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Appendix 3.16A

UL 9540A Test Results (Confidential)

Appendix 3.16B

Hazard Mitigation Analysis

Seahawk BESS

Hazard Mitigation Analysis for Outside Ground Mounted Battery Energy Storage Systems: CATL EnerC+ Watsonville, California

Draft Report | Rev.A | December 4, 2025

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TABLE OF CONTENTS

TABLE OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

Fire and Risk Alliance, LLC (FRA) conducted a Hazard Mitigation Analysis (HMA) in accordance with the requirements of the 2022 Edition of the California Fire Code (CFC). This HMA is being used to evaluate the Contemporary Amperex Technology Co., Limited (CATL) EnerC+ lithium-ion Battery Energy Storage System (BESS). The EnerC+ is a pre-assembled, non-walk-in (NWI) style BESS container with a capacity of 4,073 kilowatt hours (kWh). It is intended for outdoor installations and is the type of BESS (outdoor, ground mounted, NWI style) that is typically installed at BESS sites like the Seahawk BESS. For the purposes of this analysis, the Seahawk BESS is anticipated to initially include 245 EnerC+ BESS containers with an augmentation capacity of 21 containers. It will have an approximate capacity of 200 megawatts (MW)/800 megawatt hours (MWh).

This narrative has been developed by FRA and summarizes our analysis. It is intended to be used as a tool for a Fire Code Official (FCO) or an Authority Having Jurisdiction (AHJ) to assist in their review of the Seahawk BESS. Based on our review of the available materials, our background, experience and training, and the analysis performed to date, the following conclusions are provided for the Seahawk BESS:

1. The EnerC+ and the Seahawk BESS site design can meet the CFC requirements for a remote outdoor BESS installation when it is installed in accordance with the manufacturer's specifications, its listing, the approved drawings, and the CFC. As the design of the site is being finalized, to ensure compliance, the following must be provided:
    a. Labels and signage must be provided for the ESS disconnecting means in accordance with CFC §1207.4.1.
    b. Signage must be provided per CFC §1207.4.8.
    c. Fire apparatus access roads must be approved by the AHJ per CFC §503.
    d. The water supply design must be provided per CFC §507.
    e. Provide backup power for the explosion control system.
2. The HMA demonstrates the Seahawk BESS meets all the HMA performance criteria for approval outlined in CFC §1207.1.4.2, as follows:
    a. Fires will be contained within unoccupied ESS rooms or areas for the minimum duration of the fire-resistance rated separations identified in Section 1207.7.4. (CFC §1207.1.4.2 #1)
    b. Fires in occupied work centers will be detected in time to allow occupants within the room or area to safely evacuate. (CFC §1207.1.4.2 #2)
    c. Toxic and highly toxic gases released during fires will not reach concentrations in excess of the immediately dangerous to life or health (IDLH) level in the building

or adjacent means of egress routes during the time deemed necessary to evacuate occupants from any affected area. (CFC §1207.1.4.2 #3)

d. Flammable gases released from ESS during charging, discharging, and normal operation will not exceed 25 percent of their lower flammability limit (LFL). (CFC §1207.1.4.2 #4)

e. 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. (CFC §1207.1.4.2 #5)

In summary, based on a review of the EnerC+ and the UL 9540A testing, the Seahawk BESS meets the HMA approval criteria outlined in the CFC, as described above.

Note, this executive summary is an abbreviated list of findings. Refer to the main report for details of the analysis.

1.0 INTRODUCTION

Fire and Risk Alliance, LLC, performed an HMA for the BESS proposed for installation at the Seahawk BESS located in Watsonville, California. The HMA was performed in accordance with the requirements of the 2022 CFC as well as local amendments to this code. The Seahawk BESS is anticipated to initially include 245 EnerC+ cabinets manufactured by CATL with an augmentation capacity of 21 containers and will have an approximate capacity of 200 MW/800 MWh. This HMA report has been prepared by FRA and summarizes our analysis. It is intended to be used as a tool for an FCO or an AHJ to assist in their review of the Seahawk BESS.

1.1 Purpose and Scope

The CFC requires an HMA to evaluate the consequences associated with the following failure modes and any others deemed necessary by the FCO. Note, only single failure modes must be considered in this analysis (CFC §1207.1.4.1):

1. 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.

The AHJ or FCO is authorized to approve the HMA provided the analysis demonstrates each of the following (CFC §1207.1.4.2):

1. Fires will be contained within unoccupied ESS rooms or areas for the minimum duration of the fire-resistance rated separations identified in §1207.7.4.
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 the 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 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 framework for this analysis is as follows:

- **Review the BESS and UL 9540A test data**: FRA reviewed the EnerC+, its construction, design, fire safety features, listings, and UL 9540A fire test data (see Section 2.0 and 3.0).
- **Review site specifications:** FRA reviewed the proposed Seahawk BESS site layout and installation including the area surrounding the BESS (see Section 4.0).
- **Prescriptive code compliance review:** The proposed site layout and site response plans/training procedures were reviewed for compliance with the CFC requirements. Where gaps were identified in the BESS installation and response plans/training procedures, recommendations were provided (see Section 5.0 and 6.0, respectively).
- **Hazard Mitigation Analysis:** The HMA evaluates the BESS failure modes as required by the CFC. The consequence-based analysis considers product level and site level barriers to prevent failure or reduce the consequences of a failure scenario. Based on the provided barriers, the consequences of a failure event are analyzed. The CFC details acceptance criteria for which the FCO or AHJ is authorized to approve the HMA provided the consequences of the analysis meet or exceed the criteria (see Section 7.0).
- **Recommendations:** Recommendations are provided throughout the report where gaps exist between the site design and code requirements and where the consequences of failure modes exceed the approval criteria (see Section 8.0).

1.2 Applicable Codes and Standards

The following codes and standards are applicable to the Seahawk BESS installation in Watsonville, California:

- California Fire Code – 2022 Edition (CFC).
- California Senate Bill 38 (CA SB38)
- NFPA 69, Standard on Explosion Prevention Systems – 2019 Edition.
- NFPA 70, National Electric Code – 2020 Edition.
- NFPA 72, National Fire Alarm and Signaling Code – 2022 Edition.
- UL 1973, Batteries for Use in Stationary and Motive Auxiliary Power Applications – 2022 Edition.
- UL 9540, Energy Storage Systems and Equipment – 2020 2nd Edition.

- UL 9540A, Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems – 2019 4th Edition.

1.3 References

The following reference materials were reviewed as part of this analysis:

- Seahawk Energy Storage – Civil Plans Dated 2025.07.02.
- CATL EnerC+ UL 9540A Cell Level Fire Test Report (4790838636.3), UL (Changzhou) Quality Technical Service Co., LTD Dated 2023.08.24.
- CATL EnerC+ UL 9540A Module Level Fire Test Report (4790931782), UL (Changzhou) Quality Technical Service Co., LTD Dated 2023.09.13.
- CATL EnerC+ UL 9540A Unit Level Fire Test Report (4790931774), UL (Changzhou) Quality Technical Service Co., LTD Dated 2023.10.27.
- CATL EnerC+ NFPA 69 Test Report, Dated 2023.10.26.
- EnerC+ Containerized Lithium Ion Battery Storage System (Rechargeable Li-ion Battery System) FMEA Report.

1.4 Limitations

At the request of Seahawk Energy Storage 1 LLC, FRA performed an HMA in accordance with the requirements of the CFC for the Seahawk BESS located in Watsonville, CA. The scope of services performed during this analysis may not adequately address the needs of other users of this report, and any re-use of this report or its conclusions presented herein are at the sole risk of the user. The opinions and comments formulated during this assessment are based on observations and information available at the time of the analysis, which has been provided to FRA by others. No guarantee or warranty as to future performance of any reviewed condition is expressed or implied.

As the Seahawk BESS site is still under development, this analysis assumed that the BESS and its associated equipment, as well as all fire protection systems, will be installed, commissioned, inspected, tested, and maintained as required by the manufacturer(s), the CFC, and/or other applicable codes and standards throughout the lifetime of the BESS. The accuracy and applicability of this report's findings are subject to change based on changes to the site. FRA assumes no liability for performance, errors, omissions, or failures that may arise during construction or operation, and no warranty of fitness for a particular purpose is implied.

2.0 ENERC+ DESCRIPTION

The EnerC+ is a fully integrated BESS consisting of battery modules, power electronics, control systems, a battery/energy management system (BMS/EMS), a thermal management system (TMS), and an explosion control system. Each EnerC+ measures 20 ft long, 8 ft deep, and 9.5 ft high and weighs approximately 79,400 lbs (6,096 mm x 2,438 mm x 2,896 mm and 36,015 kg). Each EnerC+ arrives at the site fully assembled, needing only its power and communication cables to be connected. Below is a brief description of the EnerC+, its components, design listing, and fire safety features. For a more detailed discussion of the EnerC+ components, their location, functionality, and purpose, refer to the EnerC+ Product Manual.

2.1 Container Layout

The EnerC+ is intended for outdoor installations, ground-mounted to a foundation or base strong enough to support the weight of the equipment and anchor loads (including concrete pads, grade beams, etc.).

