrolytes could leak or spill chemicals, so these systems are normally equipped with spill containment. Batteries with aqueous electrolytes may emit small quantities of hydrogen gas in normal operation and larger amounts under fault conditions, but these emissions are handled by ventilation systems and are not considered polluting. As discussed previously, all batteries release toxic substances in a fire, and if water is used for firefighting, it can create contaminated runoff – another reason for manufacturers' recommendations to allow fires to burn themselves out.

Do batteries give off electromagnetic radiation?

Like batteries used in handheld devices, lithium-ion and other types of batteries do not give off electromagnetic radiation. These batteries store electrical energy in chemical form, which can be converted back into electrical energy and discharged back to the grid. This conversion is performed by a bidirectional inverter, which must be tested and certified for electromagnetic compatibility.

Do batteries produce noise?

Batteries alone do not make any noise. Unlike other power infrastructure or generation facilities, energy storage systems have very low noise profiles, with fans, HVAC systems, and transformers producing sounds at similar levels to standard commercial buildings.

What do grid batteries look like? Is there light pollution?

Battery energy storage systems may or may not be visible from a facility's property line. Grid batteries can be housed in a variety of enclosures or buildings, none of which are taller than a house. Energy storage facilities are often unmanned and do not need light to function. Some may have lighting for security purposes, and this would be consistent with normal streetlighting.

Figure 1. Battery storage systems come in a variety of sizes

Source: Clean Energy Group

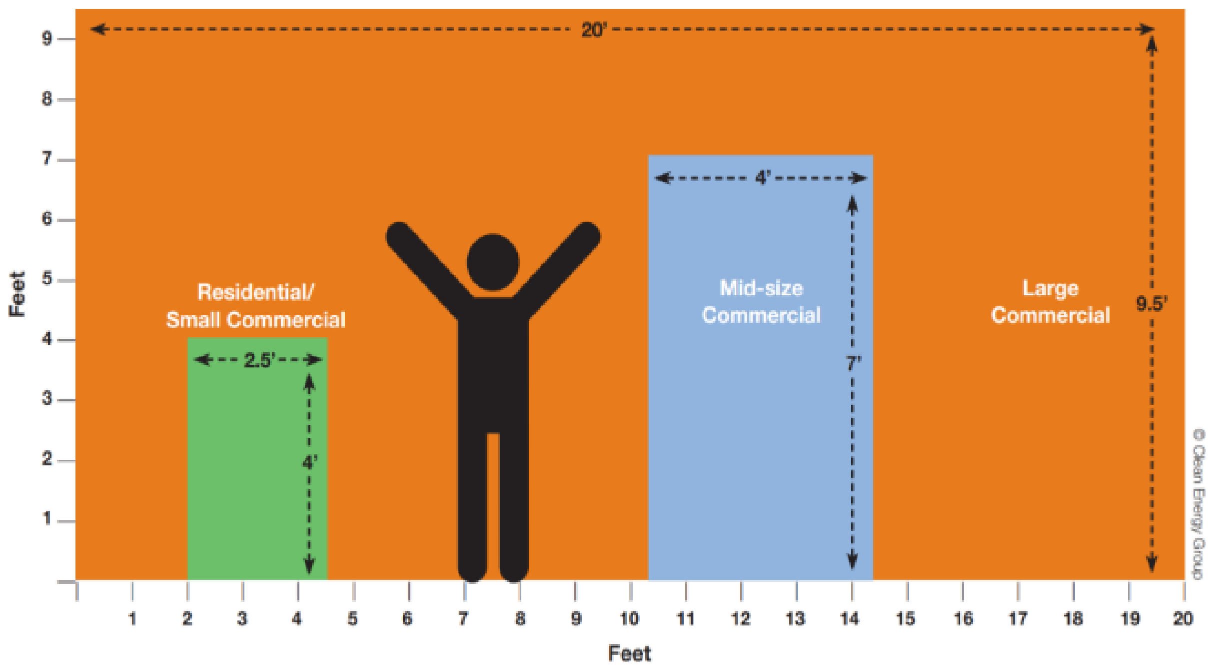


Image Source: AES

How long will grid batteries last?

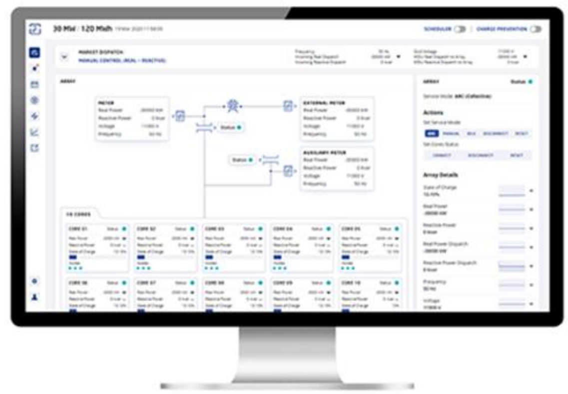
Grid battery life depends on usage and can last for 20 years or more. One of the earliest deployed grid-scale battery energy storage systems, put into operation in Alaska by the Golden Valley Electric Association, has been in continuous operation since 2003. Batteries will degrade based on numerous factors such as chemical composition, number of charge and discharge cycles, and the temperature of the environment that the batteries are exposed to.

What happens to the batteries when they reach the end of their lifetime?

The U.S. lithium-ion battery recycling industry is growing rapidly to accommodate batteries from both electric vehicles and energy storage systems. Companies are moving beyond simple recovery of raw materials and into direct recycling of electrode materials that can be built sustainably and cost-effectively into new batteries. Indeed, energy storage applications provide the opportunity to repurpose batteries from end-of-life electric vehicles, extracting maximum usage from these units for the benefit of consumers.

How are batteries monitored?

Battery energy storage systems are equipped with sensors that track battery temperatures and enable storage facilities to turn off batteries if they get too hot or too cold. Battery management systems also monitor the performance of each individual cell voltage and other key parameters then aggregate that data in real time to assess the entire system's operation, detect anomalies, and adjust the system to maintain safety. Battery management systems often contain state of the art software designed to safely operate and monitor energy storage systems.



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How are battery energy storage systems regulated?

Battery energy storage systems must comply with electrical and fire codes adopted at the state and local level. Facility owners must submit documentation on system certification, fire safety test results, hazard mitigation, and emergency response to the local Authority Having Jurisdiction (AHJ) for approval. Before operation, facility staff and emergency responders must be trained in safety procedures and are required to be given annual refresher training.

To learn more, refer to ACP’s ESS Codes and Standards Overview. The U.S. storage industry has continuously supported the development of codes, standards, and best practices to promote safety.

What are the certification requirements for energy storage systems?

The fire codes require battery energy storage systems to be certified to UL 9540, *Energy Storage Systems and Equipment*. Each major component – battery, power conversion system, and energy storage management system – must be certified to its own UL standard, and UL 9540 validates the proper integration of the complete system. Additionally, non-residential battery systems exceeding 50 kWh must be tested in accordance with UL 9540A, *Standard for Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems*. This test evaluates the amount of flammable gas produced by a battery cell in thermal runaway and the extent to which thermal runaway propagates within the battery system.

What are some key parameters for energy storage systems?

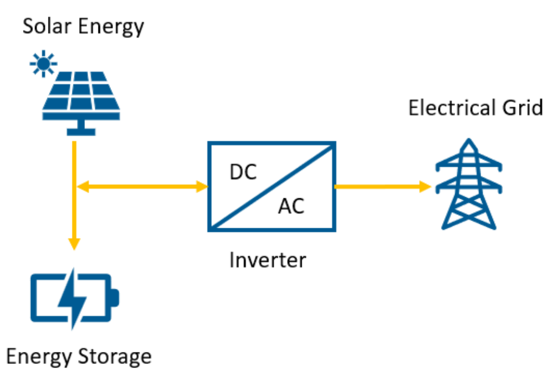
Rated power is the total possible instantaneous discharge capability, usually in kilowatts (kW) or megawatts (MW), of the system. Energy is the maximum amount of stored energy (rate of power over a given time), usually described in kilowatt-hours (kWh) or megawatt-hours MWh. Cycles are the number of times the battery goes from fully (or nearly fully) charged to discharged (or fully discharged). The amount of time or cycles a battery storage system can provide regular charging and discharging before failure or significant degradation is typically the cycle lifetime. State of Charge (SoC) is usually expressed as a percentage and represents the battery's level of charge and ranges from completely discharged to fully charged. The state of charge influences a battery's ability to provide energy or ancillary services to the grid at any given time. State of Health (SoH) is a calculation that will express the estimated remaining capacity including degradation. This can be simplified into the difference between a new battery and the actual battery based on the amount of capacity lost to degradation caused by time, temperature, number of cycles, and several other factors.

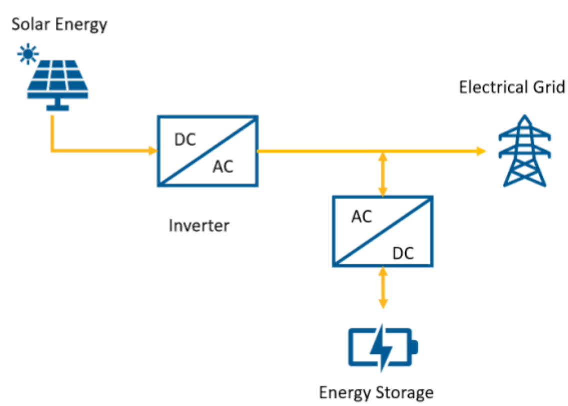
What is the difference between AC and DC coupled systems?

Energy storage systems are typically defined as either AC or DC coupled systems. This is simply the point of connection for the energy storage system in relation to the electrical grid or other equipment.

For AC (alternating current) coupled systems, the batteries are connected to the part of the grid that has AC or alternating current.

For energy storage systems that are also connected to solar energy, there is an option to have the energy storage system be DC (direct current) coupled. Since solar generation systems create DC electricity, it is often most efficient to have this go directly to the batteries (via a DC-DC converter) as DC energy. This can be utilized for residential, commercial, or utility applications.





TESLA Megapack 2 XL
Safety Overview

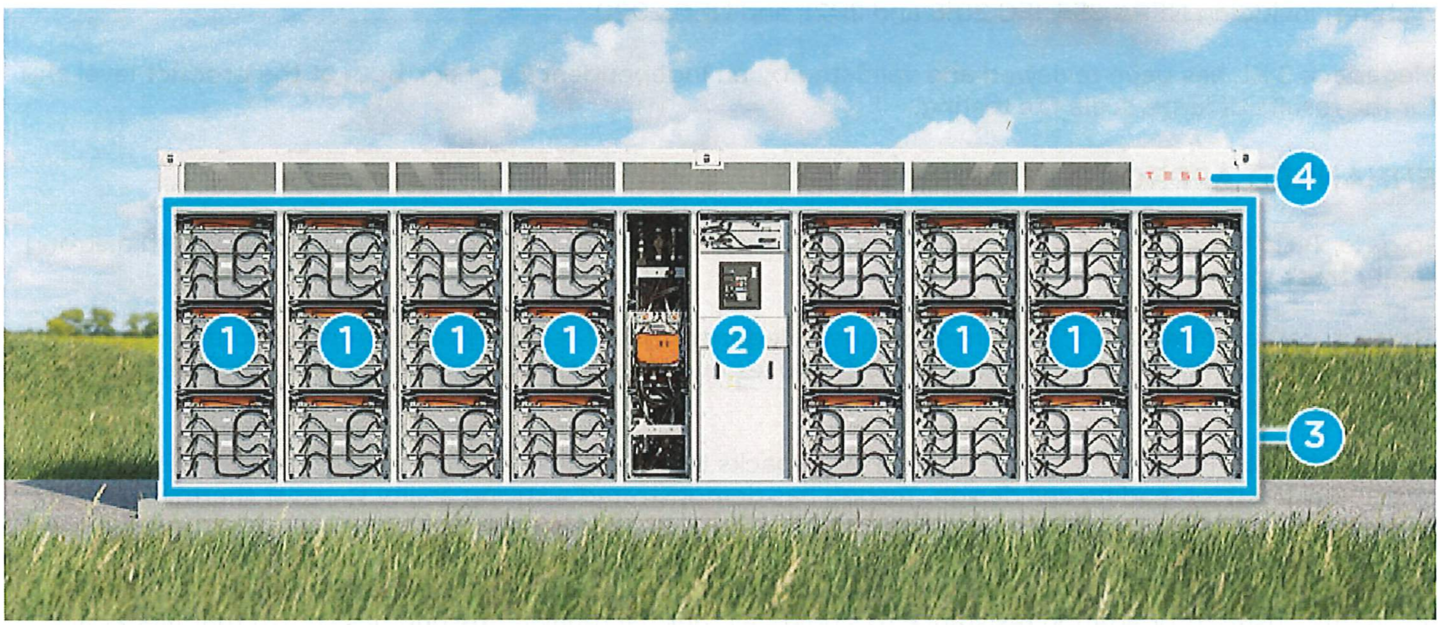
MEGAPACK 2 XL SAFETY OVERVIEW

ENHANCED SAFETY ARCHITECTURE

Tesla's commitment to safety informs every Megapack design decision and has guided 15+ years of experience in battery module design and manufacturing for both vehicle and energy storage applications. Megapack 2 XL (Megapack) is designed with features that make the product safe throughout the entire product lifecycle — during transit, installation, commissioning, operation, maintenance, and decommissioning.

Tesla's approach to safety involves comprehensive design and testing at every level of Megapack. Vertical integration across design, manufacturing, and testing ensures that safety features of the cell, battery module, inverter, thermal system, and overall system-level components are closely linked and not decoupled.

In addition, Tesla is continually improving Megapack safety features and capabilities based on data from operational experience.



1. Battery modules with active and passive fuses - externally serviceable
2. Touch-safe Customer Interface Bay
3. Non-walk-in IP66 enclosure and deflagration mitigation
4. Thermal roof with overpressure vents

INDUSTRY-LEADING COMPLIANCE AND THIRD-PARTY VALIDATION

Tesla is constantly pushing the boundaries and raising the bar on product safety. This commitment to safety not only ensures that Tesla's products are compliant to the industry's most stringent global standards, but also sets a benchmark for the industry to follow regarding energy storage safety. Megapack has met and exceeded many industry safety standards and has demonstrated through extensive third-party testing that it is one of the safest energy storage systems on the market.

Megapack 2 XL is listed to the following standards by OSHA-recognized Nationally Recognized Testing Laboratories:

- UL 1642 (cell-level certification)
- UL 1973 and IEC 62619 (battery module-level certification)
- UL 9540, IEC 62933-5-2, IEC 62109-1 (system-level certification)
- UL 1741, CSA C22.2 #107.1 (power electronics)
- UL 1998 and IEC 60730 Annex H (functional safety of software)
- IEC 61000-6-2, and EN 55011 (EMC)
- UN 38.3 (transportation, self-certified)
- IEEE 693 (seismic safety)
- UL 9540A (large-scale fire testing): Tested at the cell, module, and unit level
- And many more, including compliance to major market grid codes

Megapack 2 XL, like Megapack, is designed to comply with major installation codes for energy storage systems, including NFPA 855, IFC 2018 and 2021, and NEC 2020.

Megapack 2 XL has been reviewed and validated by an Independent Engineer, both at the product level and for the results of large-scale fire testing.

ENHANCED APPROACH TO FIRE SAFETY

To date, Tesla has deployed more than 10 GWh of stationary energy storage products globally with a strong safety track record.

Through vertical integration, Tesla has designed Megapack with fire safety built directly into the product at every level. This makes the product safer and reduces overall project costs by eliminating the need for fire suppression systems.

At the cell level, Tesla's latest generation of Megapacks leverages the lithium iron phosphate (LFP) chemistry and a new industry-leading cell design. Testing has demonstrated a strong ability to resist thermal runaway, and has shown controlled venting in worst-case events, without explosive bursts or fire.

All Tesla products also undergo rigorous testing at the module level. While standards such as UL 1973 and IEC 62619 ensure propagation resistance to single-cell thermal runaway, testing has shown that Megapack battery modules are resistant to multiple co-located cells sent into runaway at the same time. This greatly mitigates the risk of a thermal event.

At the system level, Megapack is designed with a combination of dedicated runaway gas igniters and overpressure vents built into the roof that passively mitigate the risk of deflagration hazards in case of unlikely accumulation of flammable gases due to arc flash events or thermal runaways.

In the unlikely event of a fire, rigorous full-scale fire testing has shown that Megapack performs in a safe and controlled manner, consuming itself slowly and without explosive bursts, projectiles, or unexpected hazards. The vents are designed to direct all gases, smoke, and flame out of the top of the Megapack, minimizing risk to nearby response personnel and exposures.

In the event of a fire at a Megapack site, the fire service will be able to manage the event with standard fire service response equipment. Tesla's *Lithium-Ion Battery Emergency Response Guide* provides more details on that subject. The cells used in Tesla products do not contain solid metallic lithium and thus do not react with water. When required by local code, Tesla recommends fire detection at the site level with the use of third-party thermal imaging cameras that can detect fires on site.

24/7 GLOBAL SUPPORT

Megapack is supported by Tesla's Network Operations Center, designed to support the global fleet of energy storage products. The 24/7 operations center offers remote monitoring, diagnostics, and troubleshooting capabilities, without the need of having a Tesla technician on site. Customers and first responders also benefit from immediate hotline support from trained technicians in case of emergencies.

TESLA

Rev 1.0 — September 13, 2022

TESLA Megapack 2 XL
KCE NY 31 BESS Shoreham –
Hazard Mitigation Analysis (HMA)

TESLA MEGAPACK 2 XL

KCE NY 31 BESS SHOREHAM – HAZARD MITIGATION ANALYSIS (HMA)

08/30/2024 | Rev. 0

SUMMARY

This document serves as a site-specific Hazard Mitigation Analysis performed for the Tesla Megapack 2 XL installation (KCE 31) in Shoreham, NY.

Prepared For:
Key Capture Energy

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PROJECT DESCRIPTION

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1 INTRODUCTION

1.1 Background

Energy Safety Response Group (ESRG) has been retained by Key Capture Energy to perform a site-specific Hazard Mitigation Analysis (HMA) in accordance with the *2020 Fire Code of New York State (FCNYS) §1206.5 and NFPA 855 Standard for the Installation of Stationary Energy Storage Systems §4.1.4 Hazard Mitigation Analysis*. This HMA can be utilized to assess the anticipated overall effectiveness of protective barriers in place to mitigate the consequences of a battery-related failure. The analysis was performed based on the current documentation available at the time of the report.

1.2 Applicable Codes and Standards

FCNYS §1206.5 requires that an approved hazard mitigation analysis be performed where allowed as a basis for increasing maximum allowable quantities (MAQ) of energy storage capacity (600 kWh for lithium-ion batteries). The hazard mitigation analysis shall evaluate the consequences of the following failure modes:

1. *A thermal runaway condition in a single ESS rack, module or unit.*
2. *Failure of any battery (energy) management system.*
3. *Failure of any required ventilation or exhaust system.*
4. *Voltage surges on the primary electric supply.*
5. *Short circuits on the load side of the ESS.*
6. *Failure of the smoke detection, fire detection, fire suppression, or gas detection system.*
7. *Required spill neutralization not being provided or failure of a required secondary containment system.*

Similar requirements for hazard mitigation analysis are required by *NFPA 855 §4.1.4* as a basis for increasing maximum stored energy (600 kWh for lithium-ion batteries), though items 4 and 5 above are not required.

Per *FCNYS §1206.5.2,* the fire code official shall be permitted to approve the hazardous mitigation analysis as documentation of the safety of the ESS installation provided the consequences of the analysis demonstrate the following:

1. *Fires will be contained within unoccupied ESS rooms or areas for the minimum duration of the fire-resistance rated separations identified in Section 1206.14.4.*
2. *Fires in occupied work centers will be detected in time to allow occupants within the room or area to safely evacuate.*

3. *Toxic and highly toxic gases released during fires will not reach concentrations in excess of IDLH level in the building or adjacent means of egress routes during the time deemed necessary to evacuate occupants from any affected area.*
4. *Flammable gases released from ESS during charging, discharging and normal operation will not exceed 25 percent of their lower flammability limit (LFL).*
5. *Flammable gases released from ESS during fire, overcharging and other abnormal conditions will be controlled through the use of ventilation of the gases preventing accumulation or by deflagration venting.*

The following key codes, standards, and local requirements are referenced throughout the report:

- *2020 Fire Code of New York State §1206 Electrical Energy Storage Systems*
- *2021 International Fire Code §1207 Electrical Energy Storage Systems*
- *NFPA 855 Standard for the Installation of Stationary Energy Storage Systems*, 2020 Edition
- *NFPA 855 TIA 20-2 (*includes revisions for *§4.12 Explosion Control* and Annexes *A.4.12* and *A.4.12.1*, effective September 15, 2021)
- *UL 9540A Standard for Test Method for Evaluation Thermal Runaway Fire Propagation in Battery Energy Storage Systems,* 4th Edition
- *UL 9540 Standard for Energy Storage Systems and Equipment,* 2nd Edition
- *NFPA 68 Standard on Explosion Protection by Deflagration Venting,* 2018 Edition
- *NFPA 72 National Fire Alarm and Signaling Code,* 2019 Edition

Summary of Findings

Based on review of documentation provided by Key Capture, ESRG finds that adequate protections are provided for the fault conditions listed per *NFPA 855 §4.1.4* and *FCNYS §1206.5.1,* as well as for analysis approval requirements per *NFPA 855 §4.1.4.2*. Key findings include:

- The Tesla Megapack 2 XL is equipped with a number of protection systems (e.g., deflagration control system consisting of overpressure vents and sparker system, BMS control, electrical shutdowns and disconnects, etc.) that are anticipated to effectively manage all applicable fault conditions required per *NFPA 855 §4.1.4* and *FCNYS §1206.5.1.*

NFPA 855 §4.1.4* and *FCNYS §1206.5.1 Hazard Mitigation Analysis Requirements	
Thermal runaway condition in a single module, array, or unit	The system is provided with several passive and active measures to mitigate or contain a propagating thermal runaway condition. UL 9540A testing further shows that the effects of thermal runaway are contained within the module and Unit.