Each EnerC+ is contained within an IP55 enclosure that prevents particles and water from coming into contact with the battery modules and power electronics. The container cannot be entered but is provided with equipment access doors. This cabinet-style approach allows for the system to be easily maintained and serviced from outside the containers, thus eliminating the need for personnel to enter an enclosure, structure, building, or container to perform those activities. Since the BESS containers do not permit walk-in access, they are considered a non-walk-in (NWI) style BESS; they are not defined as occupied buildings or structures per the CFC. Each EnerC+ houses modules containing lithium iron phosphate (LFP) cells, safety systems, communications, controls, the AC load panel, and climate control. The modules are configured in racks consisting of eight modules each. It should be noted that fire suppression is often not an effective measure in preventing/ending thermal runaway fires. It is recommended that the dry pipe suppression systems not be used, however, they may be utilized as part of the site design if requested by the FCO. See Figure 1 for EnerC+ container layout.

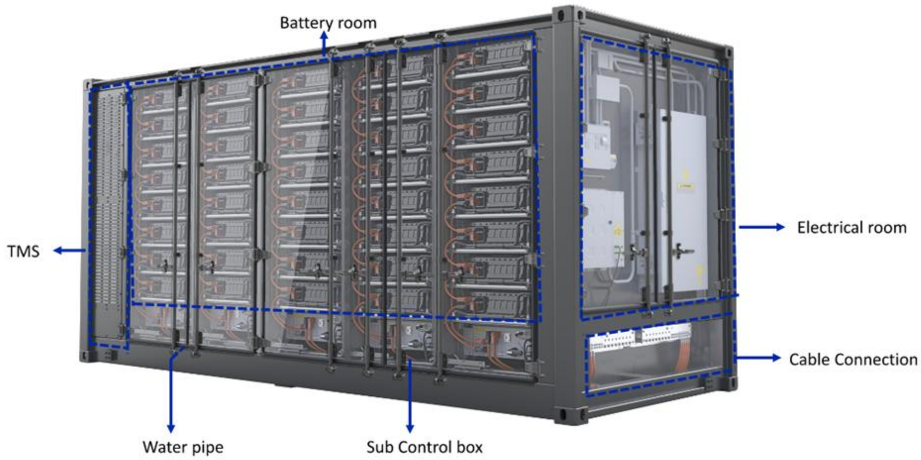


Figure 1. EnerC+ System Components

2.2 Cells and Battery Modules

The cell is the smallest anatomy of the battery assembly. The EnerC+ utilizes an LFP prismatic cell, as shown in Figure 2. The LFP cells utilized in the EnerC+ are 306-amp hour (Ah) with a nominal voltage of 3.2 volts (V). They are approximately 8.2 inches tall, 6.9 inches in length, 2.8 inches in width and weigh 12.1 pounds (207.3 mm x 174.3 x 71.55 mm and 5,500 g). UL (Changzhou) Quality Technical Service Co., LTD (UL) performed UL 9540A cell level testing and issued a report.[1]

The battery module is the second smallest level of the BESS anatomy. The EnerC+ module is model M02306P05L01, which is a liquid-cooled enclosure where the top of the enclosure is plastic, and the bottom is aluminum, as shown in Figure 3. The module, with a 52S2P cell configuration, has a nominal capacity of 612 Ah, a nominal voltage of 166.4 V, a nominal energy capacity of 101.83 kWh, and is composed of 104 CATL model CBDD0 LFP cells. Each module has overall dimensions of 7.33 ft × 2.72 ft × 0.82 ft (2,235 mm x 830 mm x 250 mm). UL performed UL 9540A module level testing and issued a report.[2]

[1] Project # 4790838636.3, UL (Changzhou) Quality Technical Service Co., LTD Dated 2023.08.24

[2] Project # 4790931782, UL (Changzhou) Quality Technical Service Co., LTD Dated 2023.09.13

Figure 2. EnerC+ Cell

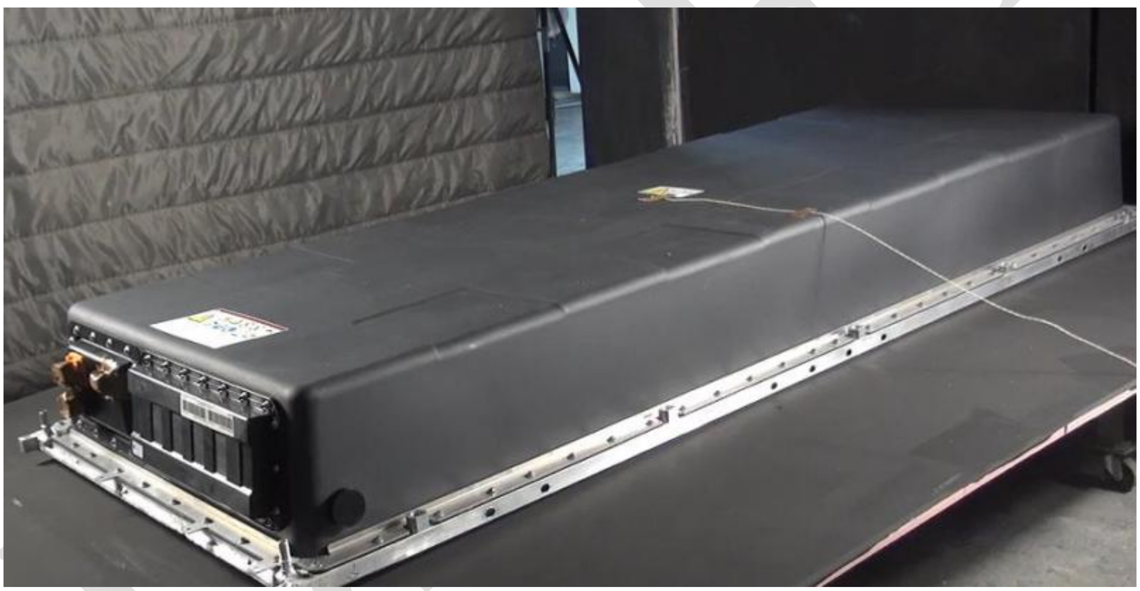


Figure 3. EnerC+ Module

2.3 Thermal Management System

The TMS compartment houses the liquid cooling (water-glycol mixture) TMS for the battery modules. The TMS maintains the battery modules at an optimum operating temperature. It consists of a compressor, heater, fan, and pump. The TMS compartment is located on the opposite side of the EnerC+ container from the electrical compartment, as shown in Figure 4.

Figure 4. TMS Compartment

2.4 Battery Management System

The EnerC+ is provided with a BMS that can identify possible risks to the battery system by monitoring battery cell temperature, voltage, current, and dry contact switching value in real-time. The BMS function is intended to mitigate the risk of thermal runaway by preventing the risks of overcharge, over-discharge, over-temperature, and overcurrent. It provides thermal runaway risk protection by safely disconnecting the batteries in case of fault conditions.

2.5 System Controller and Monitoring

The BMS integrates with and monitors external systems such as the power conversion system (PCS), TMS, smoke detection, and gas detection. The BMS monitors dry contacts from the relay modules, and when safety parameters are exceeded, the BMS sends the necessary safety-related commands to the equipment's associated controller.

2.6 Electrical Fault Protection Devices

The EnerC+ is equipped with a layer of electrical fault protection devices designed to protect the battery cells from abnormal electrical conditions. These include:

- High-voltage interlock: This ensures real-time monitoring of the stability of the battery system's high-voltage connection. When any connector is loose, the BMS detects this abnormal condition and sends a fault alarm.
- High-voltage relay: Through the high-voltage control relay, the occurrence of arc pulling and relay adhesion can be effectively reduced to ensure the safety of the whole power supply system.

- Insulation detection: The BMS carries out real-time insulation detection for the whole container to prevent the risk of electric shock caused by an insulation failure.
- Manual Switch Disconnector (MSD): During assembly, maintenance, and transportation the removable MSD can cut off the high voltage connection to protect personnel from electrical shock injuries.
- Internal High Speed DC Fuse: Each battery module contains a high-speed DC fuse. These fuses are one-time-use-only safety devices that can interrupt the flow of an overcurrent in the battery module during an abnormal electrical event.
- Surge Protection (Lightning Protection): A surge protection device (SPD) provides overvoltage protection to the EnerC+. The surge protection is designed for the AC system and can prevent an overvoltage to the system, providing protection from lightning strikes.

2.7 Explosion Control System

The EnerC+ BESS container is equipped with an explosion control system designed by CATL in accordance with NFPA 69, Standard on Explosion Prevention Systems. The system is a combustible gas concentration reduction system and consists of gas detection, an explosion-proof 820-cubic feet per minute (CFM) exhaust fan, and a make-up air louver, as shown in Figure 5. The EnerC+ is equipped with two flammable gas detectors calibrated to hydrogen. Upon the detector sensing 10% of the lower flammability limit (LFL), the explosion control system (exhaust system) activates, ventilating the EnerC+ to keep the gas concentration of the container below 25% LFL. In addition, the BMS receives an alarm, the horn/strobe on the exterior of the container activates, the BMS shuts down the battery system, and the TMS system shuts down.

Figure 5. Explosion Control System Inlet/Outlets (Left) And Exhaust Fan (Right)

2.7.1 Explosion Control System Evaluation

TLB Fire Protection Engineering, Inc. (TLB) performed a review of the explosion control system and computational fluid dynamics (CFD) simulations for the EnerC+ and determined the system complies with NFPA 69. Additionally, CATL has issued an NFPA 69 test report that demonstrates the ability of the system to maintain a combustible gas concentration below 25% LFL.