Failure of an Energy Storage Management System	Multiple levels of system monitoring provide redundant protection in the unlikely event of a failure of the energy storage management system.
Failure of a Required Ventilation or Exhaust System	The Megapack 2 XL is not required to have a ventilation or exhaust system. A proprietary explosion protection system is designed to mitigate the effects of flammable gasses generated during an abnormal condition.
Failure of a Required Smoke Detection, Fire Detection, Fire Suppression, or Gas Detection System	The Megapack 2 XL does not rely on dedicated smoke detection, fire suppression, or gas detection systems to mitigate the hazards associated with thermal runaway. Along with subsequent safety actions, the BMS fault notifications are transmitted to Tesla's 24/7 Operations Center, alerting key stakeholders of any abnormal conditions.
Voltage Surges on the Primary Electric Supply	Voltage surges on the primary electric supply are mitigated by BMS and inverter controls, voltage monitoring, and automatic disconnects.
Short Circuits on the Load Side of the ESS	Short circuits on the load side are mitigated by BMS controls and automatic safety actions.

- The Tesla Megapack 2 XL is compliant with all applicable Analysis Approval requirements per the 2020 *FCNYS §1206.5.2.*

***2020 FCNYS §1206.5.2* – Analysis Approval**	
Fires will be contained within unoccupied ESS rooms or areas for the minimum duration of the fire resistance rating identified in 1206.14.4.	N/A – The Megapack 2 XL is intended for outdoor installations.
Fires in occupied work centers will be detected in time to allow occupants within the room or area to safely evacuate.	N/A – The Megapack 2 XL is not intended for installation within occupied work centers.
Toxic and highly toxic gases released during normal charging, discharging, and operation will not exceed the PEL in the area where the ESS is contained.	N/A – Lithium-ion batteries do not release toxic or highly toxic gases during normal charging or discharging operations.

Toxic and highly toxic gases released during fires will not reach concentrations in excess of immediately dangerous to life or health (IDLH) level in the building or adjacent means of egress routes during the time deemed necessary to evacuate any affected area.	Internal Unit level testing conducted on the products of combustion from the Megapack 2 XL indicated that there was no Mercury (Hg) observed, and trace levels of HF far below NIOSH Immediately Dangerous to Life or Health (IDLH) levels.
Flammable gases released during charging, discharging, and normal operation will not exceed 25 percent of the LFL.	N/A – Lithium-ion batteries do not release flammable gasses during charging, discharging, or normal operations.
Flammable gases released from ESS during fire, overcharging and other abnormal conditions will be controlled through the use of ventilation of the gases, preventing accumulation, or by deflagration venting	The Megapack 2 XL is provided with a proprietary explosion protection system. The effectiveness of the explosion protection system was validated during internal destructive fire testing.

- The proposed BESS facility and location poses minimal risk to public or life safety and property by way of being on a secured site adequately set back from public spaces or roadways with no public access to the site. It is recommended that training is provided to the First Responders to familiarize themselves with the site and hazards associated with lithium-ion ESS and are instructed to stay at a safe distance in the unlikely event of a system failure.
- It is recommended that an external radiant energy sensing automatic Fire Alarm System is provided for the facility to satisfy the prescriptive requirements for automatic fire detection for outdoor lithium-ion battery systems per *2020 FCNYS Table 1206.15*.

- Voluntary fire propagation modeling was conducted by Tesla to determine the anticipated impacts on representative target Megapack 2 XL units from an external heat flux generated by a failing unit. Even with worst-case wind scenarios taken into account, in the unlikely event of a Megapack 2 XL fire, the model shows that thermal runaway would not propagate to the adjacent units that are installed as per Tesla’s site design requirements.

2 SITE DESCRIPTION

2.1 Site Overview

The proposed BESS facility is proposed to be located within Shoreham NY, in an Industrial 1 zoned area. The site is located at 1 Lico Rd, Shoreham NY, 11789 with coordinates of 40.96110103762209, -72.86759457191717. Access to the facility is provided via Lico Rd with an access gate on the East side of the facility. The site will be enclosed by a 10' chain link barbed wire fence.

Figure 1. BESS Facility Overview

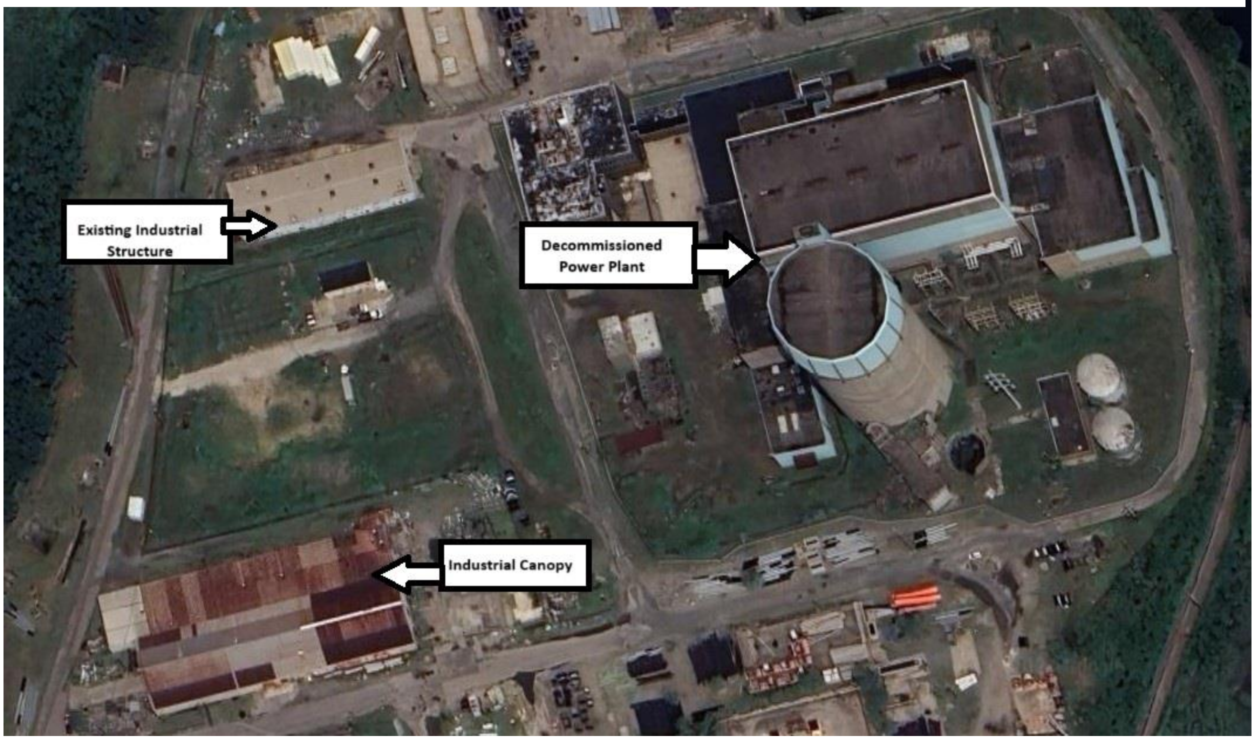
Figure 2 Aerial View of Site

The site will be comprised of sixty (60) Tesla Megapack 2XL Battery Energy Storage Systems (BESS), for a total system capacity of 200 MWh.

2.2 Nearby Exposures

The Megapack 2 XLs will be sited outdoors. The nearest exposure to the BESS is the decommissioned Shoreham Nuclear Power Plant East (approximately 175 ft from the nearest Megapack 2XL), an industrial structure North (approximately 50 ft from the nearest Megapack 2XL) and an existing industrial shade canopy South (approximately 85 ft from the nearest Megapack 2XL).

Figure 3 Nearby Exposures



2.3 Fire Department Access and Water Supply

The Wading River Fire Department is located approximately 4.3 miles away and are anticipated to arrive on-scene expeditiously after receiving emergency alert from the Central Station Monitoring facility or Network Operations Center.

The site will have access to sixteen (16) hydrants that are located in the area around the BESS facility to support first responder operations.

Figure 4 Hydrant Locations

3 ENERGY STORAGE SYSTEM DESCRIPTION

3.1 Megapack 2 XL Overview

The Tesla Megapack 2 XL (which may also be referred to as MP2 XL throughout this report), is a modular, fully integrated, AC-coupled battery energy storage system (BESS or ESS). The Megapack 2 XL is a design evolution of Megapack 2 and leverages the same core technology platform (cells, vents, sparker system, etc.). The Megapack 2 and 2 XL utilizes lithium iron phosphate (LFP) battery cells provided by CATL, as opposed to the nickel manganese cobalt oxide (NMC) and nickel cobalt aluminum oxide (NCA) cells used in the Megapack 1.

The Megapack 2 XL and constituent components are tested and certified to UL 9540, UL 1642, UL 1973, IEC 62619, and IEC 62933-5-2. UL 9540A (4th Edition) large-scale fire testing was performed at the Cell, Module, and Unit level (Installation level testing was not required, as all Unit level performance criteria were met). From the UL 9540A Unit level report by TUV, "Based on the limited module propagation observed during MP2 testing (7 cells in runaway) the behavior would be the same with MP2 XL. With the increase in volume and sparker count, the deflagration risk is minimized. The testing performed on MP2 is considered harsher with higher gas concentrations, and fundamental engineering analysis for MP2XL shows comparable behavior as worst case".

Figure 3-1 – Megapack 2 XL Internal Architecture

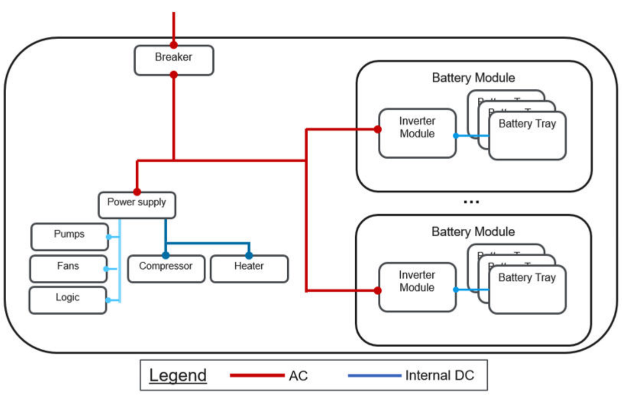
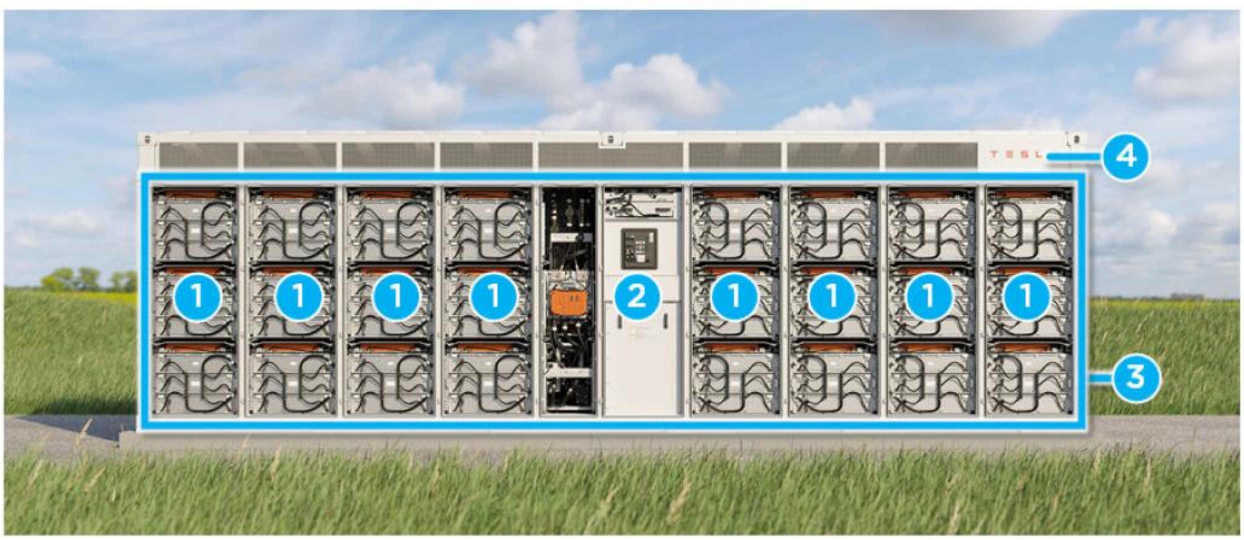


Figure 3-2 - Battery Module

Figure 3-3 - Tesla Megapack 2 XL



1. Battery modules with active and passive fuses – externally serviceable
2. Touch-safe Customer Interface Bay
3. Non-walk-in IP66 enclosure and deflagration mitigation
4. Thermal roof with overpressure vents

For more information on the Tesla Megapack 2 XL, please refer to official product documentation provided by Tesla.

3.2 Fire Safety Features

The Tesla Megapack 2 XL is equipped with a number of fire safety features designed to mitigate the propagation of a battery failure or prevent the failure from occurring altogether. These protections are aligned with the requirements of the 2020 Edition of NFPA 855 and the 2020 FCSNY §1206 Electrical Energy Storage Systems (ESS).

Deflagration Control System

Each Megapack 2 XL is provided with an integral and proprietary explosion mitigation system (deflagration control). This explosion mitigation system is comprised of numerous pressure-sensitive (overpressure) vents located at the top of the Megapack and a sparker system; working in conjunction to ignite any flammable gasses that could be generated within the unit during a failure event. The Megapack 2 XL is provided with twenty-six (26) overpressure vents and 12 sparkers. Any overpressures generated from the ignition of flammable gasses within the unit will be relieved via the nearest pressure-sensitive vents and routed upwards, protecting the Megapack's structural integrity and preventing any hazardous pressure build-up within. The sparkers are located throughout the Megapack at various heights and continuously operate to ensure that any flammable gas build-up is ignited early – limiting the concentration of flammable gas within the unit and activating the pressure-sensitive vents to create a natural ventilation pathway to the exterior.

Battery Management System (BMS)

An integrated Battery Management System (BMS) monitors key datapoints such as voltage, current, and state of charge (SOC) of battery cells, in addition to providing control of corrective and protective actions in response to any abnormal conditions. Each battery module is equipped with a dedicated BMS, with a Megapack-level bus controller supervising output of all modules at the AC bus level. Critical BMS sensing parameters include battery module over / under voltage, cell string over / under voltage, battery module over temperature, temperature signal loss, and battery module over current. In the event of any abnormal conditions, the BMS will generally first raise an information warning, and then trigger a corresponding corrective action should certain levels be reached.

Fire Detection

In addition to monitoring of thermal sensors within the Megapack by the BMS – which may be transmitted to Tesla's 24/7 Operations Center, described below, an external radiant energy sensing automatic Fire Alarm System is recommended for the facility to satisfy the prescriptive requirements for automatic fire detection for outdoor lithium-ion battery systems per *2020 FCNYS Table 1206.15*.

While the radiant energy sensing detectors were not activated during UL 9540A unit level testing for the Megapack 2 XL (as no fire occurred), full-scale testing of previous Megapack systems showed that the external third-party multi-spectrum IR detectors effectively detected failure conditions that initiated within the unit.

Site Controller and Monitoring

The Tesla Site Controller provides a single point of interface for the utility, network operator, or customer SCADA systems to control and monitor the entire energy storage site. It hosts the control algorithm that dictates the charge and discharge functions of the battery system units, aggregating real-time information and using the information to optimize the commands sent to each individual Megapack unit.

The Megapack 2 XL is supported by Tesla's 24/7 Operations Center, which is designed to support the global fleet of energy storage products. In conjunction with local operation centers, the Megapack 2 XL has 24/7 remote monitoring, diagnostics, and troubleshooting capabilities. In the event of an emergency, this information may be made available to the Fire Department to provide guidance to emergency response personnel.

Fire Suppression Systems

The Tesla Megapack 2 XL does not rely on any external or internal fire suppression systems to mitigate cascading thermal runaway. Additional full-scale testing and subsequent fire modeling has indicated that the Megapack's passive construction provides a robust thermal resistance from the impacts of an adjacent Megapack during a large-scale failure.

Electrical Fault Protection Devices

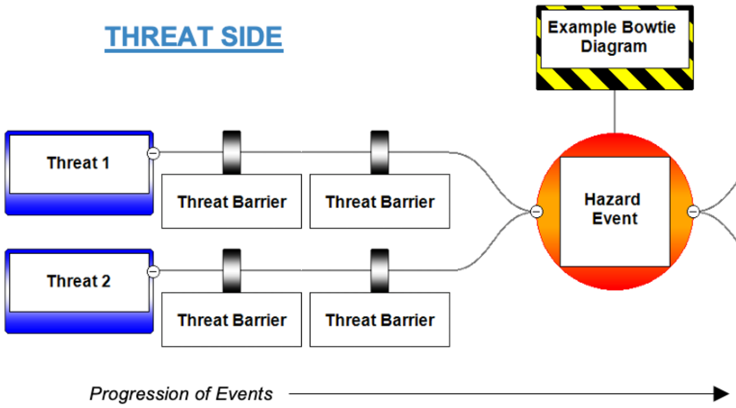
Multiple levels of passive and active electrical protections are provided for the Megapack 2 XL. At the battery module level, overcurrent protection is provided for each module in the form of single-use fusible links, providing interruption of overcurrent in the battery module in the case of an abnormal electrical event. Inverter modules, which are installed at each of the battery modules, are equipped with both DC protection via high-speed pyrotechnic fuse for passive or active isolation of battery module, as well as dedicated AC contactor and AC fuses should an abnormal electrical event occur at the inverter module on the AC side of the circuit. Additionally, the Megapack 2 XL is equipped with DC ground fault detection system and AC circuit breaker with ground fault trip settings for distribution system protection.

4 HAZARD MITIGATION ANALYSIS

4.1 HMA Methodology

ESRG utilizes the bowtie methodology for hazard and risk assessments, as is described in *ISO.IEC IEC 31010 §B.21*, as it allows for in-depth analysis on individual mitigative **barriers** and serves as a strong tool for visualizing the chronological pathway of **threats** leading to critical hazard events, and ultimately to greater potential **consequences**, as depicted in the figure below. This simple diagrammatic way of describing and analyzing the pathways of a risk from hazards to outcomes can be considered to be a combination of the logic of a fault tree analyzing the cause of an event and an event tree analyzing the consequences.

Figure 4-1 - Example Bowtie Diagram



Each fault condition per *NFPA 855* and *FCNYS* assessed in Sections 3.4.1 – 3.4.6 below is accompanied by a corresponding bowtie diagram indicating critical *threat* and *consequence* pathways and the mitigative barriers between them. As the most critical risk posed by lithium-ion battery cells comes from the propagation of thermal runaway from a failing cell (or multiple cells) to surrounding cells, this serves as the primary critical hazard for the subsequent failure scenarios.

In addition to main barriers for fault conditions on the *threat* side of the diagram, the *consequence* barriers on the right side of the diagram (e.g., explosion protection and emergency response plan) **also** contribute added layers of safety on top of the main threat barriers shown. It is important to note that the barriers on the left side, along a threat path, are intended to keep the threat from becoming a thermal runaway, while the barriers on the right side, along the consequence pathway, are intended to keep that single thermal runaway from evolving into one of the more severe consequences such as fire spread beyond containment, off-gassing leading to explosion, or fire spread beyond containment. For more on the methodology and relevant terminology, see Appendix B of this report.

4.2 Relevant Supporting Information

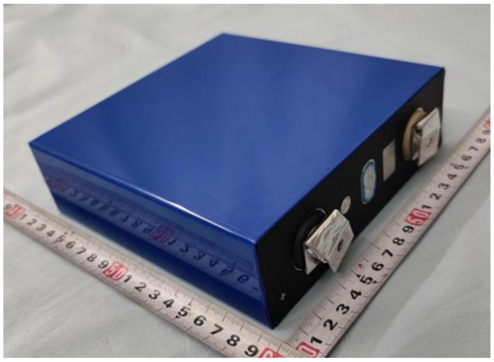
UL 9540A Large-Scale Fire Testing

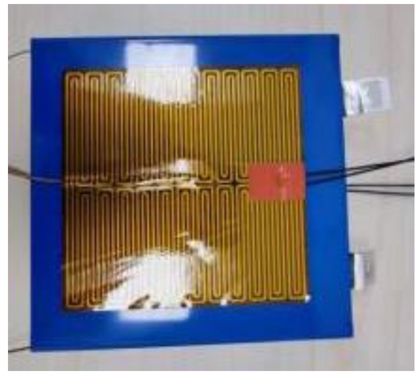
UL 9540A (4th Edition) testing was performed for the constituent Cell, Module, and Unit levels of the Tesla Megapack 2 XL.

Cell Level and Module Level Test Reports

UL 9540A (4th Edition) Cell level testing was performed on the Contemporary Amperex Technology Co., Ltd. (CATL) 3.22V, 157.2Ah lithium iron phosphate (LFP) battery cell at UL LLC (Changzhou) Quality Technical Service Co., LTD. in December of 2021. Thermal runaway was initiated via film strip heater. As these performance criteria per *UL 9540A Clause 7.7* and *Figure 1.1* were not met, Module level testing was required.