2.8 Fire Detection and Suppression

The EnerC+ container is provided with fire and gas detection. The fire and gas detection system includes three photoelectric smoke detectors (two in the battery compartment and one in the electrical compartment), two heat detectors in the battery compartment, and two hydrogen gas detectors in the battery compartment, as shown in Figure 6. These devices are monitored by a local fire alarm control panel (FACP). In addition, a site-FACP will be provided to monitor the individual BESS FACP for alarm, trouble, gas detector alarm, and gas detector fault. For local notification, an audible/visible appliance is installed on the exterior of the electrical compartment on each EnerC+ container.

The EnerC+ can come equipped with an optional aerosol suppression system or an optional dry sprinkler system. The EnerC+ containers at the Seahawk BESS will not be equipped with a fire suppression system.

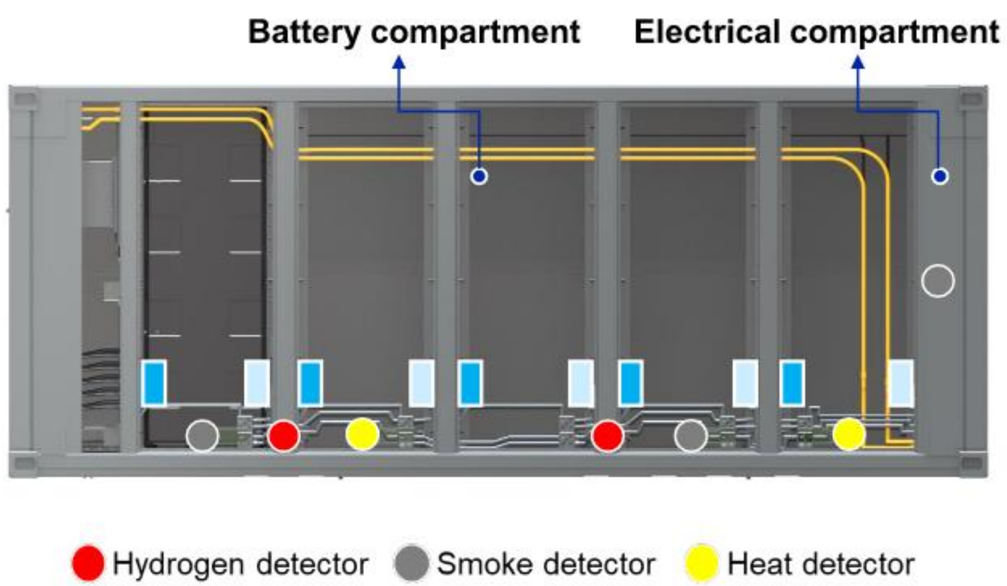


Figure 6. Fire and Gas Detector Locations

2.9 Product Listings

The EnerC+ and its subcomponents are certified or listed to multiple national and international product design standards. These certifications and listings apply to the cells, battery modules, inverters, power electronics, control systems, integration between the BESS and the grid, as well as the BESS as a whole. The EnerC+ is listed to UL9540 in accordance with CFC §1207.3.1.

3.0 ENERC+ UL 9540A TESTING

UL 9540A provides a method to evaluate thermal runaway and fire propagation of a lithium-ion BESS at the cell level, module level, unit level, and installation level. The data generated from the test method can be used to determine the fire and explosion protection systems/features required for a BESS installation. This includes, but is not limited to, thermal runaway characteristics of the cell; cell thermal runaway gas composition; the fire propagation potential from cell to cell, module to module, and unit to unit; products of combustion; heat release rate; smoke release rate; and performance of fire protection systems.

Initially, cells are tested to determine if further testing is required. Module level testing is required if the following observations are recorded during cell level testing:

- Thermal runaway is induced in the cell; and,
- The cell vent gas is flammable in air when tested in accordance with ASTM E918.

Module level testing examines the module design, heat release rate, gas generation, external debris, and flying debris hazards. Unit level testing is required if the following observations are recorded during module level testing:

- Module design is unable to contain thermal runaway; and,
- Cell vent gas is flammable.

Unit level testing assesses the BESS design of the unit, heat release rate, gas generation and composition, deflagration and flying debris hazards, BESS and wall surface temperatures, heat flux at the target walls, and reignition. Installation level testing is required if the following observations are recorded during unit level testing:

- Flaming is observed outside the initiating BESS unit.
- Surface temperature of the modules in the adjacent BESS unit exceeds the temperature at which cell level gas venting occurred.
- Surface temperatures of wall surfaces increase more than 97ºC from ambient; and,
- Explosion hazards are observed.

Installation level testing assesses the effectiveness of fire protection systems installed as mitigation methods for the BESS in its intended installation configuration. A summary of the cell, module, and unit level testing for the EnerC+ are included below.

3.1 UL 9540A Cell Level Summary

Cell-level testing was conducted by UL Solutions in April and May of 2024. Testing was performed on five CBDD0, 3.2 V, 306 Ah, LFP cells manufactured by CATL. Each cell was charged to 100% state of charge (SOC) prior to testing. Thermal runaway was initiated via film strip heaters installed on the wide side surfaces of each cell, meaning two heaters were installed on each cell, as shown in Figure 7. The heaters were programmed to increase the temperature of the cell's surface by approximately 4.5°C per minute until the cell vented and went into thermal runaway. Cell 5 was placed within an enclosure and the products released during testing were collected and analyzed.

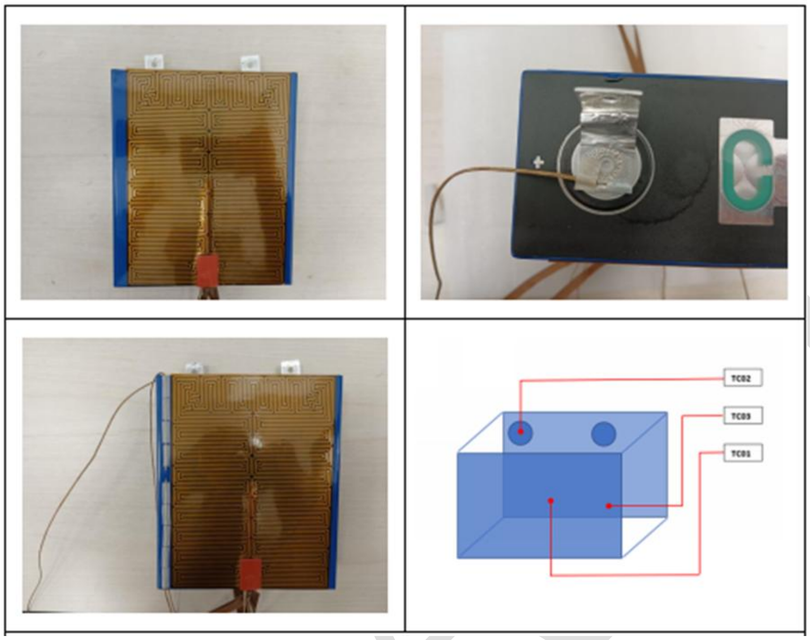


Figure 7. Sample Instrumentation Prior to the Test

3.1.1 Key Takeaways and Results

Key takeaways from the tests include:

- The average cell vent and thermal runaway temperatures were determined to be 166°C (330.8°F) and 223°C (433.4°F), respectively, as listed in Table 1.
- 171.4 liters of cell vent gases were released.
- The cell vent gas mixture is flammable and has an LFL of 8.15% at ambient temperature.
- The cell vent gases were predominantly (approximately 91%) Carbon Monoxide (CO), Carbon Dioxide (CO_2), Hydrogen (H_2), and Methane (CH_4), as listed in Table 2.

Table 1. UL 9540A Cell Level Testing: Key Flammability Characteristics

Flammability Property	Value
Average cell surface temperature at gas venting	166°C
Average cell surface temperature at thermal runaway	223°C
Cell vent gas volume released	171.4 L
LFL, % volume in air at the ambient temperature	8.15%
LFL, % volume in air at the venting temperature	7.45%
Burning Velocity (Su)	62.86 cm/s
Maximum pressure (Pmax)	93.60 psig

Table 2. UL 9540A Cell Level Testing: Cell Vent Gas Composition (Excluding O_2 and N_2)

Gas Name	% Measured	Component Volume (L)
Carbon Monoxide	12.074	20.69
Carbon Dioxide	28.193	48.32
Hydrogen	45.205	77.48
Methane	6.030	10.33
Acetylene	0.225	0.39
Ethylene	3.613	6.19
Ethane	1.036	1.78
Propadiene	0.005	0.01
Propylene	0.991	1.70
Propane	0.266	0.46
Total C_4	0.409	0.70
Total C_5	0.076	0.13
Total C_6	0.029	0.05
Benzene	0.016	0.03
Toluene	0.002	0.00
Dimethyl Carbonate	1.749	3.00
Ethyl Methyl Carbonate	0.081	0.14
Total	**100**	**171.4**

3.1.2 Performance Criteria

UL 9540A, Section 7.7 outlines the performance criteria for the cell level test. If all these conditions are met, further testing (such as module, unit, or installation level tests) is not required. The acceptable performance criteria during the UL 9540A cell level test are as follows:

1. Thermal runaway cannot be induced in the cell; and

2. The cell vent gas does not present a flammability hazard when mixed with any volume of air, at both ambient and vent temperatures.

Given the cell went into thermal runaway and vented flammable gases, UL 9540A module level testing was required.

3.2 UL 9540A Module Level Summary

Module level testing was conducted at a UL laboratory on June 13, 2024. Testing was performed on a 166.4 V, 612 Ah, CATL EnerC+ module (model M02306P05L01), manufactured by CATL, as shown in Figure 8. Each module consists of 104 CATL model CBDD0 LFP cells that were charged to 100% SOC prior to testing. During the test, the module is not connected to the BMS, i.e., it is not actively operating to prevent thermal runaway in a cell or to prohibit the propagation of thermal runaway from cell to cell. Thermal runaway was initiated via a film strip heater installed on one wide surface of one cell. The heating of this one cell forced three others into thermal runaway. The heaters were programmed to increase the temperature of the cell's surface by approximately 4-7°C per minute until the cells vented and went into thermal runaway. The module was placed under an instrumented hood and the products released during combustion were collected for analysis.

Figure 8. Module Level Testing Assembly

3.2.1 Key Takeaways and Results

Key takeaways from the test include:

- Thermal runaway propagated from the initiating cell to three additional cells in the EnerC+ module.
- No sparks, electrical arcs, flying debris, or explosive discharges were observed.

- Generated gases were collected, as listed in Table 3.

Table 3. UL 9540A Module Level Testing: Products of Combustion

Gas Name	Chemical Structure	Volume (L)
Total Hydrocarbons	-	132.35
Carbon Dioxide	CO_2	154.92
Carbon Monoxide	CO	55.01
Hydrogen	H_2	181.87
Total	-	524.15

3.2.2 Performance Criteria

UL 9540A, Section 8.4 outlines the performance criteria for the module level test. If all these conditions are met, further testing (such as unit or installation level tests) is not required. The acceptable performance criteria during the UL 9540A module level test are as follows:

1. Thermal runaway is contained by module design; and
2. Cell vent gas is nonflammable as determined by the cell level test.

Given the cell vent gases are flammable (as summarized previously), UL 9540A unit level testing was required.

3.3 UL 9540A Unit Level Summary

Unit level testing was conducted at a UL lab on August 8, 2024. Below is a summary of the UL 9540A unit level test results as well as a description of the performance of key fire safety features and systems during the test. This discussion is a summary of the test setup, test data, and results. For a full description of the test, please refer to the UL 9540A unit level test report.

3.3.1 Test Setup and Initiation

The test was performed on an EnerC+ model BESS. The test consisted of three units (racks) with the initiating rack equipped with eight live modules tested at 100% SOC. Two target units were installed directly adjacent to the initiating unit, as shown in Figure 9. The target units were populated with dummy modules containing no battery cells. The exterior enclosure of the container was not installed during the test. Combustible, instrumented walls were installed near the container. During the test, the BMS is disabled, i.e., it is not actively operating to prevent thermal runaway in a cell or to prohibit the propagation of thermal runaway from cell-to-cell, or module-to-module. As such, the UL 9540A unit level test can be considered a worst-case scenario fire scenario, where: (1) the initiating rack tested was at the highest energy density possible (100% SOC); and (2) the BMS was disabled and, therefore, unable to actively respond to the thermal runaway condition.

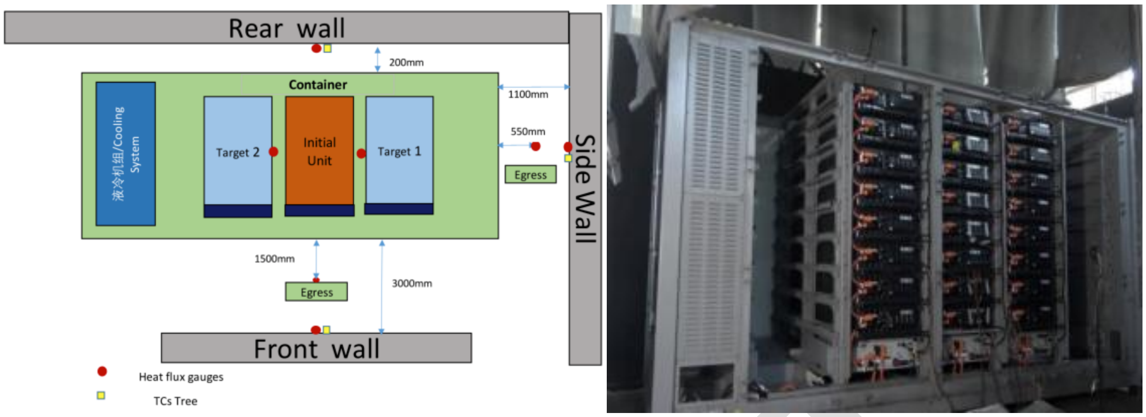


Figure 9. UL 9540A Unit Level Test Configuration

The initiating battery module was chosen to be the third battery module from the bottom, as shown in Figure 10. This location was deemed to be the worst-case scenario, given there are battery modules directly above it and below it. Within the battery module itself, one interior cell was heated via film heaters. The heaters were controlled to provide a heating rate of 4-7°C per minute, as specified by UL 9540A. The number of cells and the location were selected to provide the greatest thermal exposure to adjacent cells to ensure cell to cell propagation during the test.

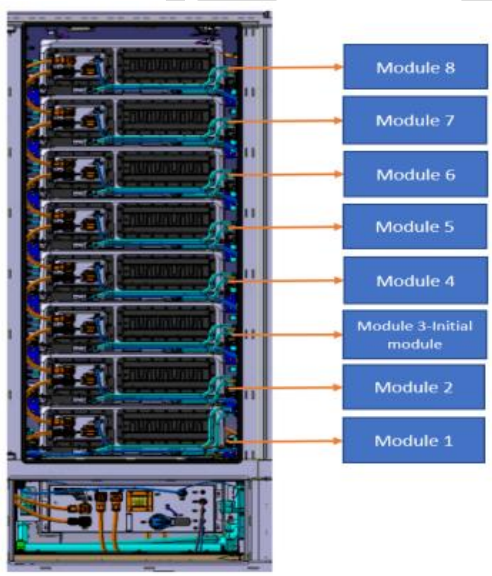


Figure 10. UL 9540A Unit Level Test Initiating Module Location

3.3.2 Test Results

Table 4 provides a summary of key events from the UL 9540A unit level test.

Table 4. UL 9540A Unit Level Testing: Timeline of Key Events

Time	Event
00:00:00	**Start of Test.** Heaters on.
00:47:40	Cell 20-2 (initiating cell) vented. Visible venting not observed, but temperature dip observed in Cell 20-2 data. Measured temperature dip was 176.6°C.
00:56:24	Cell 20-2 thermal runaway. Heaters turned off.
00:59:14	Cell 21-1 thermal runaway.
01:00:06	Cell 20-1 thermal runaway.
01:12:00	Cell 21-2 thermal runaway.
01:40:00	Recording of test ended.

3.3.3 Key Takeaways

After the test, analysis of the data and a visual inspection of the initiating unit yielded the following observations:

- Over the duration of the test, four cells went into thermal runaway: the one that was forcibly heated and three additional cells. This demonstrated that cell to cell propagation occurred during the test, as is required by UL 9540A.
- No other signs of distress were observed in the initiating battery module. Thermal runaway did not propagate beyond the three additional cells, nor did it spread to the module above or below it.
- The target battery modules within the container were unaffected.
- External flaming was not observed.
- Heat flux measurements were recorded throughout the UL 9540A unit level test at the instrumented walls. Since external flaming was not observed, predictably, these measurements were 0.00 kW/m^2 throughout the entire test, even with the open container configuration of the test article.
- The maximum surface temperature of the modules within the target racks was 40.3ºC which does not exceed the cell venting temperature of 166ºC.
- The maximum wall surface temperature was 32.6ºC which does not exceed 97ºC rise above ambient.
- The UL 9540A unit level fire test results demonstrate that a suppression system is not required to prevent thermal runaway propagation from cell-to-cell, module-to-module or rack-to-rack when a failure of up to four cells occurs within the same battery module.

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

3.3.4 Performance Criteria

UL 9540A Table 9.1 outlines the performance criteria for outdoor, ground-mounted BESS. If all these conditions are met, further testing (such as installation-level testing) is not required. The performance criteria during the UL 9540A unit level fire test are as follows:

1. No flaming outside of the initiating unit.
2. Surface temperatures of battery modules within the targets adjacent to the initiating unit cannot exceed the temperature at which thermally initiated cell venting occurs.
3. Surface temperatures on wall surfaces cannot exceed 97°C rise above the ambient temperature.
4. No explosion hazards, including but not limited to, observations of deflagration, projectiles, flying debris, detonation, or other explosive discharge of gases observed.
5. Heat flux in the center of the accessible means of egress cannot exceed 1.3 kW/m^2.

These test results meet all five of UL 9540A's performance criteria for outdoor ground mounted BESS units. The unit level test demonstrated that the failure of four cells within the same battery module did not lead to flaming combustion nor to a propagating thermal runaway event throughout the EnerC+ container.

4.0 SEAHAWK BESS SITE

The Seahawk BESS site is located at 90 Minto Road in Watsonville, California. It is bounded by Minto Road to the north and west and agricultural land to the east and south as shown in Figure 11. The facility is accessible via Minto Road from the west and a new road that will be installed as a part of the project from the east.