Figure 4-2 – Cell Level Testing – Flexible Film Heater Installation





<u>Module Level Test Report</u> [2]

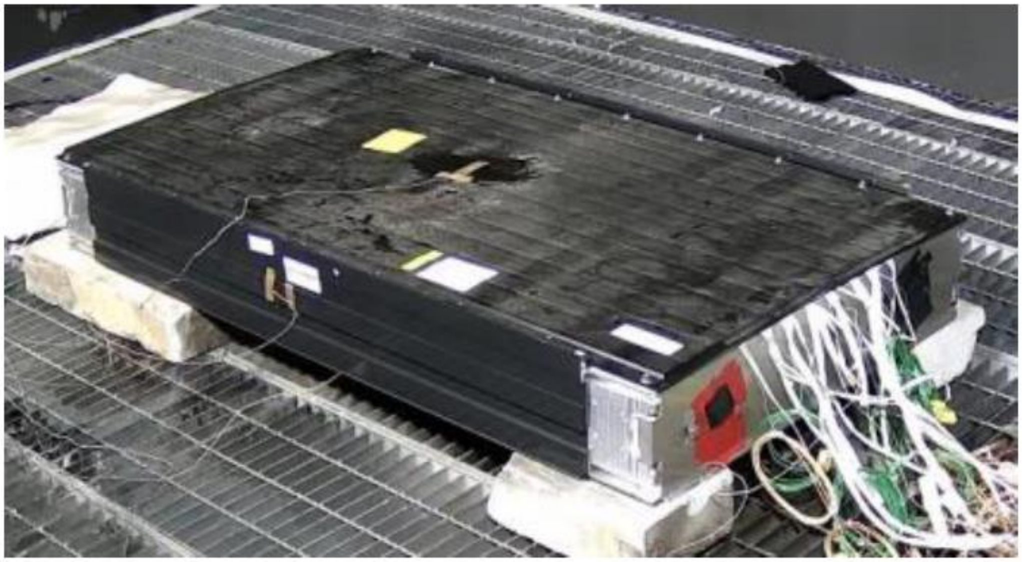
UL 9540A (4th Edition) Module level testing was performed on the Contemporary Amperex Technology Co., Ltd. (CATL) MP2 360.64Vdc, 156Ah battery module at TÜV SÜD SW Rail Transportation Technology (Jiangsu) Co., Ltd. in May of 2022.

Thermal runaway was initiated via film strip heaters installed on both of the wide side surfaces of each cell, similar to the cell level test. In the module level test, however, two cells were heated simultaneously to force multiple cells into thermal runaway at the same time.

Thermal runaway propagated from the initiating cells to all cells within the MP2 tray (module). Sparks and flying debris were observed, however, there were no explosive discharges of gases. Gases generated from the cell were identified as flammable, but there was no detection of toxic gases that are sometimes associated with lithium-ion battery failure such as HF, HCL, and HCN. Unit level testing to the UL 9540A test method is required due to the fact that the gases generated are flammable.

Additional information regarding Cell and Module level testing can be found in the MP2 and MP2XL FPE report by Fisher Engineering.

Figure 4-3 - Highlights of Module Testing



Unit Level Test Report [3]

UL 9540A (4^{th} Edition) Unit level testing was performed for the Tesla Megapack 2 XL model 1748844-XX-Y at TUV Rheinland of North America, Inc. March 9, 2022.

Burn marks were observed on initiating AC battery module, though no external damage was observed. No damage to target units or adjacent walls were observed. All performance criteria for outdoor ground mounted non-residential use ESS were met, therefore Installation level testing was not required.

A full review of Unit level testing was provided by Fisher Engineering, Inc., as is briefly summarized below.

Tesla Megapack 2/XL: Fire Protection Engineering Analysis

A fire protection engineering analysis and UL 9540A Unit level fire test analysis report was provided by Fisher Engineering, Inc. (FEI) which includes review of the Megapack 2 and Megapack 2 XL construction, design, fire safety features, and large-scale fire test data [4]. A brief summary of key takeaways is provided below. For more information, please refer to **Tesla_Megapack_2_and_XL_-_FPE Report_Final.pdf**.

Key takeaways from the report include:

- The MP2 XL design is almost identical to the MP2 other than being greater in length to accommodate the additional battery modules. Given the limited module propagation observed during UL 9540A unit level testing of the MP2 (seven cells went into runaway) the behavior is expected to be no different with the MP2 XL. As such, a stand-alone UL9540A unit level fire test for the MP2XL was not performed. The UL

9540A unit level fire test results, described above for the MP2, can be applied to the MP2XL.

  a. Similarly, after reviewing the MP2 unit level fire test results and comparing the MP2 and MP2 XL to one another, TÜV determined the MP2 UL 9540A unit level fire test results can be applied to the MP2XL and an additional UL 9540A unit level fire test for the MP2XL was <u>not required</u> for its listing.

- The largest variant of the Megapack 2 was tested at a worst-case scenario (i.e., 100% SOC with BMS and TMS disabled) to the UL 9540A Unit level fire test method in which six cells within a battery module of the initiating Megapack 2 unit were forced into thermal runaway. Thermal runaway propagated to a seventh cell but did not propagate any further. No propagation to adjacent battery modules or target Megapack units occurred.

- All Unit level performance criteria outlined in 9540A, Table 9.1 for outdoor, ground-mounted ESS were met, therefore Installation level testing was not required. Specifically, these results included:

  a. No flaming was observed outside of the unit.

  b. Surface temperatures of battery modules within the target units did not exceed the temperature at which thermally initiated cell venting occurs. The maximum temperatures recorded at the battery modules of the adjacent cabinets were 13.8°C and 13.2°C, which are significantly below the temperature at which cell venting occurs (174°C).

  c. Surface temperatures of exposures 5 ft (1.52 m) to the side and 8 ft (2.44 m) in front of the initiating unit did not exceed 97°C (175°F) above ambient. The maximum external surface temperatures recorded at the instrumented wall 5 ft to the side was 25.9°C (78.6°F) with a temperature rise above ambient of 5.5°C (9.9°F). The maximum external surface temperatures recorded at the front target 8 ft directly in front of the initiating unit was 16.8°C with a temperature rise above ambient of 5.5°C. These temperatures are significantly below the maximum permitted temperature rise above ambient of 97°C (175°F).

  d. Explosion hazards, including, but not limited to, observations of a deflagration, projectiles, flying debris, detonation, or other explosive discharge of gases were not observed.

  e. Heat flux did not exceed 1.3 kW/m2. The maximum heat flux recorded was 0.0000016 W/m2, which was the sensor installed on the front target cabinet and was the ambient heat flux the sensor was exposed to throughout the test.

- A maximum surface temperature of 16.8°C was measured on the front target Megapack 2 unit installed 8 ft in front of the initiating Megapack 2 unit, and 13.8°C and 13.2°C at the battery modules of the adjacent unit. Based on cell venting and thermal runaway temperatures from 9540A Cell level test report (174°C and 239°C, respectively), propagation to the battery modules within a unit at clearances of 8 ft is not possible.

- Smaller capacity MP2 cabinets, populated with less than nineteen battery modules, would be expected to perform similarly given they are designed and constructed substantially similar (with the same cells, battery modules, fire safety features, etc.) than the larger capacity 3,100 kWh MP2 cabinet tested and described in the Fisher report.
- None of the fire detectors activated during the fire test (two multi-spectrum IR flame detectors and two thermal imagers), which is expected, as no flaming was observed outside of the cabinet during the test; however, previous testing on the Tesla Megapack 1 units demonstrated that multi-spectrum IR flame detectors can detect a fire should flames exit the cabinet through the roof.
- An internal fire suppression system or an external fire suppression system is not required to stop propagating thermal runaway from cell to cell, module to module, or MP2 cabinet to cabinet when near simultaneous failure of up to six cells occurs within the same battery module.
- Manual fire suppression (hose lines) is not required to stop propagating thermal runaway and the spread of fire from a MP2 cabinet to adjacent MP2 cabinets installed 6 in (150 mm) behind and to the sides when a near simultaneous failure of up to six cells occurs within the same battery module.

Tesla Megapack 2/XL: Internal Fire Testing and Modeling

Destructive Unit Level Testing

Voluntary destructive Unit level testing was conducted by Tesla on a representative and fully populated Megapack 2 XL. This destructive fire testing utilized a more aggressive approach than what is required by the UL 9540A test method in order to force the system into a more severe cascading thermal runaway event. This destructive test was conducted to demonstrate the Megapack 2/XL's ability to fail in a safe manner, even in the extreme event of a catastrophic failure within an entire battery module. Additionally, the destructive testing further validated the design of the Megapack 2/XL proprietary explosion mitigation system.

This testing was conducted at the Northern Nevada Research Center on May 19th, 2022. The test utilized fil heaters to simultaneously heat forty-eight (48) cells within a module, creating a severe failure scenario that is well beyond what is contemplated by the UL 9540A test method. The goal of this testing was to assess the risk of a large-scale fire resulting from an initiating Megapack 2/XL during a thermal runaway event propagating to an adjacent Megapack 2/XL. The results of this testing show some key takeaways, as detailed in the Fisher Engineering FPE report:

- Thermal runaway propagated from the initiating cells to all the cells in the initiating tray.
- A thermal event occurred, likely initiated by the ignition of flammable gases by the sparker system. An overpressure vent installed above the initiating battery module opened and was visually confirmed through video. The cabinet doors immediately

adjacent to the initiating battery module remained closed. No hazardous pressure waves, debris, shrapnel, or pieces of the cabinet were ejected.

- After approximately 10 minutes of smoking, a sustained fire began within the initiating battery module. The fire spread to the adjacent battery bays until reaching the CIB and stopped. The fire only burned half of the cabinet.
- Fire spread from battery bay to battery bay was a slow progressing event. In total, visible flames were observed for 6 hours and 40 minutes while the four battery bays (bays 7-10) burned, as shown in Figure 18 of the Fisher report.
- Maximum flame heights were observed to be 11.5 ft (3.5 m) from ground to the top of the flame, 2.5 ft (0.75 m) above the top of the cabinet and had a base (a width) of 3.3 ft (1 m) during peak flame intensity. This peak flame intensity occurred approximately 60-90 minutes after initial flaming was observed.
- An analysis of the pressure profile inside the cabinet during the test demonstrated the operation of the explosion control system, as shown in Figure 19 of the Fisher report. Pressure inside the cabinet increased to nearly 11 kPa (1.60 psi) until the deflagration vent opened and the pressure diminished. The overpressure vents are designed to operate at approximately 12 kPa (1.74 psi), or 2.5 times below the cabinet's strength of 30 kPa (4.35 psi).

Fire Modeling – Propagation Model

Subsequent fire propagation modeling was conducted to assess the fire propagation risk to adjacent Megapack 2 XL units during a more severe event such as what was observed during the internal destructive testing referenced in Section 3.2.3.1. This fire propagation model showed that due to the robustness of the system design, it is unlikely that a fire from an initiating Megapack 2 XL would propagate to the adjacent Megapack 2 XL, even during worst-case scenario wind conditions. The modeling assessed two scenarios – a non-flaming event and the impact of heat transfer on a target Megapack 2 XL as well as a flaming event and the impact of radiative heat transfer on a target Megapack 2 XL installed per Tesla's recommendations.

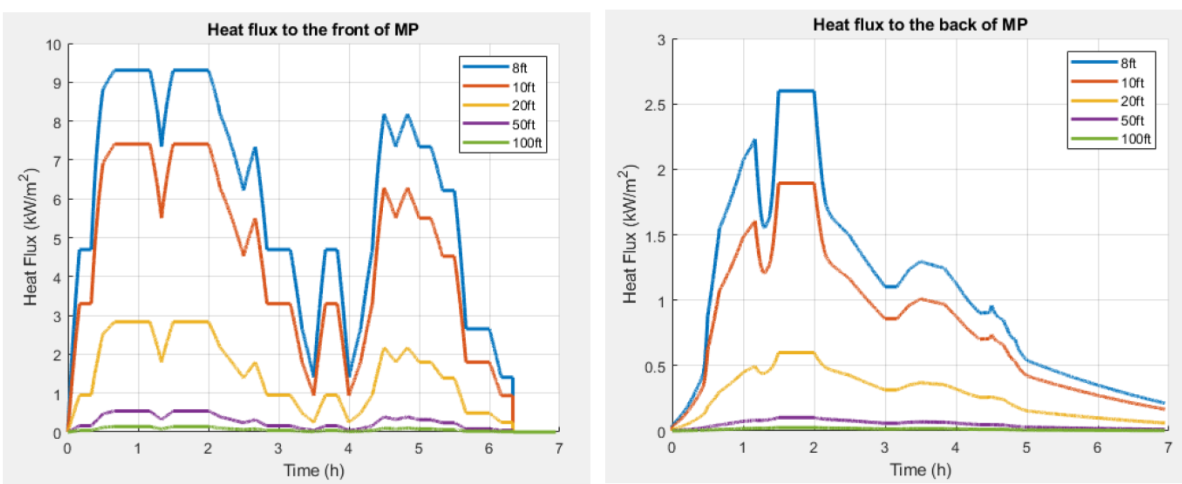
Product of Combustion - Unit Level Testing

Tesla conducted additional internal Unit Level testing to obtain and analyze the products of combustion from a failing Megapack Unit. The products of combustion were collected at locations 20 ft upwind and 5 ft downwind from the initiating unit to assess airborne contaminants which may be present during an incident. Subsequent third-party analysis concluded that no traces of Mercury were present over the entire 2.5-hour test duration. Hydrogen Fluoride (HF) was detected at values of 0.10 and 0.12 parts per million (ppm) in the two sampling locations over the course of the test – far below accepted NIOSH Immediately Dangerous to Life or Health (IDLH) value of 30 ppm for HF. These results can be extrapolated to the Tesla Megapack 2 XL, as TUV indicated in the UL 9540A unit report that the testing performed on the Megapack 2 is considered "harsher with higher gas concentrations, and fundamental engineering analysis for the Megapack 2 XL shows comparable behavior as worst case".

4.2.1 Tesla Megapack 2/XL: Heat Flux Analysis

The subsequent fire propagation modeling was conducted to assess the fire propagation risk to adjacent Megapack 2XL units during a more severe event. As mentioned in the report, the heat flux model was utilized to also determine the estimated heat fluxes at distances further from the Megapack 2XL cabinet. These values can be utilized to analyze the risk of flame spreading to exposures in proximity to the MP2XL installation.

The peak heat flux values were utilized for this analysis, utilizing the higher values that are expected at the front of the Megapack 2XL. For conservativeness, it is assumed that the higher heat flux values (front) are experienced at all orientations from the Megapack 2XL.



The heat flux values are estimated (and rounded up for conservativeness) from the peak values of the chart and are prescribed as the following discrete values:

- Approximately 9.5 kW/m2 at 8ft (radius) from the Megapack 2XL
- Approximately 7.5 kW/m2 at 10ft (radius) from the Megapack 2XL

- Approximately 3 kW/m2 at 20ft (radius) from the Megapack 2XL
- Approximately 0.5 kW/m2 at 50ft (radius) from the Megapack 2XL
- Approximately 0.1 kW/m2 at 100ft (radius) from the Megapack 2XL

4.2.1.1 Failure Criteria and Thresholds

There are numerous sources of impacts from heat flux, depending on the data source. The information from NIST utilizes the following information:

Heat Flux is the rate of heat energy transferred per surface unit area - kW/m^2.

Heat Flux (kW/m^2)	Example
1	Sunny day
2.5	Typical firefighter exposure
3-5	Pain to skin within seconds
20	Threshold flux to floor at flashover
84	Thermal Protective Performance Test (NFPA 1971)
60 - 200	Flames over surface

In a conservative manner, the minimum acceptable heat flux shall not exceed 2.5 kW/m2 where First Responders are expected to stage at an extended duration of time.

Additionally, the SFPE Fire Protection Handbook references the maximum allowable heat flux to determine tenability for exposure of skin to radiant heat. That value is 2.5 kW/m2 as well. It is expected that exposure can be tolerated for at least several minutes at heat flux values below this level. This would afford time for people (without PPE) to egress to a safe location.

The CUNY UL 9540A data utilization guidelines reference the SFPE handbook for radiant heat flux values and their observed effects (Table below). As indicated, a critical heat flux of 12.5 kW/m2 can be utilized as a failure threshold to assess the threshold for the potential ignition of combustibles.

Approximate Radiant Heat Flux (kW/m^2)	Comment or Observed Effect
170	Maximum heat flux as currently measured in a postflashover fire compartment.
80	Heat flux for protective clothing Thermal Protective Performance (TPP) Test.[a]
52	Fiberboard ignites spontaneously after 5 seconds.[b]
29	Wood ignites spontaneously after prolonged exposure.[b]
20	Heat flux on a residential family room floor at the beginning of flashover.[c]
20	Human skin experiences pain with a 2-second exposure and blisters in 4 seconds with second-degree burn injury.[d]
15	Human skin experiences pain with a 3-second exposure and blisters in 6 seconds with second-degree burn injury.[d]
12.5	Wood volatiles ignite with extended exposure[e] and piloted ignition.
10	Human skin experiences pain with a 5-second exposure and blisters in 10 seconds with second-degree burn injury.[d]
5	Human skin experiences pain with a 13-second exposure and blisters in 29 seconds with second-degree burn injury.[d]
2.5	Human skin experiences pain with a 33-second exposure and blisters in 79 seconds with second-degree burn injury.[d]
2.5	Common thermal radiation exposure while fire fighting.[f] This energy level may cause burn injuries with prolonged exposure.
1.0	Nominal solar constant on a clear summer day.[g]

4.2.2 Sensitive Exposures

There are numerous sensitive exposures within the vicinity to the proposed ESS that will be evaluated for heat flux impact. All distances to and from these exposures will be taken to the nearest battery system.

Exposure	Distance (ft.)
Decommissioned Shoreham Nuclear Power Plant	175 ft.
Industrial Structure	50 ft.
Industrial Shade Canopy	85 ft.

Figure 5. BESS Facility Overview

4.2.3 Heat Flux and Conclusions

Extrapolating the heat flux data, the 2.5 kW/m2 threshold is located at approximately 28 feet from the front of the nearest Megapack 2 XL unit. All exposures previously indicated are expected to experience negligible heat flux in the rare event of a full Megapack failure and are all outside of the 28 foot boundary, which is located primarily within the bounded limits of the facility.

Emergency Response Guide

A product-level Emergency Response Guide (ERG) was provided by Tesla and provides an overview of the product materials, handling and use precautions, hazards, emergency response procedures, and storage and transportation instructions. Tesla's Emergency Response Guide is publicly available to all First Responders and can be found at: https://www.tesla.com/firstresponders

In addition to this product-level guide, a site-specific Emergency Response Plan (ERP) will provide an additional level of safety and familiarization for first responders who may be arriving on-scene to an incident at an installation utilizing the Megapack 2 XL system.

4.3 Primary Consequences of ESS Failure and Mitigative Barriers

The dynamics of lithium-ion ESS failures are extremely complex, and the pathway of failure events may vary widely based on system design, mitigative approaches utilized, and even small changes in environmental or situational conditions. However, the primary consequences stemming from a propagating lithium-ion battery failure largely fall into a number of specific hazard scenarios, as depicted in the diagram and associated table below (though other scenarios not listed may certainly also occur). These primary consequences serve as the basis for the consequence side of the majority of the fault condition diagrams in the following sections of this report.

While not explicitly detailed in the simplified diagram below, the criticality and effectiveness of the barriers may vary based on associated threat or consequence pathway. For example, a water-based suppression system may be more critical for mitigation of cell or module combustion from spreading, ultimately leading to fire spread beyond containment, than it is for preventing off-gassing within the enclosure, potentially leading to explosion. Similarly, the same water-based suppression system may be more effective for mitigating spread of fire throughout the system than it is for reducing risk of explosion).

Figure 4-4 - Primary Consequence Diagram

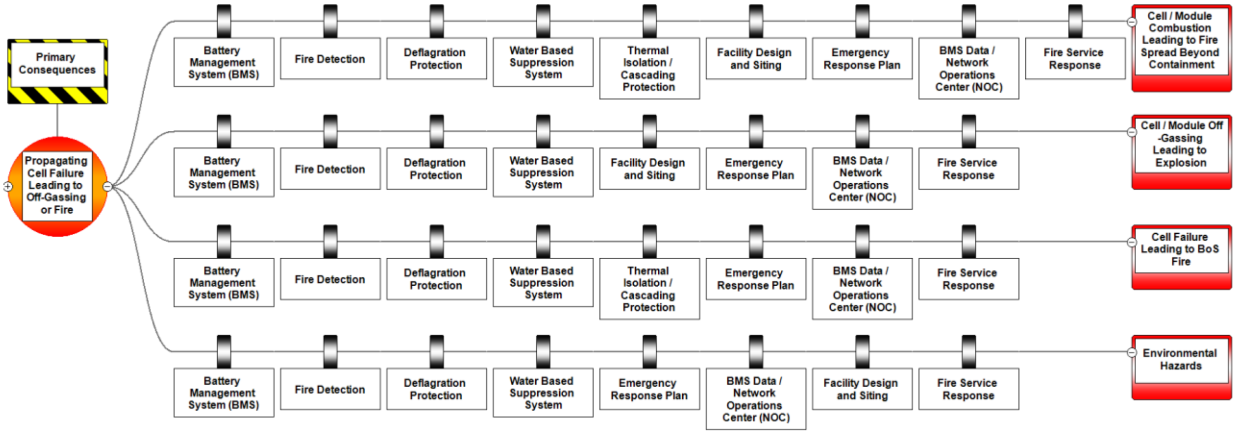


Table 4-1 - Primary Consequence Barriers

PRIMARY CONSEQUENCE BARRIERS	
Battery Management System (BMS)	Critical BMS sensing parameters for the Megapack 2 XL include battery module over / under voltage, cell string over / under voltage, battery module over temperature, temperature signal loss, and battery module over current. In the event of any abnormal conditions, the BMS will generally first raise an information warning, and then trigger a corresponding corrective action should certain levels be reached.
Fire Detection	External multi-spectrum radiant energy sensing detectors are recommended to be provided to satisfy automatic fire detection requirements of *2020 FCNYS Table 1206.15*.
Water-Based Suppression System	The Megapack 2/XL does not rely on any external or internal water-based suppression system to prevent or mitigate hazards resulting from large-scale failure.
Deflagration Protection	The Megapack 2 XL is equipped with deflagration protection in the form of pressure-sensitive vents and sparker system designed to ignite any flammable gases and release in a controlled manner before they are allowed to accumulate and create an explosive atmosphere within the enclosure.
Electrical Fault Protection Devices	The Megapack 2 XL is equipped with a number of electrical fault protection in the form of battery module overcurrent protection, inverter DC and AC protection, and ground fault protection.
Facility Design and Siting	The facility is sited with adequate separation distances from sensitive occupancies that may be affected. The BESS installation is provided with adequate separation distances from the nearest exposures. The BESS facility is bounded by a chain-link fence to prevent unauthorized access to the facility.

Emergency Response Plan / First Responders	A product-level Emergency Response Guide (ERG) is provided for the Tesla Megapack 2 XL, outlining key product information, safety hazards, and general emergency response procedures. A site-specific Emergency Response Plan (ERP) will provide an additional level of safety for the installation utilizing the Megapack 2XL.
BMS Data Availability / Operations Center	Tesla Site Controller provides point of interface for the utility, network operator or customer SCADA systems to control and monitor the energy storage site. 24/7 remote monitoring by Tesla's Operations Center will be provided.
Fire Service Response	The site is located within access to the municipal water supply on site (hydrant), and the capabilities of the Fire Department are strong. As recommended in Tesla's Emergency Response Guide (ERG); a defensive firefighting approach shall be utilized, with water sprayed on neighboring exposures and neighboring enclosures if advised by Tesla or at the discretion of the first responders. Site-specific training and installation familiarization for local responding stations may further increase the strength of this barrier, and fire department equipment and capabilities will be strong with this familiarization.

4.4 Fault Condition Analysis

Per *FCNYS §1206.5.1*, the analysis shall evaluate the consequences of the following failure modes and others deemed necessary by the AHJ:

1. *A thermal runaway condition in a single ESS rack, module or unit.*
2. *Failure of any battery (energy) management system.*
3. *Failure of any required ventilation or exhaust system.*
4. *Voltage surges on the primary electric supply.*
5. *Short circuits on the load side of the ESS.*
6. *Failure of the smoke detection, fire detection, fire suppression, or gas detection system.*
7. *Required spill neutralization not being provided or failure of a required secondary containment system.*

For the purposes of this report, it shall be assumed that all construction, equipment, and systems that are required for the ESS shall be installed, tested, and maintained in accordance with local codes and the manufacturer's instructions. The assessment is based on the most recent information provided by Key Capture at the time of this report.

The following table provides a summary of findings from the hazard mitigation analysis performed in fulfillment of the *2020 FCNYS §1206.5.1,* with each fault condition described in greater detail, accompanied by simplified bowtie diagrams for visualization of mitigative barriers. Additionally, full bowtie diagrams with barrier descriptions are provided in Appendix A.

Table 4-2 - Summary of Fault Condition Analysis

Compliance Requirement	Comments
1. Thermal runaway condition in a single ESS rack, module, or unit	A number of passive and active measures are implemented to reduce the potential of a thermal runaway event from occurring including BMS control and active cooling to internal components. Battery modules and cells have been listed to UL 1973 and UL 1642. Should a thermal runaway event occur, additional mitigative measures are provided to prevent further propagation of failure throughout the system (see Section 3.3 above for list of all consequence barriers).
2. Failure of any battery (energy) storage management system	In the event of a failure of module-level BMS, the Megapack-level BMS (which may be considered “ESMS”) shall isolate effected modules, mitigating against further propagation of failure across the system. Should a failure of the Megapack-level BMS occur, each module is equipped with a dedicated BMS to provide corrective actions in case of detection of abnormal operation outside of set parameters. To further isolate any failure stemming from a failure of the energy storage management system, passive and active electrical fault protections are provided at multiple levels, as described in Section 2.2.6 above.
3. Failure of any required ventilation or exhaust system	The Megapack 2 XL does not utilize a system to exhaust flammable gasses, as lithium-ion batteries do not release flammable gas during normal operations. Flammable gasses generated during abnormal operations are mitigated by the Megapack 2 XL’s proprietary explosion mitigation system.
4. Failure of the smoke detection, fire detection, fire suppression, or gas detection system	The Tesla Megapack 2 XL does not rely on a dedicated smoke detection, fire detection, or gas detection system for safe operation or to mitigate the effects of thermal runaway. Multi-spectrum infrared (IR) detection, however, are recommended to be provided to satisfy the automatic fire detection requirements. Should the eternal automatic detection systems fail, it is anticipated that BMS fault notifications shall be transmitted to Tesla’s 24/7 Operations Center, alerting system owner to abnormal

	conditions. Data from the BMS may be communicated to the Subject Matter Expert to provide guidance to the fire department in case of emergency. The Megapack 2 XL does not rely on an integrated fire suppression system (such as internal water-based or gas-phase suppression system) to mitigate the hazards associated with propagating thermal runaway. Destructive fire testing and subsequent fire modeling has shown that the robust passive thermal protection of the Megapack 2 XL design will prevent an unlikely fire from cascading to an adjacent Megapack from the initiating system. Furthermore, UL 9540A Unit level testing indicates that no flaming occurred and that no propagation of heat from the initiating unit to adjacent units / modules reached levels capable of initiating cell venting or thermal runaway. It is anticipated that sufficient water will be accessible for defensive operations by firefighters arriving on-site, due to the robust municipal water supply that is provided in proximity to the installation.
5. Voltage surges on the primary electric supply *(FCNYS §1206.5.1(4))*	Voltage surges on the primary electric side are anticipated to be mitigated by the provided BMS and inverter controls, voltage monitoring and automatic disconnect provided by the BMS, in addition to a number of passive circuit protections briefly noted in Section 2.2.6 of this report.
6. Short circuits on the load side of the ESS *(FCNYS §1206.5.1(5))*	Short circuits on the load side of the ESS are anticipated to be mitigated by BMS control and subsequent safety actions, in addition to a number of passive circuit protections briefly noted in Section 2.2.6 of this report.

Thermal Runaway Condition

Thermal runaway, as defined per *NFPA 855 §3.3.20*, is defined as the condition when an electrochemical cell increases its temperature through self-heating in an uncontrollable fashion and progresses when the cell's heat generation is at a higher rate than it can dissipate, potentially leading to off-gassing, fire, or explosion. The cause of a thermal runaway event can range from a manufacturer defect in the cell, external impact, exposure to dangerously high temperatures, or a multitude of controls and electrical failures. Furthermore, a thermal runaway event in a single cell can propagate to nearby cells, thus creating a cascading runaway event across battery modules and racks, leading to more heat generation, fire, off-gassing, and increased potential for a deflagration event.

The Tesla Megapack 2 XL is equipped with a number of passive and active mitigations such as BMS Control and active thermal management system for cooling of internal components to reduce the potential of a thermal runaway event from occurring, as is depicted on the *threat* side of the diagram below. Threat scenarios accounted for include single-cell thermal runaway, multi-cell thermal runaway, and internal defect or failure not resulting in thermal runaway, leading to the primary hazard event (propagating cell failure leading to off-gassing or fire).

Should thermal runaway occur within a battery module, a number of key barriers are provided to mitigate against propagation of failure throughout the system leading to more severe consequences, which are described in detail in Section 3.3 of this report above.

Figure 4-5 - Thermal Runaway Condition Diagram

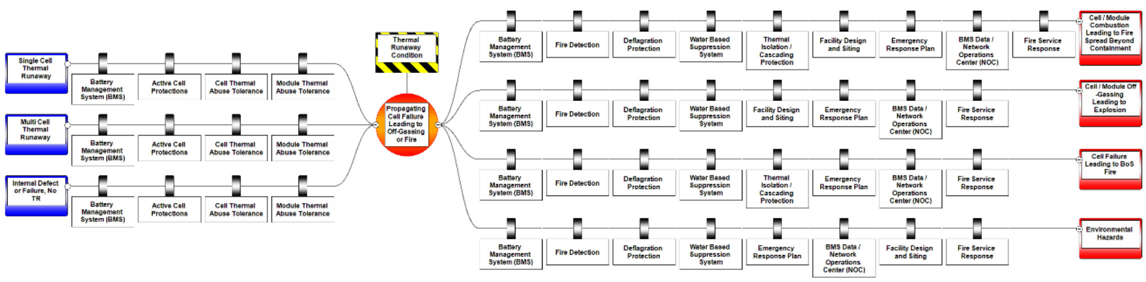


Table 4-3 - Thermal Runaway Condition Barriers

Barrier	Barrier Description
THREAT BARRIERS	
Battery Management System (BMS)	BMS provides sensing and control of critical parameters and triggers protective or corrective actions if system is operating out of normal parameters. Parameters include battery module over / under voltage, cell string over / under voltage, battery module over temperature, temperature signal loss, and battery module over current. In the event of any abnormal conditions, the BMS will first raise an information warning and then trigger a corresponding corrective action should certain levels be reached.
Thermal Management System	Active thermal management system provides liquid cooling to internal components within the Megapack 2 XL to limit heat diffusion.
Cell Thermal Abuse Tolerance	Cell has been tested and listed to UL 1973 in which thermal abuse tolerance was tested.
Module Thermal Abuse Tolerance	Module has been tested and listed to UL 1973 in which thermal abuse tolerance was tested.

CONSEQUENCE BARRIERS
See Section 3.3 above for list of primary consequence barriers.

Failure of any Battery (Energy) Storage Management System

The loss, failure, or abnormal operation of an energy storage control system (controllers, sensors, logic / software, actuators, and communications networks) may directly impact the proper function of the system. The Tesla Megapack 2 XL utilizes a tiered hierarchy of controls starting at the module level up to the site level.

In the event of a failure of module-level BMS, the Megapack-level BMS (which may be considered "ESMS") shall isolate effected modules, mitigating against further propagation of failure across the system. Should a failure of the Megapack-level BMS occur, each module is equipped with a dedicated BMS to provide corrective actions in case of detection of abnormal operation outside of set parameters. To further isolate any failure stemming from a failure of the energy storage management system, passive and active electrical fault protections are provided at multiple levels, as described in Section 2.2.6 above.

Finally, should a propagating thermal runaway occur, a number of key barriers are provided to mitigate against propagation of failure throughout the system leading to more severe consequences, which are described in detail in Section 3.3 of this report above.

Figure 4-6 - Failure of an Energy Storage Management System Diagram

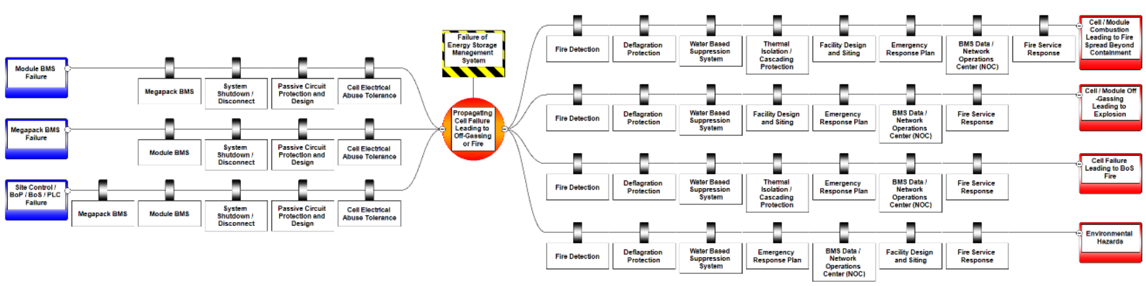


Table 4-4 - Failure of an Energy Storage Management System Barriers

Barrier	Barrier Description
THREAT BARRIERS	
Energy Storage Management System (ESMS)	Megapack-level Energy Storage Management System (ESMS) supervising output of all modules at AC bus level to provide isolation / protective actions in case of module BMS failure.
Module BMS	Module-level BMS to provide isolation / protective actions in case of ESMS failure.

System Shutdown / Disconnect	Multiple levels of passive and active electrical protections are provided for the Megapack 2 XL including module overcurrent protection via fusible links on the DC side of the modules, inverter DC and AC protections, and ground fault detection.
Passive Circuit Protection and Design	Fused disconnects and DC disconnect switches, in addition to ground fault detection / interruption and over voltage protection provided.
Cell Electrical Abuse Tolerance	Cell tested and certified to UL 1642 Standard for Lithium Batteries.
CONSEQUENCE BARRIERS	
See Section 3.3 above for list of primary consequence barriers.	

Failure of any Required Ventilation or Exhaust System

The Megapack 2 XL does not utilize a system to exhaust flammable gasses, as lithium-ion batteries do not release flammable gas during normal operations. Flammable gasses generated during abnormal operations and explosion hazards are mitigated by the Megapack 2 XL's proprietary explosion mitigation system.

Failure of the Smoke Detection, Fire Detection, Fire Suppression, or Gas Detection System

The Tesla Megapack 2 XL does not rely on a dedicated smoke detection, fire detection, or gas detection system. Multi-spectrum infrared (IR) detection are recommended to be provided to satisfy the automatic fire detection requirements of *the 2020 FCNYS Table 1206.15.* Should IR detection systems fail, it is anticipated that BMS fault notifications shall be transmitted to Tesla's 24/7 Operations Center, alerting system owner to abnormal conditions. Data from the BMS may be communicated to a Subject Matter Expert to provide guidance to the fire department in case of emergency.

The Megapack 2 XL does not inherently rely on an integrated or external fire suppression system to mitigate a thermal runaway failure event. A fire is not expected to propagate through the system or to nearby exposures based on UL 9540A Unit level testing, indicating that no flaming occurred and that no propagation of heat from the initiating unit to adjacent units / modules reached levels capable of initiating cell venting or thermal runaway. Destructive fire testing and subsequent fire modeling has further assessed the robustness of the Megapack 2 XL system design and resistance to propagating failures. Furthermore, fire department response is expected to be strong based on training, robust firefighting capabilities and timely response.

Figure 4-7 - Failure of Smoke Detection, Fire Detection, Fire Suppression, or Gas Detection System Diagrams

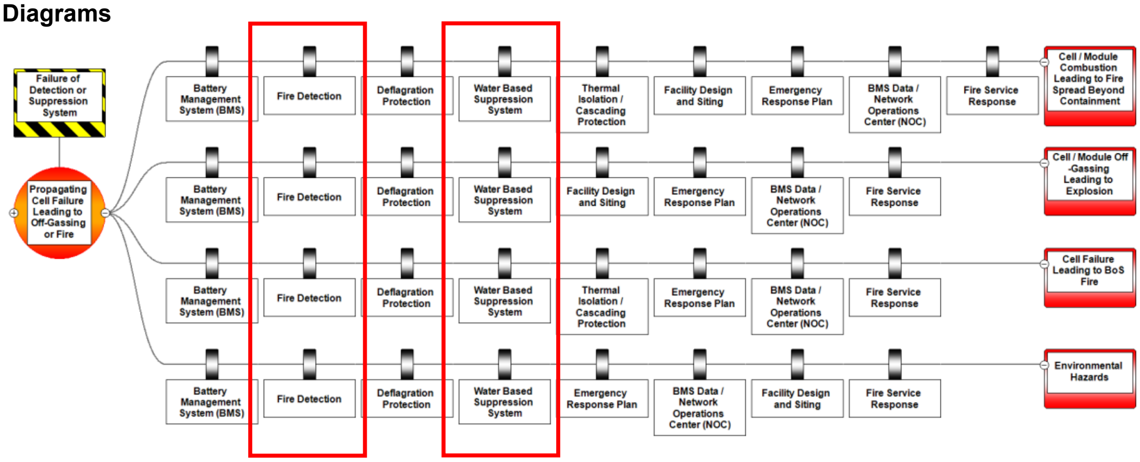


Table 4-5 - Failure of Smoke Detection, Fire Detection, Fire Suppression, or Gas Detection System Barriers

Barrier	Barrier Description
CONSEQUENCE BARRIERS	
Battery Management System (BMS)	BMS provides sensing and control of critical parameters and triggers protective or corrective actions if system is operating out of normal parameters. Parameters include battery module over / under voltage, cell string over / under voltage, battery module over temperature, temperature signal loss, and battery module over current. In the event of any abnormal conditions, the BMS will first raise an information warning and then trigger a corresponding corrective action should certain levels be reached.
Deflagration Protection	The Megapack 2 XL is equipped with deflagration protection in the form of pressure-sensitive vents and sparker system designed to ignite any flammable gases and release in a controlled manner before they are allowed to accumulate and create an explosive atmosphere within the enclosure.
Thermal Isolation / Cascading Protection	Thermal isolation shown to be effective in limiting heat transfer between Megapacks in UL 9540A Unit level testing.
Facility Design and Siting	Facility design and siting is strong. The system is proposed to be installed in a secured area. The Megapack 2XLs are provided with the minimum required separation distances from the adjacent exposures.
Emergency Response Plan / First Responders	Product-level Emergency Response Guide (ERG) provided by Tesla. An additional level of safety will be provided via site-specific Emergency Response Plans

	(ERP) in accordance with the requirements of the FCNYS.
BMS Data / Operations Center	Megapack data accessible remotely via Tesla's 24/7 Operations Center.
Fire Service Response	Site-specific training and installation familiarization for local responding stations will increase the strength of this barrier, and fire department equipment and capabilities will be strong with this familiarization. Given the adequate water supply within the vicinity of the installation, water will be available for defensive firefighting tactics such as cooling of nearby enclosures or other high-risk exposures (if warranted).

Voltage Surges on the Primary Electric Supply

Voltage surges on the primary electric supply are expected to be largely mitigated by voltage monitoring and corrective actions taken by the BMS. Should corrective actions triggered by the BMS fail to prevent further propagation of failure, a number of electrical fault protections are provided for the Megapack 2 XL, as are briefly described in Section 2.2.6 of this report.

Figure 4-8 - Voltage Surges on the Primary Electric Supply Diagram

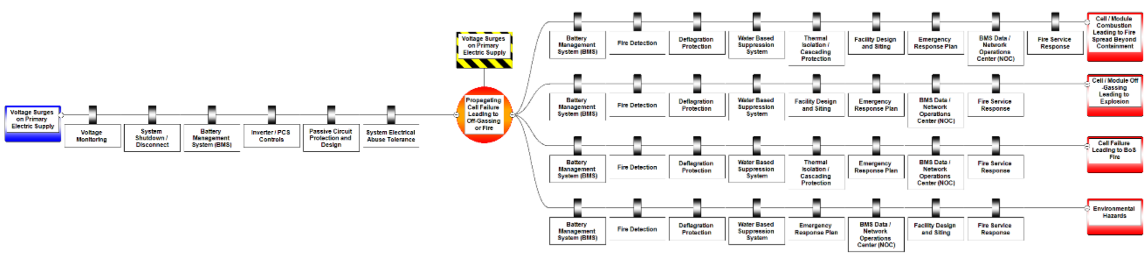


Table 4-6 - Voltage Surges on the Primary Electric Supply Barriers

Barrier	Barrier Description
THREAT BARRIERS	
Voltage Monitoring	Voltage is measured by BMS, triggering fault and alarm monitor indicators, and potential system disconnect or other corrective actions if operating out of normal parameters.
System Shutdown / Disconnect	Multiple levels of passive and active electrical protections are provided for the Megapack 2 XL including module overcurrent protection via fusible links on the DC side of

	the modules, inverter DC and AC protections, and ground fault detection.
Battery Management System (BMS)	BMS provides sensing and control of critical parameters and triggers protective or corrective actions if system is operating out of normal parameters. Parameters include battery module over / under voltage, cell string over / under voltage, battery module over temperature, temperature signal loss, and battery module over current. In the event of any abnormal conditions, the BMS will first raise an information warning and then trigger a corresponding corrective action should certain levels be reached.
Inverter / PCS Controls	Inverter modules equipped with both DC protection via high-speed pyrotechnic fuse for passive or active isolation of battery module, as well as dedicated AC contactor and AC fuses should an abnormal electrical event occur at the inverter module on the AC side of the circuit.
Passive Circuit Protection / Design	Fused disconnects and DC disconnect switches, in addition to ground fault detection / interruption and over voltage protection provided.
System Electrical Abuse Tolerance	System tested and listed to UL 9540.
CONSEQUENCE BARRIERS	
See Section 3.3 above for list of primary consequence barriers.	

Short Circuits on the Load Side of the ESS

Short circuits on the load side of the ESS are anticipated to be largely mitigated by BMS control and passive circuit protection and design (e.g., fused disconnects, ground fault detection / interruption, and overvoltage protection), as described in previous sections of this report. The Megapack 2 XL has been tested and listed to UL 9540A, demonstrating adequate system electrical abuse tolerance and compatibility of constituent components.

Finally, as is consistent across all previous fault conditions covered above, should propagating thermal runaway occur, a number of key barriers are provided to mitigate against propagation of failure throughout the system leading to more severe consequences, which are described in detail in Section 3.3 of this report above.

Figure 4-9 - Short Circuits on the Load Side of the ESS Diagram

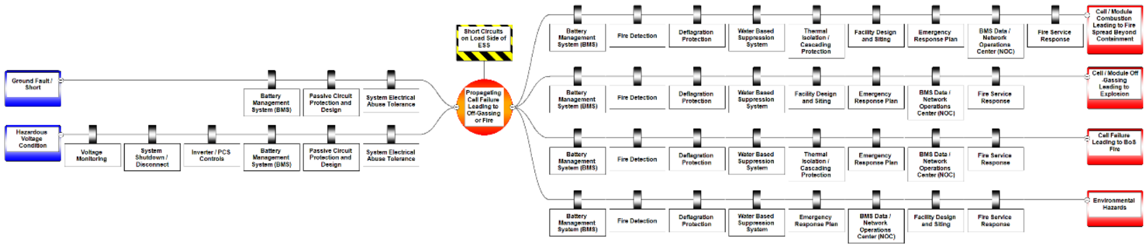


Table 4-7 - Short Circuits on the Load Side of the ESS Barriers

Barrier	Barrier Description
THREAT BARRIERS	
Battery Management System (BMS)	BMS provides sensing and control of critical parameters and triggers protective or corrective actions if system is operating out of normal parameters. Parameters include battery module over / under voltage, cell string over / under voltage, battery module over temperature, temperature signal loss, and battery module over current. In the event of any abnormal conditions, the BMS will first raise an information warning and then trigger a corresponding corrective action should certain levels be reached.
Voltage Monitoring	Voltage is measured by BMS, triggering fault and alarm monitor indicators, and potential system disconnect or other corrective actions if operating out of normal parameters.
System Shutdown / Disconnect	Multiple levels of passive and active electrical protections are provided for the Megapack 2 XL including module overcurrent protection via fusible links on the DC side of the modules, inverter DC and AC protections, and ground fault detection.
Passive Circuit Protection / Design	Fused disconnects and DC disconnect switches, in addition to ground fault detection / interruption and over voltage protection provided.
System Electrical Abuse Tolerance	System tested and listed to UL 9540.
CONSEQUENCE BARRIERS	
See Section 3.3 above for list of primary consequence barriers.	