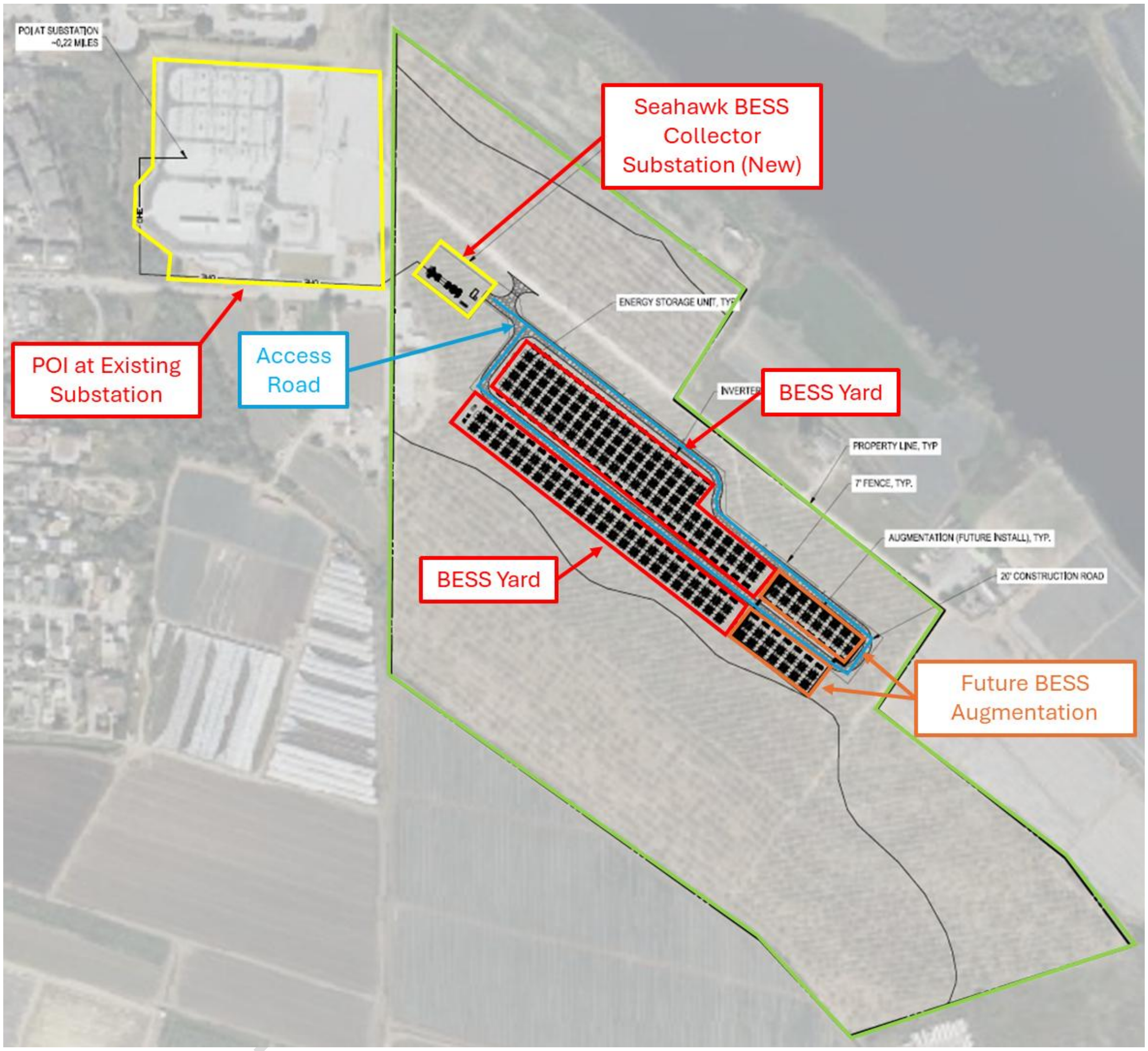


Figure 11. Seahawk BESS Aerial Map

Based on a drawing set, the site is anticipated to initially include 245 EnerC+ containers with an augmentation capacity of 21 containers and an approximate site capacity of 200 MW/800 MWh, as shown in Figure 12 and Figure 13. The site will be surrounded by a perimeter security fence. The site will include other electrical equipment to support the BESS, including auxiliary power equipment and the project substation northwest of the BESS containers.

Figure 12. Seahawk BESS Site Plan (West)

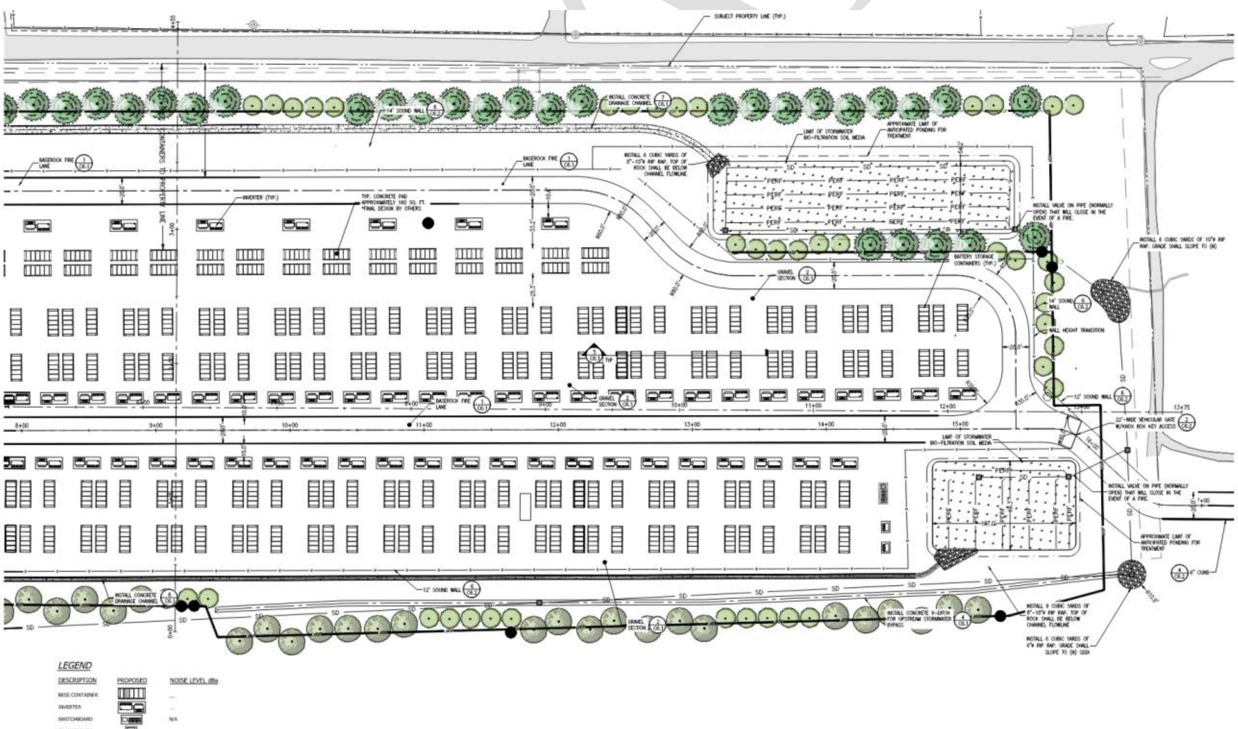


Figure 13. Seahawk BESS Site Plan (East)

4.1 Site Level Fire Safety Features

Based on a review of the drawing set provided and the EnerC+ product documentation, the Seahawk BESS will have a number of site-level fire safety systems and features as described in the following sections.

4.1.1 BESS Monitoring and Emergency Notification

TBD

4.1.2 Periodic Maintenance

It is anticipated that the Seahawk BESS will be periodically inspected and serviced by trained operation and maintenance (O&M) service personnel in accordance with CATL documentation and guidance.

4.1.3 BESS Security

Based on a review of the drawing set, a chain-link fence will be installed around the perimeter of the Seahawk BESS to prohibit unauthorized access to the EnerC+ containers. The secured area around the Seahawk BESS will include two 22-feet wide access gates at the east and west ends of the facility.

4.1.4 Fire Department Access

Watsonville Fire Station No. 2 is the closest fire department to the Seahawk BESS and is approximately 2 miles away from the BESS installation. The site is accessible via minimum 20-feet wide access roads. The interior of the Seahawk BESS is provided with a looped access road. Note, any access to the facility should be provided with the facility's Owner/Operator and the utility, if necessary.

4.1.5 Emergency Water

TBD

4.1.6 Fire Alarm and Notification System

The EnerC+ is equipped with a smoke and heat detection system that is required by the CFC and NFPA 72 to be monitored by a remote supervising station. In addition, the EnerC+ is equipped with an audible/visual notification appliance located on the exterior of the container. The internal EnerC+ fire alarm equipment will be monitored by a local FACP. The local FACPs will be monitored by a site FACP which will report to a remote supervising station.

4.2 Permanent Public Exposure Hazards

All permanently installed public exposures (lot lines, public ways, buildings, stored combustible materials, hazardous materials, high-piled stock, and exposure hazards not associated with electrical grid infrastructure) are greater than 10 ft from the nearest EnerC+ container. As described in the drawing set and aerial map, clearance distances to public exposures are summarized in Table 5.

Table 5. Distance to Permanent Public Exposures

Exposure	Distance
Minto Road	~145 ft
Property Line	~190 ft
Agricultural Land (southwest)	~200 ft
Nearest Residence (78 Minto Road)	~300 ft
College Lake	~700 ft

New Leaf please verify distances and add any other public exposures or sensitive receptors in the area.

5.0 BESS CODE ANALYSIS

The 2022 CFC was used in the development of this HMA. For the purposes of this analysis, the Seahawk BESS is anticipated to include 245 EnerC+ containers. The EnerC+ is pre-assembled, NWI-style BESS that is unoccupiable with all internal components accessible via exterior doors. Based on a review of the EnerC+, the Seahawk BESS can meet the CFC installation level requirements for an outdoor BESS when it is installed in accordance with the manufacturer's instructions, its listing, and the approved drawings.