4.5 Analysis Approval

As per *FCNYS §1206.5.2*, the fire code official shall be permitted to approve the hazardous mitigation analysis as documentation of the safety of the ESS installation provided the consequences of the analysis demonstrate the following:

1. *Fires will be contained within unoccupied ESS rooms or areas for the minimum duration of the fire-resistance rated separations identified in Section 12014.4.*
2. *Fires in occupied work centers will be detected in time to allow occupants within the room or area to safely evacuate.*
3. *Toxic and highly toxic gases released during fires will not reach concentrations in excess of IDLH level in the building or adjacent means of egress routes during the time deemed necessary to evacuate occupants from any affected area.*
4. *Flammable gases released from ESS during charging, discharging and normal operation will not exceed 25 percent of their lower flammability limit (LFL).*
5. *Flammable gases released from ESS during fire, overcharging and other abnormal conditions will be controlled through the use of ventilation of the gases preventing accumulation or by deflagration venting.*

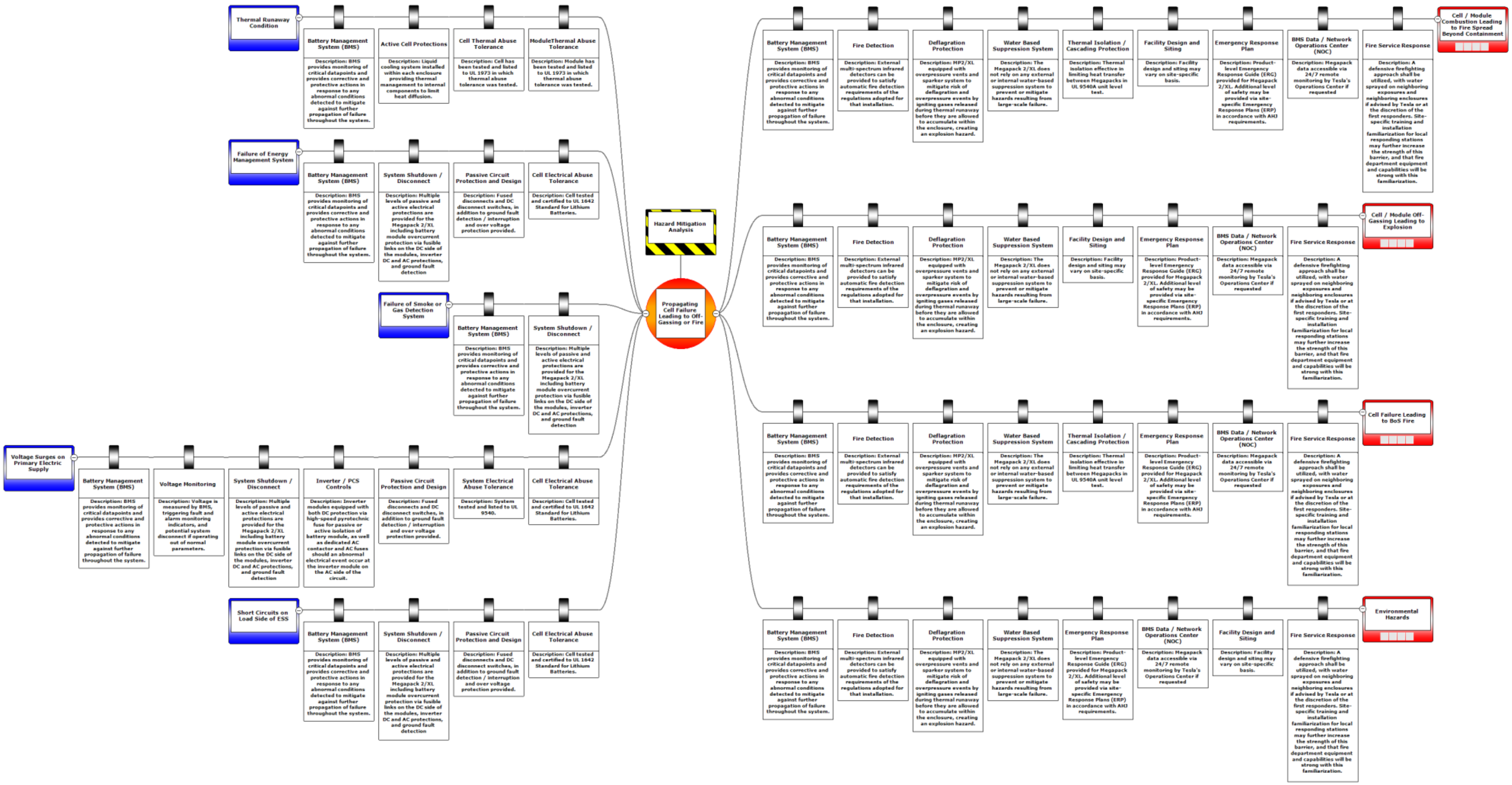
Table 4-8 - Summary of Analysis Approval

Compliance Requirement	Comments
1. *Fires will be contained within unoccupied ESS rooms or areas for the minimum duration of the fire-resistance rated separations identified in Section 1206.14.4*	**Not applicable.** The Megapack 2 XL is intended for outdoor ground-mounted installations only and shall not be installed within any ESS rooms or structures.
2. *Fires in occupied work centers will be detected in time to allow occupants within the room or area to safely evacuate*	**Not applicable.** The Megapack 2 XL is not intended to be installed in any occupied work centers.
3. Toxic and highly toxic gases released during fires and other fault conditions will not reach concentrations in excess of immediately dangerous to life or health (IDLH) level in the building or adjacent means of egress routes during the time deemed necessary to evacuate from that area.	**Compliant.** Additional testing and third-party analysis performed on products of combustion from the Megapack 2 XL at locations 20 ft and 5 ft conclude no traces of Mercury or 27 different metals tested for. HF was detected at values of 0.10 and 0.12 ppm over the course of the test – far below accepted NIOSH Immediately Dangerous to Life or Health (IDLH) value of 30 ppm for HF. The installation is proposed to be sited in an area with adequate separation distances. The Megapack 2XLs meet or exceed the minimum

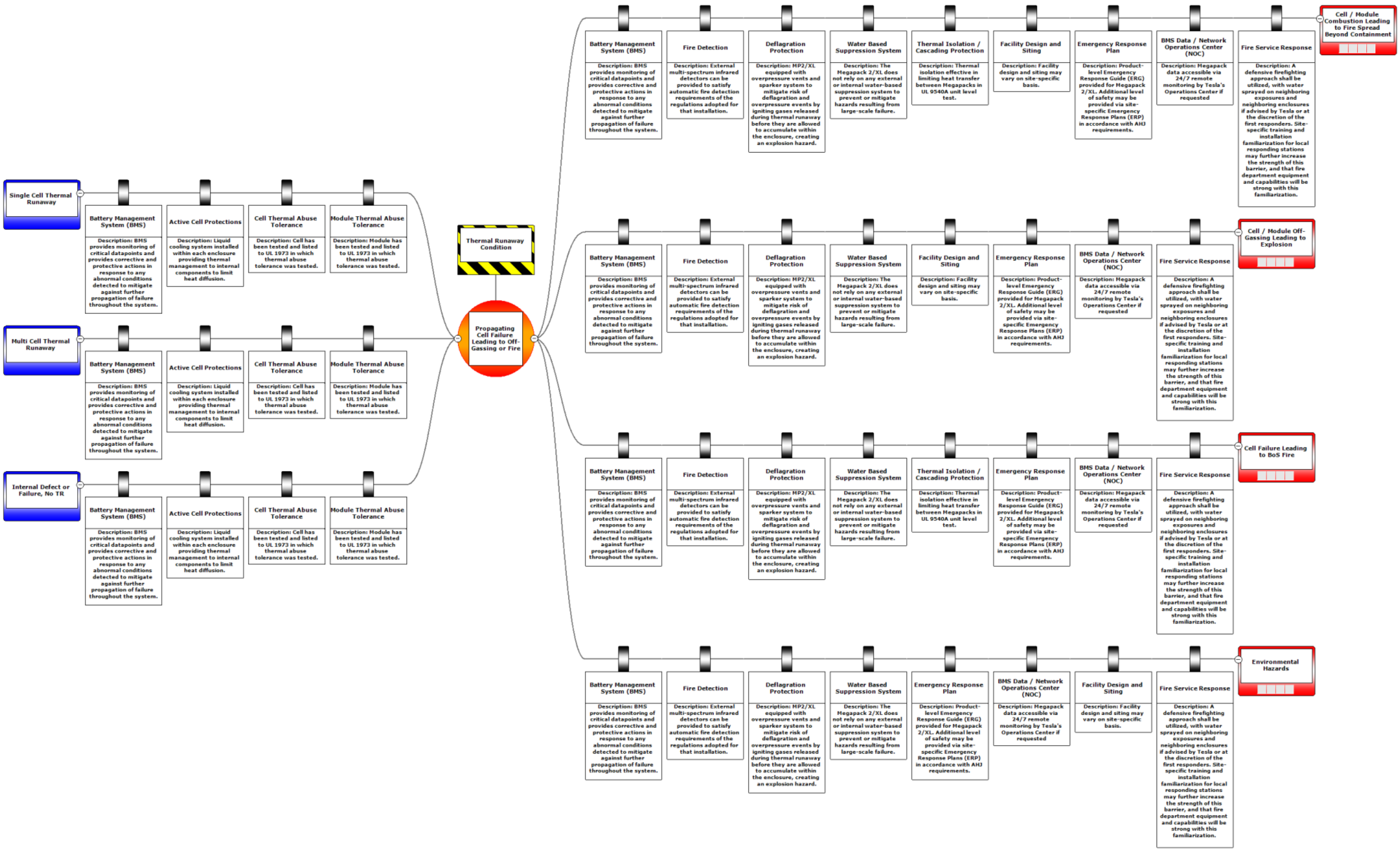
	prescribed separation distances of the 2020 FCNYS Chapter 12.
4. Flammable gases released during charging, discharging, and normal operation will not exceed 25 percent of the LFL.	**Not applicable.** Lithium-ion batteries do not release flammable gases during charging, discharging, or normal operation. In the case of flammable off-gases being released due to a thermal runaway event, the Megapack 2 XL is equipped with pressure-sensitive vents and sparker system designed to ignite any flammable gases and release in a controlled manner before they are allowed to accumulate and create an explosive atmosphere within the enclosure.
5. Flammable gases released from ESS during fire, overcharging and other abnormal conditions will be controlled through the use of ventilation of the gases preventing accumulation or by deflagration venting.	**Compliant.** The Megapack 2 XL is equipped with deflagration protection in the form of pressure-sensitive vents and sparker system designed to ignite any flammable gases and release in a controlled manner before they are allowed to accumulate and create an explosive atmosphere within the enclosure.

APPENDIX A – DETAILED HMA DIAGRAMS AND BARRIER DESCRIPTIONS

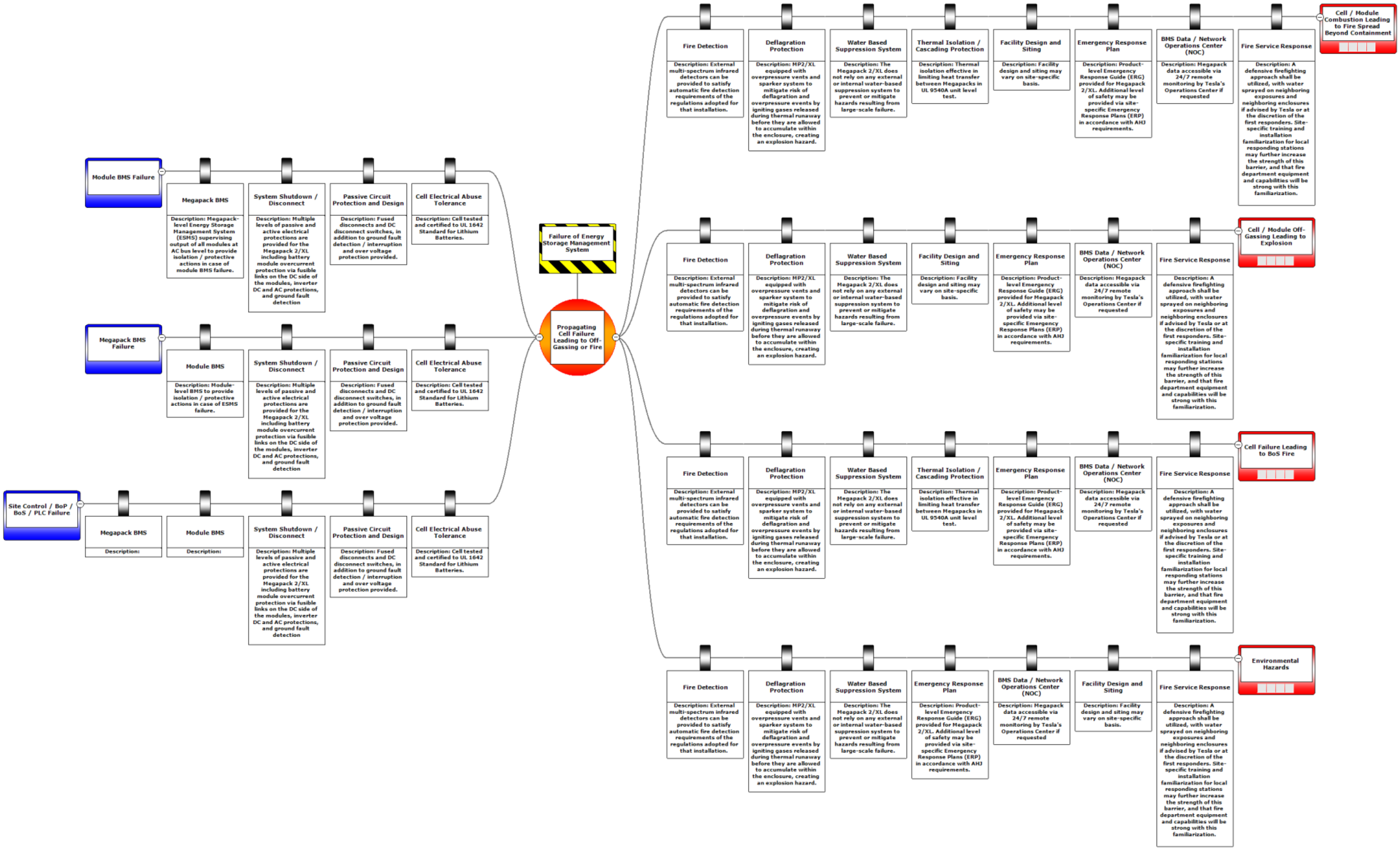
A.1 All Fault Conditions



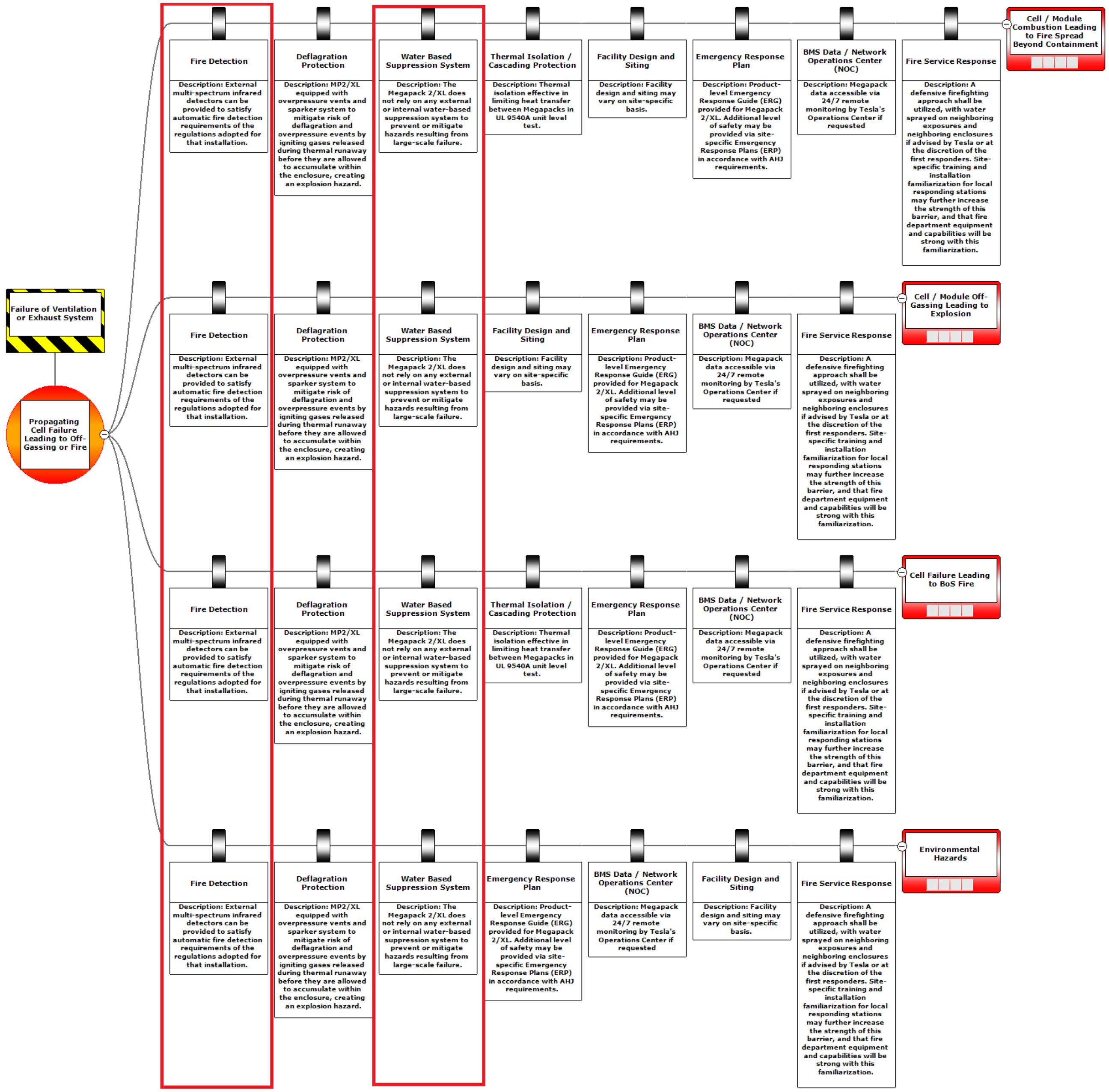
A.2 Thermal Runaway Condition



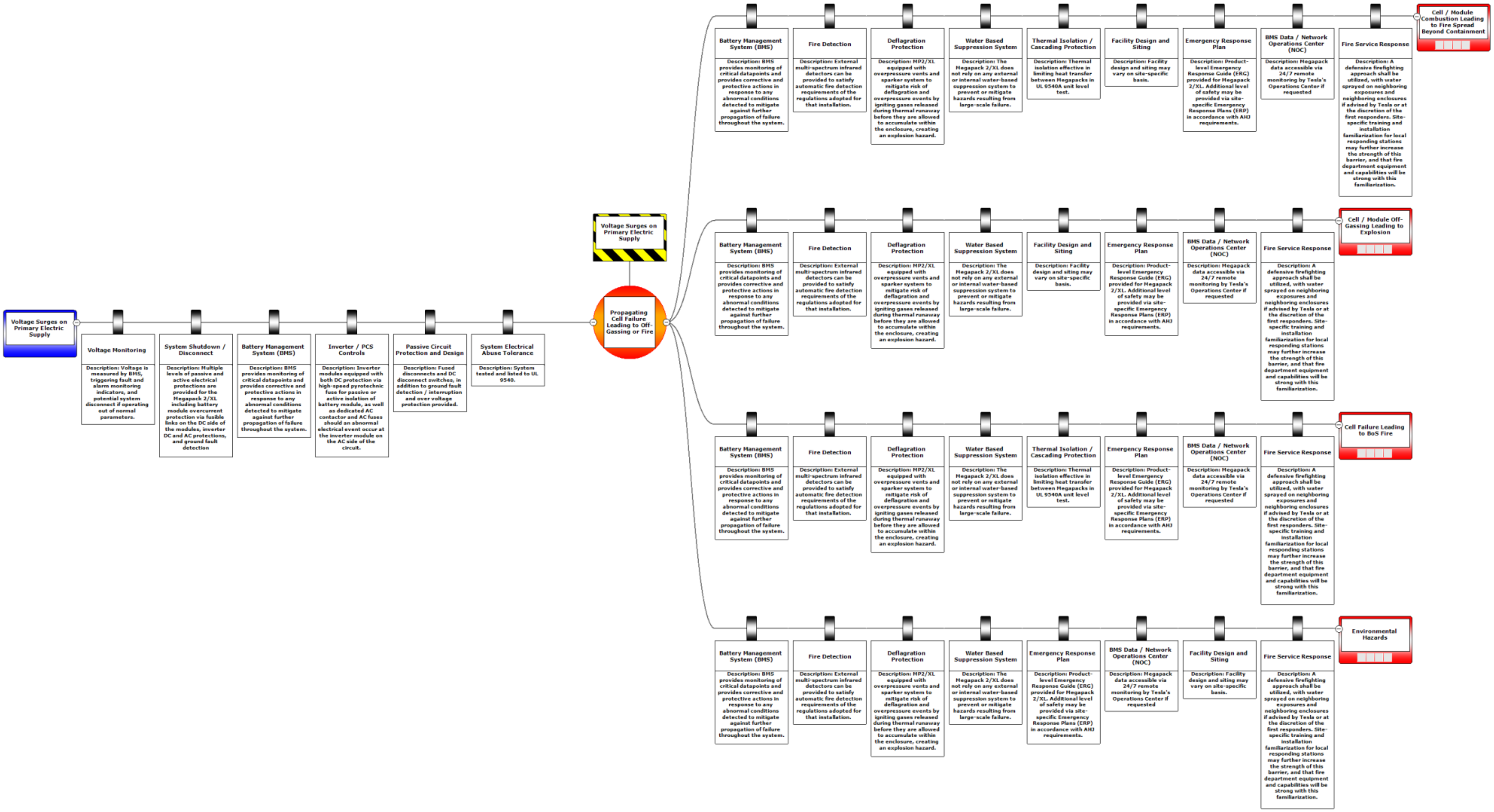
A.3 Failure of an Energy Storage Management System



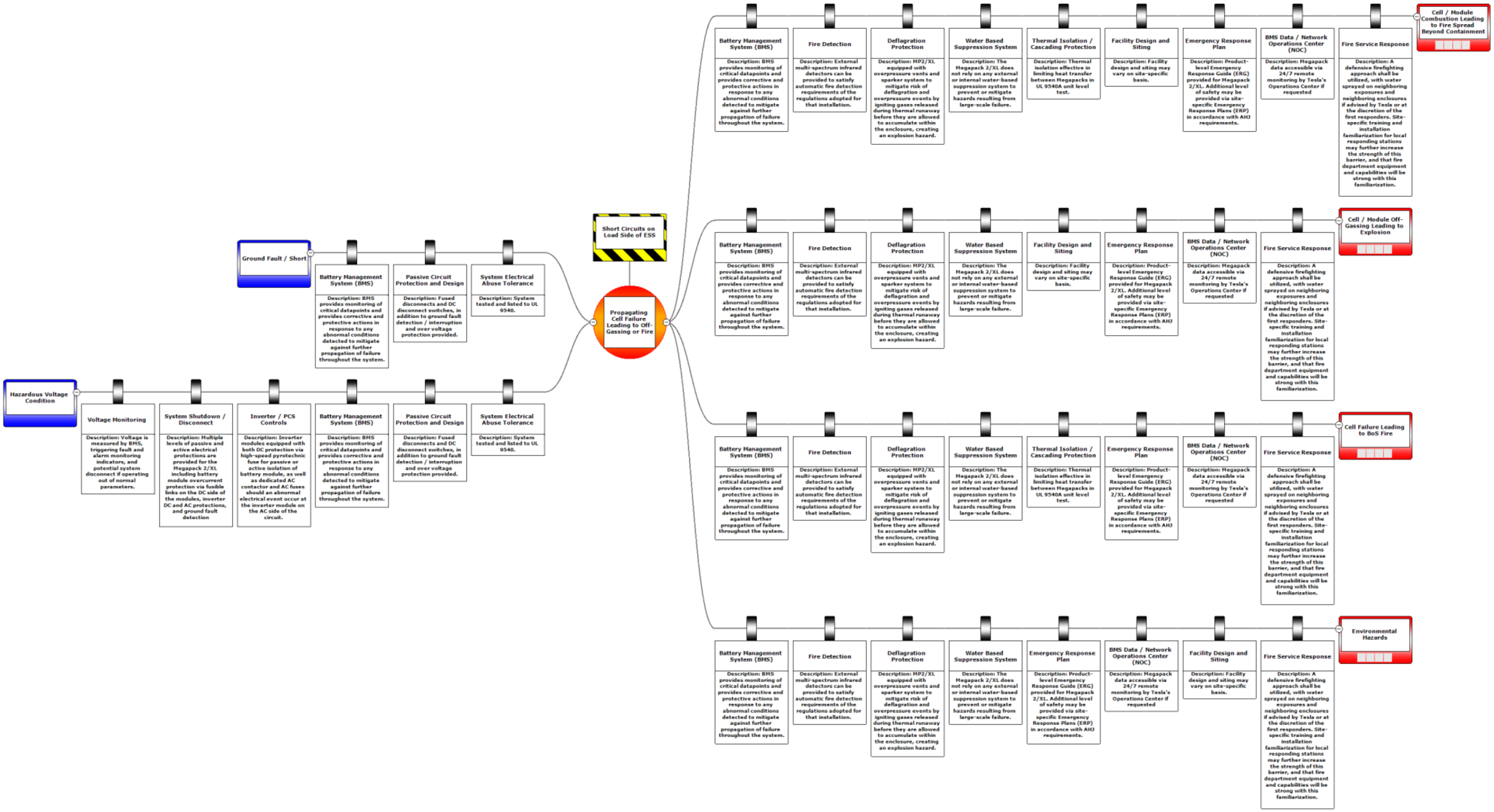
A.4 Failure of a Required Smoke Detection, Fire Detection, Fire Suppression, or Gas



A.5 Voltage Surges on the Primary Electric Supply



A.6 Short Circuits on the Load Side of the ESS

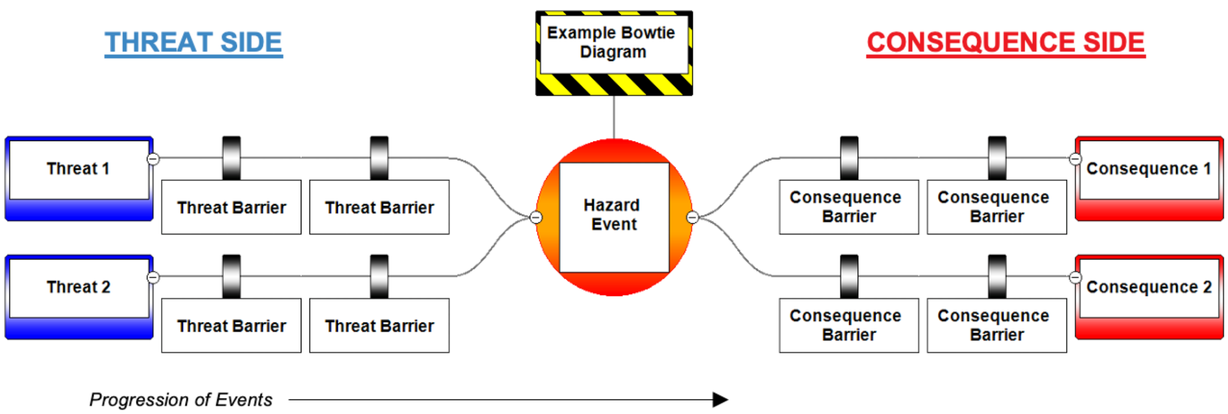


APPENDIX B – HMA METHODOLOGY

This Appendix serves as a supplemental write up for the overall Hazard Mitigation Analysis (HMA) and provides additional context on the Bowtie methodology used, as well as key definitions and concepts.

ESRG utilizes the bowtie methodology for hazard and risk assessments, as is described in *ISO.IEC IEC 31010 §B.21*, as it allows for in-depth analysis on individual mitigative **barriers** and serves as a strong tool for visualizing the chronological pathway of **threats** leading to critical hazard events, and ultimately to greater potential **consequences**, as depicted in the figure below. This simple diagrammatic way of describing and analyzing the pathways of a risk from hazards to outcomes can be considered to be a combination of the logic of a fault tree analyzing the cause of an event and an event tree analyzing the consequences.

The strength of the bowtie approach comes from its visual nature, which forgoes complex, numerical tables for threat pathways which show a single risk or consequence and all the barriers in place to stop it. On the left side are the threats, which are failures, events, or other actions which all result in a single, common hazard event in the center. For our model, many of these threats are the requirements of the fire code such as an unexpected thermal runaway.



- **Hazard Event / Top Event**

  The hazard (or "top") event – depicted as the center point in the middle of the bowtie diagram – represents a deviation from the desired state during normal operations (in this case, a thermal runaway or cell failure event), at which point control is lost over the hazard and more severe consequences ensue. This event happens before major damage has occurred, and it is still possible to prevent further damage.

- **Threats**

  There often may be several factors that cause a "top event". In bowtie methodology, these are called threats. Each threat itself has the ability to cause the center event. Examples of threats are hazardous temperature conditions, BMS failure, and water damage from condensation, each leading to cell failure (the center event for many of the following bowtie diagrams for lithium-ion ESS failures).

Threats may not necessarily address a fully involved system fire or severe explosion, but rather smaller, precursor events which could lead to these catastrophic consequences. Some threats occur without any intervention, such as defect propagation or weather-related events, while others represent operational errors (either human or system-induced). Often threats may also be consequences of even earlier-stage threats, spawning a new bowtie model that includes the threat at the center point or right side of the new bowtie. The diagrams that follow include careful selection and placement of each of the elements to best capture the perspective of system owners and operators responsible for ensuring safe operation.

- **Consequences**

  Consequences are the results of a threat pathway reaching and exceeding its center event. For the models described here, the center events were selected as the event in which proactive protections give way to reactive measures mostly related to fire protection systems and direct response. As the center event then is defined as either “cell failure” or propagating cell failure, the consequences in the models described assume a condition exists in which flammable gas is being released into the system or a fire is burning within the system.

  Consequence pathways include barriers that may help to manage or prevent the consequence event. Threat pathways are often consequence pathways from a separate hazard assessment, as is the case with thermal runaway. In other words, thermal runaway may result from many different threats at the end of a separate hazard pathway (if not properly mitigated) and may also be the threat that could result in several other consequences. The task force identified a set of common consequences representing areas of key concern to utilities, energy storage system operators, and first responders.

- **Barriers**

  In order to control risks, mitigative “barriers” are placed to prevent propagation of failure events across the system. A barrier can be any measure taken that acts against an undesirable force or intention, in order to maintain a desired state, and can be included as proactive threat barriers or reactive consequence barriers.

  Each barrier in these models is more indicative of a concept that may include a single approach or may consist of a complex series of combined measures. Similarly, the analysis may not include barriers required to prevent the threats at the far left of the diagram (which would be placed even further left) to ensure the models do not extend infinitely, though the incorporation of these variables into site-specific safety evaluations may provide additional benefit. This list does not contain all possible solutions and in some designs, these barriers may not exist at all. Many of the same barriers apply to a number of threats.

Barriers may mitigate hazards or consequences in a variety of ways. For example, common barriers to thermal runaway include active electrical monitoring and controls, redundant failure detection, and even passive electrical safeties (such as over-current protection devices and inherent impedances). Should these systems fail to detect the threat, shutdown the system, or otherwise prevent thermal runaway from occurring, the hazard may persist.

APPENDIX D – REFERENCED DOCUMENTATION

[1] *Tesla_Megapack 2_Megapack 2XL-_ANSI-UL_9540A_Unit_Level_Report.pdf*

[2] *Tesla_Megapack_2_and_XL_FPE_Report_Final.pdf*

APPENDIX E – REFERENCED CODES AND STANDARDS

- *NFPA 855 Standard for the Installation of Stationary Energy Storage Systems*, 2020 Edition
- *International Fire Code §1207 Electrical Energy Storage Systems*, 2021 Edition
- *UL 9540A Standard for Test Method for Evaluation Thermal Runaway Fire Propagation in Battery Energy Storage Systems,* 4th Edition
- *UL 9540 Standard for Energy Storage Systems and Equipment,* 2nd Edition

KCE NY 31
Draft Emergency Operations Plan (EOP)

NY 31

EMERGENCY OPERATIONS PLAN
(EOP)

Document Number
KCE-HSEQ-0004

VERSION CONTROL

Rev	Date of Issue	Reason for Issue	Prepared By:	Reviewed By:	Approved By:
0	03/01/24	Issued for Use	Various	Various	E. Nelson

Prepared By:	Reviewed By:	Approved By:
Bob Garrett	Robert Tepp	Erika Nelson
Title: Manager, Compliance	**Title:** Director, HSEQ	**Title:** Director, Project Operations
Dept: Compliance	**Dept:** HSEQ	**Dept:** Operations
Date:	**Date:**	**Date:**

A. CONTENTS

B. EOP SUMMARY

1. Overview

This Emergency Operations Plan (EOP) sets forth the emergency operations plans and procedures of Key Capture Energy, LLC (KCE). The following emergency response procedures are provided so that all personnel understand the practices to be followed to prepare for and provide immediate and effective response* to emergencies that might arise at KCE facilities. Because the safety of employees and the public is of primary concern, the Key Capture Energy (KCE) Emergency Response Coordinator (ERC) and each member of the KCE staff are committed to providing a safe, healthy work environment and are responsible for ensuring implementation of these procedures.

Life safety of personnel shall be the highest priority during any event.

2. Limitations

Responders will coordinate the plan and response according to all applicable laws and standards. Where a conflict exists between this plan and applicable laws and standards, the most conservative and restrictive approach shall be followed.

Response to emergencies, events or disasters shall only be undertaken to the level of the responders' training, Personal Protective Equipment (PPE), and resources available. No persons shall place themselves in harm's way to respond to an emergency.

Actual site conditions may be different than expected in this plan as there may be little to no warning during specific events to implement operational procedures.

3. Management of Change

A review of this Emergency Operation Plan (EOP) shall be conducted and documented at minimum on an annual basis, notionally January of each year. The plan shall also be reviewed and amended whenever there is a change in facility design, construction, operation, or maintenance or mandated regulatory changes that affect emergency response planning. When outside resources are changed or modified the plan shall be reviewed and updated to reflect the changes that may affect this plan. Details on the revision history are provided in Section F.

***Specific response details for each of the defined emergencies above can be found in the Section II Annexes.**

C. RECORD OF DISTRIBUTION

The following KCE personnel have received access to, and training on, the EOP on the following dates:

Name	Title	Date Received Access to EOP	Date Received Training on EOP
Brian Hayes	Chief Executive Officer	03/01/2024	
Rachel Goldwasser	Head of Legal & Regulatory	03/01/2024	
Erika Nelson	Head of Project Operations	03/01/2024	
Robert Tepp	Head of HSEQ	03/01/2024	
Colin Tareila	Head of Asset Operations	03/01/2024	
Jenny Fink	Director of Asset Management	03/01/2024	
Jose DeLaFuente	O&M Manager	03/01/2024	
Jose Dominguez	O&M Manager	03/01/2024	
Kyle Hull	O&M Manager	03/01/2024	
Jake Hurst	O&M Associate	03/01/2024	
Cameron Kemp	O&M Associate	03/01/2024	
Bob Garrett	Compliance Manager	03/01/2024	
Jim Brown	Head of Construction	03/01/2024	
Kendra Williamson	Head of Market Operations	03/01/2024	
Kate Goldsberry	Senior Asset Manager	03/01/2024	
Shaun Boggs	Head of IT & Cybersecurity	03/01/2024	
Anna Mayzenberg	Market Operations Analyst	03/01/2024	
Chris Linsmayer	Public Affairs Manager	03/01/2024	
Brad Lewis	Associate General Counsel	03/01/2024	

D. EMERGENCY CONTACTS

Name	Title	Contact Information	Can Immediately Address Urgent Requests and Questions During an Emergency
Primary Contacts			
Erika Nelson	Head of Project Operations	[redacted]	X
Colin Tareila	Head of Asset Operations	[redacted]	X
Rachel Goldwasser	Head of Legal & Regulatory	[redacted]	X
Backup Contacts			
Kyle Hull	O&M Manager (NY)	[redacted]	X
Jose Dominguez	O&M Manager (TX)	[redacted]	X
Jose DeLaFuente	O&M Manager (TX)	[redacted]	X

E. APPROVAL AND IMPLEMENTATION

1. Introduction to EOP

This EOP details roles and responsibilities for coordinating emergency response activities before, during, and after any type of emergency or disaster at KCE operational facilities.

The intent of the EOP is to assist with the coordination of emergency response efforts to save lives, reduce injuries, and maintain business continuity with its primary goal being the assembly, mobilization, and coordination of a team of responders and internal coordinators that can deal with any emergency.

This plan is implemented by the individual first identifying an Emergency Condition, either by dialing 911 or by contacting the posted Emergency Contact Number. An emergency response coordinator (ERC) shall be assigned immediately upon identification of an Emergency Condition. The ERC is most often the Operations Manager for the associated facility but can be any KCE employee who has been identified as having a role in the EOP.

2. Personnel with Responsibility for EOP

The following KCE personnel are responsible for maintaining and/or implementing the EOP, and have authority to change the EOP, as indicated:

Na me	Title	Responsible for Maintaining EOP	Responsible for Implementing EOP	Authority to Change EOP
Erika Nelson	Head of Project Operations	X	X	X
Kyle Hull	O&M Manager		X	

3. Revision Control

Since the EOP's initial preparation, revisions have been made to the EOP on the following dates:

Revision No.	Date Revised	Description of Revision

4. Currentness of EOP

KCE hereby affirms, as of **March 1, 2024**, that this EOP supersedes all previous EOPs. This EOP was most recently approved by KCE on **March 1, 2024**.

5. Training Requirements

KCE has initiated an annual training program for personnel who are expected to have a role or responsibility included in this Emergency Operation Plan. This training program covers all aspects of the EOP. Personnel training will be completed and documented on an annual basis.

F. COMMUNICATIONS PLAN

1. Purpose & Scope

Key Capture Energy (KCE) is dedicated to safe and responsible operations of all facilities. As such, KCE is responsible for maintaining communications with individuals and organizations affected by an incident, emergency or unforeseen accident involving company operations, projects, or people. This plan applies to all incidents covered by this document.

2. Communications Responsibilities

Crisis Communications Team: The Crisis Communications Team will be responsible for formulating a communications response to be utilized in concert with the EOP. The Crisis Communications Team will convene as promptly as possible following the occurrence of the relevant incident or event and shall continue to meet regularly as the incident and the response requires. For further information on the Crisis Communications Team, their roles and responsibilities, KCE employees shall reach out to the Manager, Public Affairs.

Purpose of Meetings: The meetings of the Crisis Communications Team will convene the relevant subject matter experts and managers of KCE required for effective information sharing and response formulation following an incident. The meetings will provide a forum for:

- exchange of information as to the relevant facts and circumstances surrounding the incident, operational actions that KCE is taking in response, and inquiries and other requests from affected stakeholders.
- communications response planning, including ensuring that all required stakeholders are notified and that KCE's messaging is unified and accurate; and
- planning for long-term incident response as needed.

Team Members: The members of the Crisis Communications Team are as follows:

- Head of Asset Operations
- Head of Legal & Regulatory
- Head of HSEQ
- Head of Public Relations
- Emergency Response Coordinator (ERC) as designated via the EOP for the incident as needed at the discretion of the Crisis Communications Team.

Additionally, incident-specific team members may be added to the Crisis Communications Team (as required by the Crisis Communications Team) for purposes of any specific incident.

3. Specific Points of Contact

Specific members of the Crisis Communications Team will serve as the points of contact responsible for communicating with specific stakeholders. Each designated member under this sub-section (3) is responsible for reporting communications with their respective stakeholders back to the rest of the Crisis Communications Team.

Media: Messaging to the media is to be formulated by the Crisis Communications Team and approved by the Manager, Public Affairs. In the immediate aftermath of an incident, The Crisis Communications Team will identify a spokesperson, as required, to speak to media.

State Public Utilities Commission: KCE's Head of Legal & Regulatory, in consultation with the Crisis Communications Team, is responsible for communications with the respective state public utilities commissions.

Consumer Advocates: KCE's Head of Legal & Regulatory, in consultation with the Crisis Communications Team, is responsible for all communications with consumer advocate groups.

Fuel Suppliers: N/A. KCE does not own or operate assets with fuel suppliers.

Local and State Government Entities, Officials, and Emergency Operations Centers: The Crisis Communications Team is responsible for communications with local and state government entities, officials, and emergency operations centers. The ERC will provide all relevant information to the Crisis Communications team, who will then communicate with local and state officials and emergency operations centers with the information that is immediately required to respond to an ongoing incident. Long-term response (including in respect of any remediation and/or root cause analysis for an incident) shall be developed by the Crisis Communications Team and communicated through the ERC or another designated member of the Crisis Communications Team, as appropriate.

Reliability Coordinator: KCE's Crisis Communications team is responsible for all communications with the applicable reliability coordinator. The Crisis Communications team shall keep the applicable reliability coordinator apprised of any incident by telephone or email, as appropriate.

G. MAINTENANCE OF PRE-IDENTIFIED SUPPLIES FOR EMERGENCY RESPONSE

As BESS facilities are normally unmanned and, except as otherwise referenced herein, do not require the use of consumable supplies, no supplies are expected or necessary to support KCE response to emergencies detailed in this plan.

H. STAFFING DURING EMERGENCY RESPONSE

As BESS facilities are normally unmanned, no on-site staffing is expected at the onset of an Incident. KCE staff or third-party support will be dispatched to the Site to troubleshoot or address the specific Incident. Except as may be specifically stated otherwise in this EOP, during an emergency the BESS may remain unmanned and, where applicable, personnel will be precluded from accessing the BESS unless / until it is determined safe for an inspection or maintenance activities to be performed. In the case of a weather emergency impacting one of KCE's offices, employees not located in the impacted region shall be knowledgeable in and prepared to support the impacted state's operations. For further information related to staffing during severe weather events, please see Appendix 6.

I. IDENTIFICATION OF WEATHER-RELATED HAZARDS

See SECTION II: Annex A (WEATHER EMERGENCIES) and Annex E (HURRICANE) for information regarding how KCE identifies weather-related hazards of various types. KCE has developed both Cold and Hot Weather Operations Plans with specific operational instructions to address extreme weather events. These plans are provided in Appendix 6 for reference.