5.1 BESS Installation Classifications

CFC Chapter 12 code requirements pertaining to BESS equipment must be applied for the site if the BESS threshold energy capacity is greater than shown in Table 6.

Table 6. Energy Storage System Threshold Quantity [CFC Table 1207.1.1]

Technology	Energy Capacity
Lithium-Ion Batteries	20 kWh

An installation of one EnerC+ container, with an energy capacity of 4,073 kWh, exceeds the 20-kWh energy capacity threshold and triggers the CFC Chapter 12 requirements.

For outdoor BESS installations, the CFC provides code requirements based on the proximity and location of the BESS from adjacent exposures. The two outdoor installation classifications are as follows:

- **Remote locations** – BESS located more than 100 ft from buildings, lot lines that can be built upon, public ways, stored combustible materials, hazardous materials, high-piled stock, and other exposure hazards not associated with electrical grid infrastructure [CFC §1207.8.1].
- **Locations near exposures** – BESS locations that do not comply with remote outdoor location requirements [CFC §1207.8.1].

Based on the drawing set, there appears to be more than a 100 ft separation distance between the EnerC+ containers and the nearest exposures not associated with the electrical grid infrastructure. As such, the Seahawk BESS will be classified as a remote, outdoor BESS for this analysis. CFC Chapter 12 code requirements pertaining to a remote, outdoor BESS installation are summarized in Table 7.

Table 7. CFC Remote Outdoor BESS Installation Requirements [CFC Table 1207.8]

Compliance Required	Remote Installations	CFC Code Reference
General installation requirements	Yes	§1207.4
Clearance to exposures	Yes	§1207.8.3
Fire suppression systems	Yes[c]	§1207.5.5
Maximum allowable quantities	No	§1207.5.2
Maximum enclosure size	Yes	§1207.5.6
Means of egress separation	Yes	§1207.5.8
Size and separation	No	§1207.5.1
Smoke and automatic fire detection	Yes	§1207.5.4
Vegetation control	Yes	§1207.5.7
Technology Specific Protection – Lithium-Ion Batteries		
Explosion control	Yes	§1207.6.3
Thermal runaway	Yes	§1207.6.5

[c] Where approved by the fire code official, fire suppression systems are permitted to be omitted.

5.2 General Installation Requirements

CFC Table 1207.8 applies to all ESS installations: indoors, outdoors, stationary, or mobile. Only the fire and life safety general installation requirements applicable to the site design of an outdoor NWI style BESS installation near exposures are summarized in the following sections. Requirements unrelated to fire and life safety or pertaining to other types of BESS installations, such as indoor installations, are not discussed. These include fire-resistance rated separations (§1207.4.3), seismic and structural design (§1207.4.4), occupied work centers (§1207.4.10), open rack installation (§1207.4.11), and walk-in units (§1207.4.12).

5.2.1 Electrical Disconnects

CFC §1207.4.1 requires placards or directories to be installed at the location of the main electrical service disconnecting means, indicating the location of the stationary storage battery system disconnecting means in accordance with the NFPA 70 when the ESS disconnecting means is not within sight of the main electrical service disconnecting means. Information related to the electrical disconnect directories has not been provided for the Seahawk BESS. To ensure compliance, placards or directories must be installed if the ESS disconnecting means is not within sight of the main electrical service disconnecting means as required by CFC §1207.4.1.

5.2.2 Working Clearance

CFC §1207.4.2 requires access and working space to be provided and maintained about all electrical equipment to permit ready and safe operation and maintenance of such equipment in accordance with the NFPA 70 and the manufacturer's instructions. Based on a review of the drawing set, the EnerC+ is provided with minimum working clearances of 9.8 feet from the chiller and electrical compartment sides, 9.8 feet from the front, and 3 feet back-to-back. Each of these distances exceeds the manufacturer's recommendations. As such, the Seahawk BESS site design complies with the CFC working clearances requirement.

5.2.3 Vehicle Impact Protection

CFC §1207.4.5 requires impact protection to be provided in accordance with CFC §312 where ESS are subject to impact by a motor vehicle, including forklifts. Vehicle impact protection is not necessary as the Seahawk BESS is a secured installation that does not have personnel on site each day. In addition, there is no motor vehicle traffic moving through the site other than the occasional maintenance vehicle (i.e., there are no public roads/ways on the site). As such, the Seahawk BESS site design complies with the CFC vehicle impact protection requirement.

5.2.4 Combustible Storage

CFC §1207.4.6 does not permit combustible materials to be stored in ESS rooms, areas, or walk-in units. The EnerC+ is an NWI style BESS that is unoccupiable, with all internal components accessible via exterior doors. It does not have free open space within the container to store additional combustible materials. As such, the Seahawk BESS site design complies with the CFC combustible storage requirement.

5.2.5 Toxic and Highly Toxic Gases

CFC §1207.4.7 requires ESS that have the potential to release toxic and highly toxic gas during charging, discharging, and normal use conditions to be provided with a hazardous exhaust system in accordance with Chapter 5 of the California Mechanical Code. The EnerC+ utilizes listed lithium-ion cells that do not vent toxic or highly toxic gases (or any gases) during charging, discharging, or normal use conditions. Therefore, no hazardous exhaust system is required for the EnerC+ containers. As such, the Seahawk BESS site design complies with the CFC toxic and highly toxic gases requirement.

5.2.6 Signage

CFC §1207.4.8 requires approved signs to be provided on or adjacent to all entry doors for ESS rooms or areas and on enclosures of ESS cabinets and walk-in units located outdoors, on rooftops, or in open parking garages. Signs designed to meet both the requirements of this section and NFPA 70 are permitted. The signage must include the following or equivalent:

1. “Energy Storage System”, “Battery Storage System”
2. The identification of the electrochemical ESS technology present.
3. “Energized electrical circuits”.
4. If water reactive electrochemical ESS are present the sign shall include “APPLY NO WATER”.
5. Current contact information, including phone numbers, for personnel authorized to service the equipment and for the fire mitigation personnel required by CFC §1207.1.6.1.

The Seahawk BESS is still in its design phase, as such a signage plan has not yet been developed.

5.2.7 Security of Installations

CFC §1207.4.9 requires rooms, areas, and walk-in units in which electrochemical ESS are located to be secured against unauthorized entry and safeguarded in an approved manner. Security barriers, fences, landscaping, and other enclosures shall not inhibit the required air flow to or exhaust from the electrochemical ESS and its components. Based on a review of the drawing set, a security fence is provided around the perimeter of the Seahawk BESS. As such, the Seahawk BESS site design complies with the CFC security of installation requirement.

5.3 Outdoor ESS Remote Installations

5.3.1 Size and Separation

CFC Table 1207.8 does not require remote outdoor BESS to be segregated into groups not exceeding 50 kWh nor does it require each group to be separated by minimum 3 ft from other groups. As such, the Seahawk BESS complies with the CFC size and separation requirement.

It should be noted that the Seahawk BESS will have larger capacities and smaller separation distances than what is specific in CFC §1207.5.1. However, the CFC permits the size and separation utilized at the Seahawk BESS based on the UL 9540A large-scale fire testing results [CFC §1207.5.1 #2]. The EnerC+ large-scale fire testing performed in accordance with UL 9540A (see Section 3.3) demonstrated that a fire will not propagate from module to module within the rack or to adjacent EnerC+ racks. As such, the UL 9540A testing supports the size and separation of the EnerC+ for the Seahawk BESS.

5.3.2 Maximum Allowable Quantities

CFC Table 1207.8 does not require remote outdoor lithium-ion BESS to be limited to 600 kWh as outlined in CFC Table 1207.5. As such, the Seahawk BESS complies with the CFC maximum allowable quantity requirement.

It should be noted, the Seahawk BESS will have a capacity of 800 MWh, which is greater than the 600 kWh threshold specified in Table 1207.5. However, the CFC permits the energy capacity utilized at the Seahawk BESS based on the development of an HMA and performing UL 9540A large-scale fire testing [CFC §1207.5.2 Exception #1]. The EnerC+ large-scale first testing performed in accordance with UL 9540A (see Section 3.3) demonstrated that a fire will not propagate from module to module within the rack or to adjacent EnerC+ racks. In addition, this HMA has been developed for the Seahawk BESS. As such, this HMA and the UL 9540A testing support the intended energy capacity for the Seahawk BESS.

5.3.3 Automatic Smoke and Fire Detection

CFC §1207.5.4 requires an approved smoke or fire detection system to be installed in rooms, indoor areas, and walk-in units containing electrochemical ESS. In addition, alarm signals from detection systems must be transmitted to a central station, proprietary or remote station service in accordance with NFPA 72, or where approved, to a constantly attended location. The EnerC+ meets this requirement. It is equipped with a smoke and gas detection system that is monitored by the FACP. The EnerC+ is equipped with a smoke and heat detection system that will be monitored by a site FACP that will transmit signals to a remote supervising station.

CFC §1207.5.4.1 permits the FCO to require an exterior visible annunciation on the enclosure exterior or in approved locations to indicate that potentially hazardous conditions associated with the ESS exist. An audible and visible notification appliance (horn/strobe) is provided on the exterior of each EnerC+ for local notification.

Backup power is provided to the fire alarm system, as required by NFPA 72, via secondary batteries installed for the FACPs. As such, the Seahawk BESS complies with the CFC automatic smoke and fire detection requirements.

5.3.4 Fire Suppression Systems

CFC §1207.5.5 requires an automatic fire suppression system to be installed in rooms and areas within buildings and walk-in units containing ESS. The EnerC+ is an NWI style BESS that is unoccupiable, with all internal components accessible via exterior doors. It is not being installed inside a room or areas within a building. Therefore, the EnerC+ installation at the Seahawk BESS does not require a fire suppression system. As such, the Seahawk BESS complies with the CFC fire suppression system requirements.

5.3.5 Maximum Enclosure Size

CFC §1207.5.6 does not permit walk-in containers to exceed dimensions of 53 ft by 8 feet by 9.5 feet high. This requirement does not extend to NWI style containers with all internal components accessible via external doors, such as the EnerC+. As such, the Seahawk BESS site design complies with the CFC maximum enclosure size requirement.

However, the EnerC+ still meets this requirement. The EnerC+ dimensions are 19.9 ft in length, 8 ft deep, and 9.5 ft in height, which does not exceed the maximum permitted size for outdoor walk-in units. As such, although not required for NWI style containers, the Seahawk BESS site design complies with the CFC maximum enclosure size requirement.

5.3.6 Vegetation Control

CFC §1207.5.7 requires areas within 10 ft on each side of outdoor ESS to be cleared of combustible vegetation and other combustible growth. Based on a review of the drawing set, the EnerC+ containers will be installed on concrete pads and will be surrounded by gravel and fire apparatus access roads. Therefore, no combustible vegetation is within 10 ft of the EnerC+. As such, the Seahawk BESS site design complies with the CFC vegetation control requirements.

5.3.7 Means of Egress Separation

CFC §1207.5.8 requires ESS located outdoors and in open parking garages to be separated from any means of egress as required by the FCO to ensure safe egress under fire conditions, but not less than 10 feet. The Seahawk BESS does not include buildings requiring a means of egress adjacent to the BESS containers. As such, the Seahawk BESS site design complies with the CFC means of egress separation requirement.

5.3.8 Clearance to Exposures

CFC §1207.8.3 requires ESS located outdoors to be separated by a minimum of 10 feet from the following exposures: lot lines, public ways, buildings, stored combustible materials, hazardous materials, high-piled stock, and other exposure hazards. Note, the "other exposure hazards" apply to other exposure hazards not associated with the electrical grid infrastructure. Based on a review of the drawing set, no exposure is within 10 ft of the EnerC+ installation. As such, the Seahawk BESS site design complies with the CFC clearance to exposures requirements.

5.4 Technology Specific Protection – Lithium-ion Batteries

CFC §1207.6 requires electrochemical ESS to comply with the requirements as outlined in CFC Table 1207.6. For lithium-ion batteries, it requires compliance with the explosion control requirements of §1207.6.3 and the thermal runaway requirements of §1207.6.5. Note, lithium-ion batteries do not need to meet the exhaust ventilation requirements of §1207.6.1, the spill control and neutralization requirements of §1207.6.2, or the safety cap requirements of §1207.6.4.

5.4.1 Explosion Control

CFC §1207.6.3 requires explosion control complying with NFPA 68 or NFPA 69 to be provided for rooms, areas or walk-in units containing electrochemical ESS technologies. The EnerC+ is equipped with a combustible gas concentration reduction explosion control system that complies with NFPA 69. It is designed to maintain the flammable gas concentration inside the EnerC+ container below 25% of the LFL.

As a critical fire protection system, it is recommended that backup power be provided for the explosion control system. The backup power will provide uninterrupted power during power outages and also during the initial moments of a fire event, even if auxiliary power to the EnerC+ has been severed. Maintaining power during this time is critical for the detection and notification (both locally and remotely) of the fire event and for the activation of the NFPA 69 ventilation system to provide site personnel, should anyone be in the area, time to evacuate. The backup power integral to the EnerC+ does not support the explosion control system. While FRA has not verified the provision of backup power for the explosion control system, backup power design will be provided at the site level and is to be verified upon completion of the design.

5.4.2 Thermal Runaway

CFC §1207.6.5 requires thermal runaway protection for lithium-ion BESS. The protection can be provided with a listed device or other approved method to prevent, detect, and minimize the impact of thermal runaway. Thermal runaway protection is permitted to be part of a BMS that has been evaluated to UL 1973 (CFC Table 1207.6). A BMS tested and verified during the UL 1973 certification process is provided for the EnerC+. As such, the Seahawk BESS complies with the CFC thermal runaway requirements.

5.5 All Facilities

CFC §501.1 requires facilities regulated by the CFC to comply with Chapter 5, Fire Service Features. For outdoor BESS installations near exposures, that requires, or could require, compliance with the fire apparatus access road requirements of §503, the key box requirements of §506, and the fire protection water supply requirements of §507. Other sections of Chapter 5 would not be applicable to an outdoor BESS installation near exposures

5.5.1 Fire Apparatus Access Roads

CFC §503.1.1 requires fire apparatus roads to be provided in accordance with CFC §503 for every facility, building, or portion of a building hereafter constructed or moved into or within the jurisdiction. At a minimum, the fire apparatus access roads must meet the following:

1. Extend to within 150 feet (45,720 mm) of all portions of the facility and all portions of the exterior walls of the first story of the building as measured by an approved route around the exterior of the building or facility (CFC §503.1.1).
2. Have an unobstructed width of not less than 20 feet (6,096 mm), exclusive of shoulders, except for approved security gates in accordance with Section 503.6, and an unobstructed vertical clearance of not less than 13 feet 6 inches (4,115 mm) (CFC §503.2.1).
3. Be designed and maintained to support the imposed loads of fire apparatus and shall be surfaced so as to provide all-weather driving capabilities (CFC §503.2.3).
4. Have a turning radius, angles of approach and departure that are approved by the FCO (CFC §503.2.4 and §503.2.8).
5. Dead-end fire apparatus access roads in excess of 150 feet (45,720 mm) in length shall be provided with an approved area for turning around fire apparatus (CFC §503.2.5).
6. The grade of the fire apparatus access road shall be within the limits established by the FCO based on the fire department's apparatus (CFC §503.2.7).

Based on the review of the drawing set, the access roads at the Seahawk BESS are 20 ft in width, all areas of the BESS facility are within 150 ft of an access road, and no dead-end roads are present. To ensure compliance, the FCO must approve of the turning radii, angles of approach and departure, grade, and imposed loads for the proposed access roads.

5.5.2 Key Boxes

CFC §506.1 permits the FCO to require a key box to be installed in an approved location when an area is restricted. The key box must be of an approved type in accordance with UL 1037 and must contain keys to gain access. Based on a review of the drawing set, a key box is being provided at each entrance of the Seahawk BESS site. As such, the Seahawk BESS complies with the CFC key box requirements.

5.5.3 Fire Protection Water Supplies

TBD

5.6 Site Design Code Analysis Summary

Based on a review of the EnerC+ and the provided site plan, the EnerC+ installation at the Seahawk BESS site design can meet the CFC installation level requirements for an outdoor, NWI style BESS when it is installed in accordance with the manufacturer's instructions, its listing, the approved drawings, and the CFC. However, as the final site design is developed, the following is recommended to be provided as part of the review conducted:

1. Labels and signage must be provided for the ESS disconnecting means in accordance with CFC §1207.4.1.
2. Signage must be provided per CFC §1207.4.8.
3. Fire apparatus access roads must be approved by the AHJ per CFC §503.
4. The water supply design must be provided per CFC §507.
5. Provide backup power for the explosion control system.

6.0 BESS PLANS AND TRAINING

A new BESS installation typically requires a number of plans to be developed for a site prior to energizing the batteries. Oftentimes, these documents are developed during construction or after substantial completion of the facility, such that they include site specific details that would not be available prior (such as during the design phase of the project).

6.1 Installation, Commissioning, Operation, Decommissioning, and ITM

CFC requires commissioning, operations, decommissioning, and inspection, testing, and maintenance (ITM) requirements for all BESS installations.

A commissioning plan will be developed for the integration of the new BESS equipment into the electrical utility grid. The commissioning documentation is to capture the commissioning roles and responsibilities, list of equipment, conditions, BESS operation compliance, fire protection feature compliance and operability, etc. [CFC §1207.2.1]. An operation and maintenance manual will be developed and provided to both the Owner, or their authorized agent, and the BESS operator before the BESS is put into operation [CFC §1207.2.2]. A decommissioning plan will be developed to provide the organization, documentation requirements, contingencies, and methods and tools necessary to indicate how the safety systems, ESS and components will be decommissioned and removed from the site [CFC §1207.2.3]. In addition, all fire protection systems must be installed/commissioned in accordance with CFC Chapter 9 and must be periodically inspected, tested, and maintained as required by the CFC and their respective NFPA standard [CFC §901.2].

Commissioning, operation/maintenance, and decommissioning plans will be developed for the Seahawk BESS. In addition, once operational, it is anticipated that all required ongoing inspection, testing, and maintenance activities for the EnerC+ containers and fire protection systems will be performed, as required by the CFC. Once these plans are developed, the Seahawk BESS will comply with the CFC requirements for commissioning, operations, decommissioning, and ITM.

6.2 Emergency Response Plan

CA SB38 requires every BESS facility in California to have an emergency response and emergency action plan.

An Emergency Response Plan (ERP) is typically developed to be readily available at the Seahawk BESS for use by facility operations and maintenance personnel. The ERP is a living document that should be updated when conditions change that affect the response considerations and procedure changes. At a minimum, the ERP shall include the following: procedures for safe operational shutdown, inspection testing and maintenance, BESS response procedures, fire response procedures, safety data sheets, emergency contact information, AHJ operations and response procedures. The ERP should be shared with and approved by the local AHJ/fire responders prior to commercial operation of the Seahawk BESS.