J. ACTIVATION OF EOP

1. Definition of Emergency

An emergency is defined as a situation in which the known, potential consequences of a hazard or threat are sufficiently imminent and severe that an entity should take prompt action to prepare for and reduce the impact of harm that may result from the hazard or threat, including an emergency declared by local, state, or federal government, or Independent System Operator (ISO) or another applicable reliability coordinator. Emergencies can happen before, during or after normal work hours and can be caused by a range of circumstances and hazards involving both equipment, nature, and people. For the purposes of this EOP, "incident", "emergency", and "event" are interchangeable terms. The many different types of emergencies include, but are not limited to:

- Smoke
- Fire
- Toxic Gas Release
- Medical Emergency
- Severe Weather
  - Extreme Heat
  - Winter Storm (Extreme Cold)
  - Hurricanes
  - Tornadoes
  - Floods
  - Lightning Storms
  - Drought / Water Shortage
- Seismic Event
- Hazardous Material Spill
- Workplace Violence
- Cybersecurity Threat
- Bomb Threats
- Pandemic / Epidemic
- Physical Security Breach

2. Activation of Emergency Response

In the event of an emergency, calling 911 is the preferred method for initiating emergency response. This should be followed by contacting KCE at the emergency contact phone number provided.

As set forth in Section III: Appendix 5 – Site Information, the KCE emergency contact phone number is clearly marked on informational/warning signs around the perimeter fencing at each facility and may be dialed by any individual, whether an employee or a member of the public. This line is answered 24 hours a day, 365 days per year by personnel instructed in how to initiate emergency response for the facility. The person receiving a call through the emergency contact number shall initiate this EOP by contacting the KCE Emergency Response Coordinator (ERC). As previously stated in Section E, the ERC is typically the Operations Manager for the associated facility/region but can be any individual who has been identified as having a role in the EOP.

3. Site-Specific Emergency Response

Responders will coordinate the response efforts identified in the EOP according to all applicable laws and standards. Where a conflict exists between this plan and applicable laws and standards, the most conservative and restrictive approach shall be followed.

Response to emergencies, events or disasters shall only be undertaken to the level of the responders' training, availability of necessary Personal Protective Equipment (PPE), and the resources available. No persons shall place themselves in harm's way to respond to an emergency.

Actual site conditions may be different than what is expected in this plan as there may be little to no warning during specific events to implement operational procedures.

4. Roles & Responsibilities

All KCE personnel with responsibilities for emergency response management or support shall be trained in the requirements of this plan on an annual basis.

Overall, the primary responsibility for the EOP lies with the Operations and Maintenance (O&M) Manager who executes the duties of the ERC. The ERC, or their designee, is responsible for program implementation, including coordinating severe weather activities, communicating emergency response procedures to personnel including the Crisis Communications Team, and contractor coordination as needed. In addition, the ERC shall conduct routine updates and overviews with Emergency Responders including tabletop exercises, walkthroughs, and drills.

The personnel identified below shall have the corresponding responsibilities described below in connection with activation of the EOP.

Operations & Maintenance Manager (or designee)

- Initiate emergency response if not already initiated by the Remote Operations Center (ROC) by dialing 911 or calling local emergency response organizations directly as may be appropriate. Information to be provided to 911 operator or local emergency response organizations include:
    - location, type, and current status of the incident;
    - personnel injury (number, severity, status) if applicable;
    - property damage (type, severity) if applicable;
    - actions taken or in progress;
    - any safety guidance to ensure the safe arrival of response organizations;
    - updated ERC contact information;
    - contact information for the on-scene coordinator (if different than the ERC);
- Establish themselves as the ERC.
- Mobilize to the site, if/when possible, to assume additional responsibility of On-Scene Coordinator.
- Communicate situational updates with all parties during an emergency.
- Direct the isolation of the facility from the grid when required or requested.
- Direct the isolation of electrical equipment to the maximum extent possible.

- Monitor local news channels for critical information from the National Weather Service (NWS) including watches, warnings, and advisories for winter storms, tropical storms, and hurricanes issued by local NWS Forecast offices.
- Responsible for implementing and ensuring personnel familiarity with this EOP.

The Operations & Maintenance (O&M) Manager, or their designee acting as the ERC or On-Scene Coordinator, shall be responsible for reporting the incident throughout KCE using the process included in the KCE HSEQ Manual. Specifically, the ERC shall initiate an e-mail via **INCIDENTS**@keycaptureenergy.com for informing relevant operations and administrative contacts within KCE, to initiate corporate awareness and public communications activities in accordance with company structure and policies.
The e-mail shall be formatted:

- *Subject: Initial Report – Location – Initial Classification – Date*
- *Body: Brief description of the event to include WHO, WHAT, WHEN, WHERE*

On-Scene Coordinator (Operations & Maintenance (O&M) Manager employee; if on-site)

- If there are employees on-site, the senior-most of such on-site employees will act as the On-Scene Coordinator and shall assist in the implementation of this plan by:
    - calling 911 (if not already done);
    - evacuating all personnel and securing the scene;
    - accounting for all personnel at a muster area;
    - assisting the evacuation of injured personnel if necessary;
    - communicating with the ERC during the emergency;
    - reporting the status of the facility to include evacuation of all on-site personnel;
    - liaising with any on-scene emergency responders*;
    - maintaining a written log and timeline of all response activities undertaken;
    - directing all media inquiries to the Communications Team.

***The On-Scene Coordinator, or the designated ERC when no KCE representative is on-site, will act as the liaison to the Fire Department and any other first responders until the ERC arrives on-site.**

All On-site Personnel

- Immediately report emergency situations to the senior KCE representative on-site;
- Call 911 to inform local emergency first responder personnel**;
- Notify the ERC of the situation using the KCE emergency contact phone number posted onsite.

****There shall be no delay to report emergency events that require local emergency responders. The senior KCE representative, if on-site, will call 911 and then immediately notify the ERC using the emergency contact phone number posted on-site.**

Chief Operating Officer (COO) or Head of Operations

- Act as the liaison to the Management Team and Crisis Communications Team
- Affirm, through endorsement of this EOP that all relevant operating personnel are familiar with this EOP and committed to following the plan, except to the extent where deviations are appropriate under the circumstances during the course of an emergency
- Provide resources necessary to expeditiously restore BESS facilities to operation after an emergency event
- Prioritize the recovery of BESS capacity (restoration) after an emergency once determined safe to do so

Market Operations

- Monitor conditions and liaise as required with market stakeholders and the reliability coordinator as may be required during an emergency and detailed throughout this plan

Legal and Government Relations

- Support in risk mitigation throughout the duration of the emergency
- Be prepared to assist or perform outreach and reporting to the appropriate State and Federal Government agencies as may be required

Crisis Communications Team

- Be prepared to implement the Crisis Communications Plan consistent with the emergency event.

5. Preparation & Planning

Pre-planning for emergencies is a crucial element of this plan. The following steps will be taken:

- Consistent with KCE's Public Awareness Manual, fire departments and other first responders will receive a copy of this plan, participate in an on-site familiarization meeting, and be updated annually on any changes in equipment or operations
- A copy of this plan shall be located at each facility
- Buildings and property surrounded by fencing will be marked by signage that identifies specific hazards (such as the NFPA diamond, and all applicable Danger, Caution, Warning signal words)
- On-site personnel shall receive a directive to keep vehicles not actively in use for maintenance or repair activities out of the BESS fence perimeter to facilitate and ensure emergency egress when necessary
- Safe approach distances are established for equipment's different failure modes and personnel are trained in these distances
- Safety Data Sheets (SDS) provided by manufacturers shall, where possible, be maintained on- site and

provided to first responders.

NOTE: As BESS facilities are normally unmanned, no supplies are expected or necessary to support KCE response to emergencies detailed in this plan. During extreme weather, BESS will remain unmanned, and personnel will be precluded from accessing the BESS until determined safe for inspection / maintenance activities.

NOTE: BESS facilities do not utilize alternative fuels and therefore do not require on-site fuel storage or fuel testing requirements

6. As previously discussed, when an incident occurs at any level, members of KCE's Crisis Communications Team will be notified. The Team will then convene and initiate the steps for evaluating and determining the severity of the event. Warning Systems & Alarms

Audible and visual (e.g., flashing lights) alarm systems have been established that reflect specific on-site hazard analyses. Personnel shall be trained on the significance of different alarms and the corresponding actions as outlined elsewhere in this plan.

Warning systems and alarms are tested at least every six months or more frequently per manufacturer specifications or code requirements are documented as completed. All site personnel, as well as those offsite at remote operations control centers shall be made aware of tests so as not to cause undue concern.

7. Emergency Response & Evacuation

No employee is required or permitted to place themself in harm's way in order to facilitate extinguishment, evacuation, or rescue. All rescue operations will be performed by trained professionals upon their arrival. Rescue operations will only be conducted after a risk-reward analysis is done and proper PPE is used to protect against any adverse hazards that may be encountered.

Only personnel who are properly trained in accordance with 29 CFR Part 1910.120(q)(6) may respond to hazardous chemical releases.

If personnel are onsite, they shall be required to evacuate to the designated muster areas for:

- Smoke
- Fire
- Toxic Gas Release
- Severe Weather
- Hurricanes
- Tornadoes

- Floods
- Lightning Storms
- Seismic Event
- Hazardous Material Spill
- Bomb Threats
- The general procedure for evacuation shall be to:
- Stop all work activities as quickly as can be done so safely
- Follow the emergency response flowchart
- Secure the work area to prevent additional hazards
- Calmly leave the work area and meet at a designated muster area
- Provide egress assistance to other personnel if needed
- Standby for instructions from the On-Scene Coordinator or ERC

A. ANNEX A – WEATHER EMERGENCIES

1. Extreme Heat

BESS are normally unmanned facilities designed with dedicated climate control and therefore have minimal exposure to hazards associated with extreme heat. The KCE HSE Manual provides direction for personnel protection from extreme heat. KCE will deem there to be an extreme heat event when the temperatures are forecasted to go above the design limits of the BESS or upon notification of an extreme heat event by the ISO or other regulatory entity.

When a summer weather threat exists, the facility's O&M Manager shall monitor local news channels for critical information from the National Weather Service (NWS) including warnings and advisories issued by local NWS Forecast offices.

During an extreme heat event, the O&M Manager shall follow the following checklist for extreme heat emergency response:

- As per KCE's standard protocols, it will ensure personnel safety is a first priority at all times
- KCE will continue to monitor internal container temperatures to assure ongoing HVAC and other BESS operations
- As per KCE's standard protocols, it will notify the System Integrator (ROC) of the extreme weather event in order to have a heightened awareness and to continue to report any and all abnormal conditions to KCE including but not limited to:
    - Enclosure interior temperatures;
    - Battery cell temperatures;
    - Ambient temperatures at the facility.
- As per KCE's standard protocols, if problems are identified, it will reacted accordingly including, but not limited to the following actions:
    - Conduct remote troubleshooting when required;
    - O&M Manager shall alert the Head of Operations and other management staff of any serious issues impacting operations or availability;
    - Request KCE's service provider dispatch HVAC technicians (if applicable) or other service staff at the earliest availability as required.

2. Winter Storm (Extreme Cold)

BESS are normally unmanned facilities designed with dedicated climate control and are therefore minimally susceptible to issues associated with extreme cold. The KCE HSE Manual provides direction for personnel protection from extreme cold. KCE will deem there to be an extreme cold event when the temperatures are forecasted to go below the design limits of the BESS or upon notification of an extreme cold event by the ISO or other regulatory entity.

When a winter weather threat exists, the facility's O&M Manager shall monitor local news channels for critical information from the National Weather Service (NWS) including winter storm watches, warnings, and advisories issued by local NWS Forecast offices.

For more information related to KCE's extreme weather response, please see the Cold Weather Operations Plan, provided in Appendix 6.

3. Hurricane

See Annex E (HURRICANE) below.

4. Tornado

BESS are normally unmanned facilities designed to local codes and standards and therefore have limited exposure to hazards associated with tornadoes.

When a tornado threat exists, the facility's O&M Manager shall monitor local news channels for critical information from the NWS including watches, warnings, and advisories issued by local NWS Forecast offices.

If personnel are on-site when the potential for a tornado exists, and prior to experiencing sustained winds >25 miles per hour, material shall be secured, and any aerial work stopped upon the issuance of a tornado warning. The facility shall be evacuated, and all personnel will report to the nearest shelter area, to be determined prior by O&M personnel during daily safety briefs. In the event O&M personnel are outside and unable to evacuate to the shelter, the following guidance is provided to personnel on-site:

- lie flat in a nearby ditch or depression, covering their head with their hands, being aware of the potential for flooding;
- find shelter in a low, flat location;
- avoid sheltering under an overpass or bridge;
- do not try to outrun a tornado in congested areas in a vehicle;
- leave their vehicle to find safe shelter;
- be aware of the potential for flying debris.

Following tornado or high wind events, the facility will be evaluated by the O&M personnel for damage. All repairs will be performed under standard operational procedures.

5. Flooding and Flash Flood

BESS are normally unmanned facilities designed to local codes and standards and therefore have limited exposure to hazards associated with flooding.

When a flooding threat exists, the facility's O&M Manager shall monitor local news channels for critical information from the NWS including watches, warnings, and advisories issued by local NWS Forecast offices.

Flash flooding is a result of heavy localized rainfall such as that from slow moving, intense thunderstorms. Flash floods often result from small creeks and streams overflowing during heavy rainfall. These floods often become raging torrents of water which rip through riverbeds or canyons, sweeping everything with them. Flash flooding can occur within 30-minutes to six hours of a heavy rain event. In hilly terrain, flash floods can strike with little or no advance warning. Distant rain may be channeled into gullies and ravines causing flash flooding in minutes. In the event of a flash flood, the following guidance is provided to personnel onsite:

NOTE: It does not have to be raining for flash flooding to occur.

- do not drive through flooded areas, even if it looks shallow enough to cross;
- person leading work shall make a judgement to either shelter in place, or immediately secure the work and travel to safe refuge;
- do not cross flowing streams on foot where water is above your ankles;
- be especially cautious at night as it is harder to recognize water danger then;
- do not attempt to outrace a flood on foot if flooding is seen or heard, move to higher ground immediately;
- be familiar with nearby land features where you work;
- wait 15 to 30 minutes, or until high water recedes, prior to leaving shelter.

6. Lightning Storms

BESS are normally unmanned facilities designed to local codes and standards and therefore have limited exposure to personnel hazards associated with lightning.

If personnel are onsite and a lightning storm is within 10 – 30 miles and approaching the site, the following guidance is provided:

- notify facility's O&M Manager and all on-site employees;
- stop work safely and head to company or personal vehicles if storm/lighting is still approaching the site, get in and stay in vehicles that have rubber tires only;
- once storm passes, remain in vehicle for at least 30 minutes depending on passing storm severity, and wait for an "OK" from the O&M Manager in charge of monitoring the storm.

Market Operations Responsibilities

In the case of any inclement weather, the Market Operations Team shall:

- monitor all communications from Independent System Operators (ISOs) including, but not limited to Operating Condition Notices (OCN), Advisories, and other communications;
- ensure site operations are aware of all ISO notices regarding impending winter weather;
- communicate with ERC regarding any such communications;
- ensure KCE representative is on-call 24/7 to receive and respond to notices and to communicate internally (including ERC) and with site operator / ROC during periods when ISOs have issued a weather notice;
- ensure local Transmission Distribution Service Provider (TDSP) has KCE/ROC contact info heading into any period when ISO has issued a weather notice.

B. ANNEX B – WATER SHORTAGE

BESS are normally unmanned facilities that do not require water or access to a water source and are unaffected by water shortages.

C. ANNEX C – RESTORATION OF SERVICE

Once emergency response is complete and locations are determined to be safe for personnel access, where required, Head of Asset Operations and Head of Project Operations, with advice from the ERC, Head of Market Development, and General Counsel, shall determine whether restoration of service is safe and appropriate. Restoration of service shall be performed in coordination with the applicable Qualified Scheduling Entity and with the appropriate approvals (if required) from the Independent System Operators (ISO).

D. ANNEX D – PANDEMIC AND EPIDEMIC

BESS are normally unmanned facilities therefore have limited exposure to personnel hazards associated with outbreaks and pandemics. Guidance associated with pandemic response shall be included in the KCE Safety Manual or provided as a standalone pandemic guideline. KCE is able to operate under work-from-home conditions if required due to a pandemic or epidemic.

E. ANNEX E – HURRICANE

BESS are normally unmanned facilities designed to local codes and standards and therefore have limited exposure to hazards associated with hurricanes.

When a hurricane threat exists, regardless of Category, the facility's O&M Manager shall monitor media outlets for critical information from the NWS including watches, warnings, and advisories issued by local NWS Forecast offices and shall be cognizant that conditions can change rapidly.

Evacuation and re-entry planning for assets located in Hurricane Evacuation Zones shall follow the guidance provided by local authorities.

The following are the general guidelines for hurricane conditions.

CONDITION 4

- hurricane within 72-hours of arrival, and possible movement towards facility
- brief all personnel
- avoid on-site work and travel
- start clean-up and securing operations, if required
- plan for next condition

CONDITION 3

- hurricane within 48-hours of arrival
- intensify clean-up and securing operations, if required
- evaluate starting some Condition 2 activity

CONDITION 2

- hurricane within 24-hours of arrival
- complete all clean-up and securing operations, if required

CONDITION 1

- hurricane within 12-hours of arrival
- shutdown all on site activities, if any
- complete all items above
- ensure complete evacuation of facility if any personnel onsite
- ensure ROC monitoring until hurricane passes

POST HURRICANE

- once practical to visit site, a walkdown shall be conducted starting with a perimeter walk outside the fence, re-entering inside the fence after visually confirming conditions are safe to continue
- take pictures from all sides of the facility for documentation

F. ANNEX F – CYBERSECURITY

Below is KCE's Cybersecurity Incident Response Plan. KCE maintains additional cybersecurity-related plans and procedures not submitted herein.

G. ANNEX G – PHYSICAL SECURITY

Sabotage may take different forms and it would be impossible to define any and all sabotage that could occur. KCE follows the NERC Event Reporting Plan used to comply with NERC Standard EOP-004 and also adheres to NERC's Critical Infrastructure Protection ("CIP") Standard, CIP-003 (Cyber Security Incident Response Plan). Additionally, the following checklist shall be used when responding to physical security, as well as cybersecurity, incidents:

1	If sabotage has been identified or reported immediately notify the O&M Manager.
2	The O&M Manager will determine when and if it is safe for personnel to continue work on site (if personnel are on-site) and, as required, make appropriate notifications to personnel based on initial information and site condition.
3	If appropriate call 911 or another designated Emergency Services provider. Refer to site contact and location information to ensure prompt response.
4	If off-site Emergency Response personnel are required, the O&M Manager shall coordinate to ensure access to the site and proper direction.
5	If appropriate, the O&M Manager shall notify appropriate law enforcement as necessary to conduct an investigation*.
6	If sabotage resulted in creating an unacceptable safety risk, the affected equipment shall be shut down or affected area cleared and barricaded.
7	The O&M Manager shall notify the Head of HSEQ and CIP Senior Manager to determine whether the event is reportable in accordance with NERC Reliability Standard EOP-004.

*** Any instances of trespassing, vandalism, or suspected criminal activity shall be immediately reported to O&M Manager so that local police can be engaged. The O&M Manager shall use judgement to determine whether components of this EOP shall be activated.**

H. ANNEX H – FIRE

1. Smoke/Flames from an Unknown Source

Smoke emanating from a KCE BESS is an indication of an abnormal and hazardous condition and can be indicative of potential issues including a thermal runaway event. The smoke is possibly flammable and an inhalation hazard and may ignite at any time.

If fire or smoke is observed emanating from a KCE BESS at any time it shall be treated as a fire.

- evacuate personnel to a designated muster location
- contact the senior KCE representative on-site or, in their absence, dial 911
- contact the KCE emergency contact phone number posted on-site to inform the ERC
- prevent non-emergency responder access to the BESS

If a report of smoke emanating from a BESS with no personnel on-site is received, the person receiving the report shall call the Emergency Services Dispatch Number set forth in Appendix 4 – Site Information and then the Emergency Contact Number for the site (also included in Appendix 4 – Site Information). illustrates the required steps.

2. Fire External to Battery Container or Enclosure

In the event there is a visible fire beyond the incipient stage external to a battery container or enclosure, including fires external to the perimeter fencing, then the following actions apply.

NOTE: Batteries remain energized even if all contactors, breakers, and switches have been opened.

- Contact the senior KCE representative onsite or, in their absence, dial 911
- Evacuate the site via the safest egress path and report to the designated muster location.
    - if heavy smoke is encountered stay low and breathe through a handkerchief or other fabric; move away from the area
    - assist anyone having trouble leaving the area so long as doing so does not put the assistor at additional risk
    - do not leave the designated muster point until advised to do so by ERC.
- On-Scene Coordinator shall account for all employees, contractors, and visitors
- Contact the KCE emergency contact phone number posted onsite to inform the ERC
- Remove any obstructions (vehicles, material, etc.) that might impede the response of emergency personnel to the scene
- Establish appropriate barriers and traffic barricades to keep unauthorized (non-emergency) personnel from accessing BESS
- Once the Fire Department is onsite, provide:
    - SDS
    - site-specific EOP
    - a liaison to remain with the Fire Department, when possible
        - To the maximum extent possible, responding fire crew should remain outside the fence, pull back to a safe distance and continue to follow a fire containment strategy

- Allow the container to burn until it self-extinguishes, while protecting surrounding areas (defensive firefighting)

- Follow the instructions of Emergency Responders
- Do not re-enter site until fire department has turned the site back over to KCE O&M Manager and KCE SME issues an 'all clear' for designated personnel.

NOTE: During defensive firefighting efforts application of high volumes of water from an appropriate distance may be applied to the outside of the container to help cool the unit and prevent further reactions or a fire from developing. Fire crews may choose to utilize a water stream or fog pattern to protect the surroundings or control the path of smoke.

NOTE: The ERC shall coordinate with BESS Supplier and direct disconnecting the BESS from the grid once notified of a fire event that has the potential to impact operations.

If a report of fire external to a BESS container with no personnel onsite is received, the person receiving the report shall call the Emergency Services Dispatch Number and then the Emergency Contact Number for the site (included in Appendix 4 – Site Information).   illustrates the required steps.

3. Fire Internal to Battery Container or Enclosure

In the event there is a known or suspected fire internal to a battery container or enclosure, then the same actions apply as a fire external to a battery container, but the below MUST be noted.

NOTE: Some fire suppression systems are designed to work in a contained environment and some ventilation systems have programmed functionality to improve effectiveness. DO NOT open container or enclosure doors until it has been determined no hazards are present, and with approval of emergency personnel and the Executive VP of Operations. Atmospheric monitoring, either remotely or via local sampling, is required to confirm atmosphere will not become explosive when outside air is admitted to container or enclosure.

4. Post-Fire Overhaul

The fire department will make the final determination regarding when the scene is safe to release the site to staff. In some circumstances the scene may need to be safeguarded for investigators to examine the event failures. If the event was caused by a criminal act, the facility's O&M Manager shall be guided by law enforcement for direction.

Hazards after a fire should be identified at the time of installation such that recommendations for personal protective equipment (PPE) are available for clean-up crews and hazardous materials (HAZMAT) teams. This may include respirators to protect personnel from toxic gas that continues to be generated from hot cells. Firewater retention and cleanup measures may be required by local regulations. Once first responders have turned the site back to KCE, the SME(s), in coordination with the ERC, shall direct on-site personnel on procedures for securing the site for safety and pending any investigation.

In addition to the gas generation risk, cells that remain hot also pose a delayed ignition risk, whereby heat in the cell may transfer to undamaged adjacent cells or remaining active material and reignite the fire. As such, fire-damaged equipment must remain monitored, remotely or by establishing a fire watch onsite for a minimum Twenty-four (24) hours to extend to a period of length identified in consultation with equipment manufacturers and the SME(s).

Care should be taken to ensure that damaged batteries containing energy have been handled safely in accordance with disposal procedures. Batteries involved in a fire, care should be taken with handling or dismantling battery systems involved in fires as they may still contain hazardous energy levels.

5. Conditions Associated with Energy Storage Systems

BESS are generally new applications of existing technology currently gaining widespread adoption. It is important to recognize certain technical aspects when developing response actions.

Unique Challenges

Energy storage systems present a unique challenge for fire fighters. Unlike a typical electrical or gas utility, an energy storage system does not have a single point of disconnect. Whereas there are disconnects that will de-energize select parts of the system, the batteries themselves will remain energized.

The following hazards may be encountered when fighting fires in energy storage systems:

- shock or arcing hazard due to the presence of water during suppression activities
- electrical enclosures may not resist water intrusion from high-pressure stream of a fire hose
- batteries damaged in the fire may not resist water intrusion
- damaged conductors may not resist water intrusion
- shock hazard due to direct contact with energized components
- no means of complete electrical disconnect
- chemical spills
- flammable gases
- toxic gases (visible and non-visible)
  thermal runaway and explosions

Fire and Water

Due to the hazards described above, care and consideration should be applied when considering fire suppression by means of water inundation within energy storage systems. Because water as an extinguishing agent is commonplace, the appropriate use of water should be assessed.

KCE recommends use of water be limited to defensive firefighting efforts (application of high volumes of water from an appropriate distance applied to the outside of the container and nearby equipment / landscaping). Fire crews may choose to utilize a water stream or fog pattern for defensive firefighting to protect the surroundings or control the path of smoke.

The local fire department should be informed of appropriate fire suppression methods for the energy storage system type as identified by the equipment manufacturer. Coordination with the BESS manufacturer is recommended as this may include water in some cases, and in all scenarios its use should not be discouraged.

All fire extinguishing equipment, whether automatic or manual, is regularly inspected for functionality as per manufacturers' guidance and required by local fire codes.

I. ANNEX I – TOXIC GAS RELEASE

Toxic gas releases may be the consequence of abnormal and hazardous conditions and can be indicative of potential issues including a thermal runaway event. The gas is possibly a combustible and inhalation hazard and may ignite at any time.

If gas is known or suspected to be released from a KCE BESS at any time it shall be treated as a fire.

- Evacuate personnel to designated muster location
- Contact the senior KCE representative onsite or, in their absence, dial 911
- Contact the KCE emergency contact phone number posted on-site to inform the ERC
- Prevent non-emergency responder access to the BESS

If a report of gas release from a BESS with no personnel on-site is received, the person receiving the report shall call the Emergency Services Dispatch Number and then the Emergency Contact Number for the site (included in Appendix 5 – Site Information). Appendix 1 - Emergency Response Flow Chart illustrates the required steps.

J. ANNEX J – MEDICAL EMERGENCY

If an employee is injured, or an accident has occurred on site and first aid is not enough treatment for the emergency, 911 must be called. The call to 911 can be made by phone by any available personnel.

A second notification will be made to Contact the KCE emergency contact phone number posted onsite to inform the ERC.

1. Serious Injury

The following procedures apply for serious medical injuries such as unresponsive subject, bite / sting for personnel who are allergic, bone fractures, neck trauma, or severe burns after 911 has been called.

- On-site personnel shall meet EMS responders at site entrance and direct them to incident location
- Do not leave or move the injured unless directed to by emergency medical service personnel
- Administer first aid if necessary
- The ERC shall inform Human Resources to contact employee's personal emergency contact
- Follow the incident reporting guidelines included in KCE Health, Safety, and Environmental (HSE) Manual

2. Non-Emergency Safety Incident

In the event a safety incident occurs where emergency response is not required (first aid treatment, near miss, etc.) work is to be stopped immediately and reported to the Operations Manager. Risk will be reassessed, adequate controls implemented, and the situation made safe before resuming the task. The Operations Manager shall follow the incident reporting guidelines included in the KCE HSE Manual.

K. ANNEX K – SEISMIC EVENT

BESS are normally unmanned facilities designed to local codes and standards and therefore have limited exposure to hazards associated with earthquakes.

Earthquakes may strike with little to no advance warning. As such, when an earthquake does occur, it is important to stay as safe as possible. Be aware that some earthquakes are actually fore-shocks, and a larger earthquake may subsequently occur. Also, be aware that many earthquakes are accompanied by aftershocks after the main event has occurred. If an earthquake occurs minimize your movements to a few steps to a nearby safe place until the shaking has stopped. Move away from the enclosures, structures, light poles, and utility wires. If safe to do so, personnel shall take the First Aid kit with them.

Once in the open stay there until the shaking stops to prevent being hit by falling debris.

Following seismic events, the facility will be evaluated by O&M personnel for damage. All repairs will be performed under standard operational procedures.

L. ANNEX L – HAZARDOUS MATERIAL SPILL

The KCE HSE Manual provides guidance for pollution prevention and spill response. The SDS shall be reviewed, and the area evacuated if necessary. Only properly trained personnel with appropriate PPE shall clean up a spill.

M. ANNEX M – WORKPLACE VIOLENCE

To ensure a safe work environment for all employees, KCE expressly prohibits any acts or threats of violence by any employee against any other employee, client, vendor, or visitor, or self-inflicted violence, except in extreme cases where self-defense may become necessary. If any behavior is noticed that could be perceived as an act or threat of violence, inform the O&M Manager, who will contact the authorities.

N. ANNEX N – BOMB THREAT

If a bomb threat is received by phone, email, text, or a handwritten note immediately notify the O&M Manager who will contact 911, or local police department. The O&M Manager shall instruct all personnel to evacuate the facility via the nearest exit.

When ordering an evacuation due to a bomb threat, it is important that employees be trained regarding how to evacuate. If a bomber is nearby and sees everyone conspicuously evacuating a space, they may decide to detonate the device early. Therefore, it is imperative that personnel remain calm and evacuate in an orderly fashion, without drawing any unnecessary attention to themselves or the situation.

If a bomb threat is received by phone:

- Remain calm and keep the caller on the line for as long as possible
- DO NOT HANG UP, even if the caller does
- Listen carefully, be polite and show interest
- Try to keep the caller talking to learn more information
- If possible, inform a colleague using text, handwritten note, or other discrete methods to call the authorities or, as soon as the caller hangs up, immediately notify them yourself
- If your phone has a display, copy the number and/or letters on the window display
- Complete the Bomb Threat Checklist in the appendices of this plan
- Write down as much detail as you can remember, trying to get exact words
- From a different phone, contact authorities immediately with information and await instructions

If a bomb threat is received by handwritten note:

- Notify the O&M Manager who will contact 911, or local police department
- Handle the note as minimally as possible. Do not throw it away.
- Turn the note over to authorities upon request when they arrive.

If a bomb threat is received by e-mail:

- Notify the O&M Manager who will contact 911, or local police department
- Do not delete the message or forward it to anyone else unless directed to do so by FIRE/EMS authorities

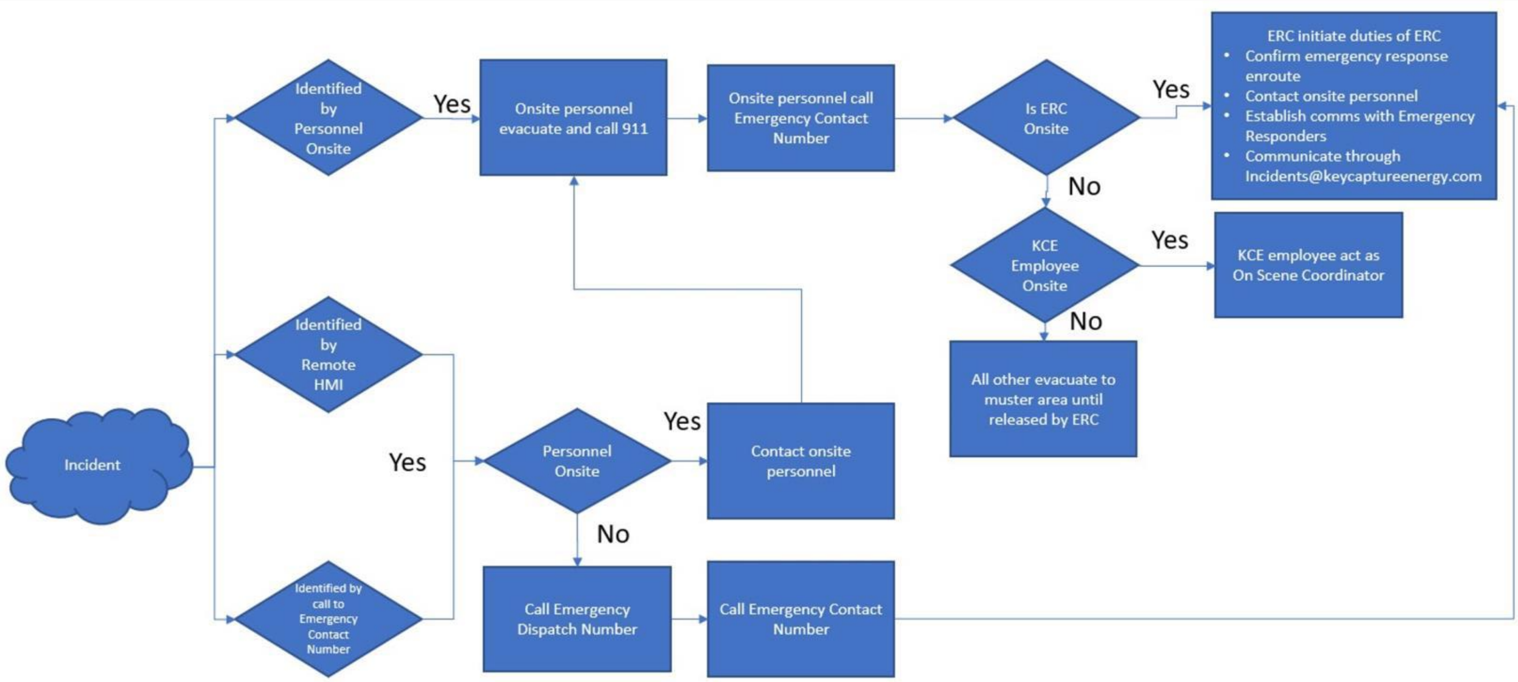
If a bomb threat is perceived due to seeing a suspicious package evident by:

  - no return address
  - excessive postage
  - stains
  - strange odor
  - strange sounds
  - unexpected delivery
  - poorly handwritten
  - misspelled words
  - incorrect titles

  - foreign postage
  - restrictive notes
- Notify the O&M Manager who will contact 911, or local police department
- Do not use two-way radios or cell phone as radio signals have the potential to detonate a bomb
- Do not touch or move a suspicious package
- As soon as the danger has passed, an authorized “all-clear” will be issued and personnel will be allowed to return to the facility

KEY CAPTURE ENERGY

APPENDIX 1 – RESPONSE FLOWCHART



APPENDIX 1 – RESPONSE CHECKLIST

Incident Identified by KCE Personnel

- ☐ 1) The Incident occurs and is identified by On-Site KCE Personnel.
- ☐ 2) The on-Site KCE Personnel will evacuate the Site and call 9-1-1.
- ☐ 3) The on-Site KCE Personnel will call all relevant Emergency Contacts listed in the Site-Specific EOP.
- ☐ 4) An Emergency Response Coordinator (ERC) will be established.
- 5) If the ERC is on-Site, they will fulfill the duties of an ERC, which include the following:
  - ☐ a. Establish communications with emergency responders and confirm if they are enroute to the Site.
  - ☐ b. Remain in contact with any other on-Site Personnel.
  - ☐ c. Communicate updates through the Incidents@keycaptureenergy.com e-mail.
- ☐ 6) If the ERC is NOT on-Site, but other KCE Personnel are on-Site, that individual will act on behalf of the ERC as the On-Scene Coordinator (OSC).

Incident Identified by 3rd Party (KCE Personnel On-Site)

- ☐ 1) The Incident occurs and is identified by an outside party or 3rd Party Monitoring (i.e. ROCC)
- ☐ 2) KCE will determine if there are any Personnel On-Site.
- ☐ 3) If KCE Personnel are present on-Site, they will be notified immediately of the Incident.
- ☐ 4) The on-Site Personnel will evacuate the Site (if necessary) and call 9-1-1.
- ☐ 5) The on-Site KCE Personnel will call all relevant Emergency Contacts listed in the Site-Specific EOP.
- ☐ 6) An Emergency Response Coordinator (ERC) will be established.
- ☐ 7) Follow steps 5 & 6 listed above.

Incident identified by 3rd Party (no KCE Personnel On-Site)

- ☐ 1) The Incident occurs and is identified by an outside party or 3rd Party Monitoring (i.e. ROCC)
- ☐ 2) KCE Personnel are NOT present on-Site, the Emergency Dispatch number will be called.
- ☐ 3) The list of KCE Emergency Contacts will then be notified via Emergency Dispatch.
- ☐ 4) An ERC will be established by KCE's Emergency Contacts.
- ☐ 5) The ERC will then fulfill the duties as outlined above (Steps 5 & 6).

APPENDIX 2 – CHECKLISTS

For each checklist item:

- If the item inspected is satisfactory, check the OK box
- If a deficiency is identified, complete the Comments section and indicate the Action Taken
- If the item does not apply, check the N/A box

Emergency Response	***OK***	***N/A***	***Action Taken / Comments***
Facility evacuated, if required			
Emergency responders are enroute, if required			
Communications established with emergency responders			
BESS disconnected from grid, if required			
Crisis communications plan initiated, if required			
Other			

Emergency Response Planning	***OK***	***N/A***	***Action Taken / Comments***
Emergency response plans (including important phone numbers) written and available			
Training provided and drills performed for persons required to implement emergency response			
Housekeeping maintained to ensure egress paths are clear and no missile hazards exist in periods of high winds			
Site work cancelled in advance of extreme weather			
ROC informed of potential for extreme weather			

Fire & Explosion Prevention	***OK***	***N/A***	***Action Taken / Comments***
Fire extinguishers inspected monthly and serviced by contractor annually			
Emergency telephone number posted in clear and conspicuous locations			
Trash is removed at least daily from building			
Fire, smoke, H2 detection systems and HVAC inspected and serviced			
Exterior locations free of trash and combustible debris			

APPENDIX 3 – BOMB THREAT CHECKLIST

Bomb Threat Checklist	
Date:	Time:
Time Caller Hung Up:	Phone # Where Call Received:
Ask Caller:	
Where is the bomb located? (Building, floor, room, etc.):	
When will it go off?	
What does it look like?	
What kind of bomb is it?	
What will make it explode?	
Did you place the bomb? Yes No Why?	
What is your name?	
Exact Words of Threat:	
Information About Caller:	
Where is the caller located? (background/level of noise)	
Estimated age:	
Is voice familiar? If so, who does it sound like?	
Other points:	

Caller's Voice		Background Sounds	Threat Language
☐ Female	☐ Excited	☐ Animal noises	☐ Incoherent
☐ Male	☐ Laughter	☐ House noises	☐ Message read
☐ Accent	☐ Lisp	☐ Kitchen noises	☐ Taped message
☐ Angry	☐ Loud	☐ Street noises	☐ Irrational
☐ Calm	☐ Nasal	☐ Booth	☐ Profane
☐ Clearing throat	☐ Normal	☐ PA system	☐ Well-spoken
☐ Coughing	☐ Ragged	☐ Conversation	
☐ Cracking voice	☐ Rapid	☐ Music	
☐ Crying	☐ Raspy	☐ Motor	
☐ Deep	☐ Slow	☐ Clear	
☐ Deep breathing	☐ Slurred	☐ Static	
☐ Disguised	☐ Soft	☐ Office machinery	
☐ Distinct	☐ Stutter	☐ Factory machinery	
		☐ Local	
		☐ Long Distance	

Other Information:

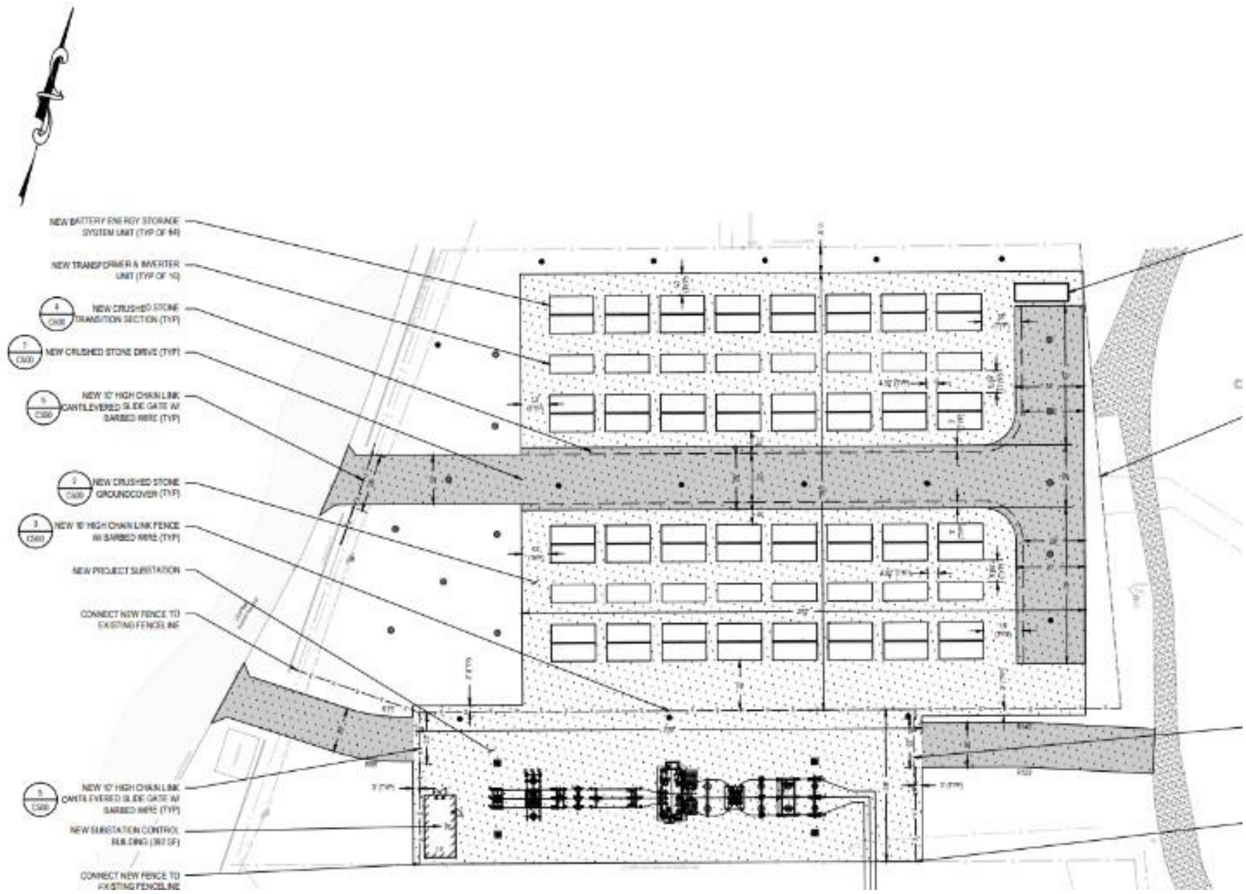
APPENDIX 4 – CONTACT INFORMATION

Organization	Contact	Phone	Description

KEY CAPTURE ENERGY

APPENDIX 5 – SITE SPECIFIC INFORMATION

NY 31 Storage – Site Plan



*** 911 should be used during an emergency ***

NY 31 Storage

1 Lilco Road
Shoreham, NY 11786
Site coordinates: 40.9581, -72.866535

Suffolk County Emergency Services Dispatch

Suffolk County Police Department	
Phone	631-852-6000

Fire Department

Rocky Point Fire Department	
47 NY Rt 25A	
Shoreham, NY 11786	
Phone	631-744-2390

Medical

Mather Hospital
75 N Country Road
Port Jefferson, NY 11777

Phone	631-473-1320

Directions from site entrance:

- Turn left out of the facility onto Lilco Road and head South for 0.2 miles.
- Turn right onto N Country Road and travel for 5 miles.
- N Country Road becomes NY-25A. Continue for 3.8 miles.
- Slight right to stay on NY-25A; continue for 0.7 miles.
- Turn right onto N Columbia St. and travel for 0.3 miles.
- Turn left onto N Country Road and travel for 0.4 miles.
- The medical facility is on the right.

KCE / NY31 Emergency Operations Line

Phone	518-216-0764

Poison Control Center

Phone	800-222-1222

APPENDIX 6 – COLD WEATHER OPERATIONS PLANS