A Seahawk BESS ERP is being developed by FRA for the Seahawk BESS. The ERP will include information and procedures for responding to the site during a thermal event or power outage where the EnerC+ fire safety systems may not be functional, such as the explosion control systems. When responding during these events, FRA recommends that all site personnel and first responders remain at a safe distance, upwind from a distressed EnerC+ container, as designated in the Seahawk BESS ERP, to ensure they are not momentarily exposed to dangerous conditions. In addition, FRA recommends that the ERP be finalized and approved prior to energizing the Seahawk BESS.

6.3 Emergency Responder Training

The owner of the BESS or their authorized representative typically engages in emergency planning and training of emergency responders such that any foreseeable hazards associated with the on-site systems can be effectively addressed. This typically includes having all personnel responsible for the operation, maintenance, repair, servicing, and response of the ESS to be trained in the procedures included in the ERP. In addition, annual refresher training is typically provided, with records of the training being retained.

FRA recommends that all site personnel and emergency response personnel, who could be responsible for responding to a Seahawk BESS emergency, be trained on the ERP prior to energizing the Seahawk BESS. In addition, refresher training should be provided as appropriate, typically annually, if requested by the AHJ.

7.0 HAZARD MITIGATION ANALYSIS

This HMA is being prepared following the guidance by CFC §1207.1.4.1. The HMA evaluates the fire safety features of the EnerC+, the findings of the UL 9540A cell, module, and unit level tests, and the site level fire safety features of the Seahawk BESS.

Based on the product level and site level safety features, the fire and life safety consequences associated with typical BESS failure modes can be evaluated to determine the impact on site personnel, the general public, and adjacent exposures.

Per CFC §1207.1.4.1 the consequences of the following failure modes must be evaluated in an HMA:

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 the secondary containment system.

Only single failure-modes must be evaluated. The consequences of each failure mode are evaluated in Section 7.1 through Section 7.7 of this report.

7.1 Thermal Runaway Condition

7.1.1 Description

Thermal runaway is a condition in which a self-heating chemical reaction occurs within a battery cell. This occurs when the battery cell generates heat faster than the battery cell is able to dissipate heat. Thermal runaway can be caused by physical damage (e.g. puncture, crushing), electrical malfunctions (e.g. overcharging), exposure to elevated ambient temperatures (e.g. adjacent cells in thermal runaway with elevated temperatures), manufacturing defects, and other internal conditions which may develop inside of aging battery cells (e.g. dendrites).

Thermal runaway typically results in an overpressure event within the battery cell due to internal heat generation inside the casing causing battery gases to be ejected from the cell through the pressure relief valve. Depending on the conditions, thermal runaway may be limited to the initiating cell(s) or thermal runaway may propagate to adjacent cells. Thermal runaway propagation typically occurs through conductive and convective heating or physical damage of adjacent cells due to swelling of the initiating cell. Conductive heating is the primary mode of heat transfer to adjacent cells for a non-flaming event and convective heating is the primary mode of heat transfer to adjacent cells for a flaming event.

Based on the cell level and module level testing, the EnerC+ cells generate flammable and toxic gases. Depending on the conditions of release, flammable gases released during a thermal runaway event may present an explosion or fire hazard. An explosion hazard exists when sufficient flammable gases are released in the absence of an ignition source and build-up within the container. A fire hazard exists when the flammable gases are released in the presence of an ignition source or self-ignite. It should be noted, the fire hazard and explosion hazard are not mutually exclusive, and both may exist at different time periods throughout a propagating thermal runaway event. In addition, toxic gases present a health exposure hazard to site personnel and first responders located in the vicinity of a BESS failure.

7.1.2 Barriers

Passive and active mitigation strategies are provided to prevent batteries from entering thermal runaway and cool adjacent batteries to prevent thermal runaway propagation. The following barriers are provided in the EnerC+:

- The cells, modules and the EnerC+ are tested to UL 9540A.
- The EnerC+ container is listed to UL 9540.
- The EnerC+ is equipped with a BMS which monitors cell health and shuts down power to modules/racks when cells are operating outside of their normal conditions.
- The EnerC+ modules are equipped with passive barriers to minimize the likelihood of thermal runaway of spreading from module to module. In addition, the EnerC+ itself is provided with passive barriers, such as the module construction, to minimize the chance of a thermal runaway event from propagating throughout the entire container.
- The EnerC+ must be regularly maintained to ensure it is operating within its specific parameters and to verify the batteries are in good working condition.

7.1.3 Consequences

The consequences of thermal runaway can vary widely depending on the gas release scenario and level of confinement; however, the primary consequences of thermal runaway can be grouped into the following hazard categories: fire and radiant heat, deflagrations and explosions, and toxic gases.

7.1.3.1 Fire and Radiant Heat Exposure Hazard

UL 9540A unit level testing did not result in a fire (i.e. flaming thermal runaway). During that test, four cells went into thermal runaway: the one that was forcibly heated and three additional cells. However, thermal runaway did not propagate beyond the fourth cell, and no sustained fire event occurred.

7.1.3.2 Deflagration and Explosion Hazard

The EnerC+ has been tested to UL 9540A as required by the CFC. The module level test results shown in Table 3 indicate flammable gases, predominantly hydrogen and hydrocarbons, are released from the battery modules. The EnerC+ is equipped with an explosion control system that actively ventilates flammable gases. Upon elevated hydrogen levels, the ventilation system activates to exhaust gases and maintain flammable gas levels below 25% LFL (according to the NFPA 69 analysis/report).

7.1.3.3 Toxic Gas Hazard

The EnerC+ is not occupiable; therefore, toxic or highly toxic gas exposure is limited to individuals standing outside, in the open ambient air, in proximity to the EnerC+ container during a failure/fire event. The only toxic gas collected during the module level testing was carbon monoxide, which is listed in Table 3. Note, measurements for toxic gases sometimes associated with lithium-ion batteries, such as hydrogen fluoride (HF), hydrogen chloride (HCl), and hydrogen cyanide (HCN) were not performed during the UL 9540A testing[3]. Therefore, in the absence of data, FRA recommends that monitoring of these gases in addition to CO and CO2 should be included during a battery emergency.

To mitigate this hazard, the EnerC+ is equipped with fire detection and notification (both locally and remotely). These systems can detect and notify local site personnel, should anyone be in the area, of a thermal event so that they can evacuate to a safe location before toxic gases can impact site personnel. Additional mitigation measures include emergency response procedures and training that will advise site personnel and first responders to stand at a safe distance, upwind from a distressed EnerC+, to wear appropriate personal protective equipment (PPE) including a self-

[3] During a fire event involving a BESS, the battery cells and plastics encasing them could experience thermal decay contributing to the fuel load, heat release rate, and producing trace toxic components. These could include the release of HF gas upon thermal degradation/decomposition. Additionally, thermal decomposition of freon from the HVAC system and wire insulation can be other potential contributing sources of HF. Other potential sources of acid gases include HCN from the incomplete combustion of nitrogen-containing materials (such as wool, silk, cotton, paper, and plastics) and HCL gas from pyrolysis of chlorinated plastics, particularly polyvinyl chloride (PVC), and other chlorine-containing materials. Note, these hazards are not exclusive to battery fires. As the modern built environment has expanded the use of plastic goods and materials to a wide variety of household products, HF, HCL, HCN and other products of combustion are also found as a result of common modern day house fires.

contained breathing apparatus and to monitor the air for toxic gases, as they would during any fire event.

The Seahawk BESS is installed outdoors, where gas release would be diluted by the entrainment of outside air. It is reasonable to expect that these gases, at the quantities measured during UL 9540A module level fire testing, would not have an adverse effect on individuals during the time deemed necessary to evacuate from the area (i.e., approximately 30 seconds to walk 100 ft away/evacuate from the vicinity of a burning EnerC+ based on the average (unimpeded) walking speed of 3.3 meters per second for able bodied maintenance personnel), provided they evacuate immediately.

7.2 Failure of Any Battery (Energy) Management System

7.2.1 Description

The EnerC+ is equipped with a BMS. The BMS tracks the performance, voltage, current, and SOC of the cells to ensure they are operating within manufacturer specifications. Per CFC §1207.3.4, the BMS is required to disconnect electrical connections to the ESS if potentially hazardous conditions occur. Consequences due to BMS failure are evaluated in this section.

7.2.2 Barriers

The following barriers are provided to prevent BMS failure and minimize the consequences of BMS failure:

- The BMS is certified and included in the UL9540 listing certification.
- The BMS will be regularly maintained to ensure it operates within its specific parameters.
- Electrical fault protection devices are integrated into the equipment.
- The cells, modules and the EnerC+ are tested to UL 9540A.

7.2.3 Consequences

Failure of the BMS will prevent active monitoring of battery cell conditions. It should be noted, BMS failure alone will not cause battery failure. In a worst-case scenario, a BMS failure in conjunction with a secondary failure condition (such as over voltage, excess temperature, etc.) may result in a thermal runaway event. Barriers and consequences of thermal runaway are provided in Section 7.1.2 and 7.1.3 of this report.

7.3 Failure of Any Required Ventilation or Exhaust System

7.3.1 Description

A failure scenario involving any required ventilation or exhaust may expose the batteries to elevated operating temperatures. Depending on the resulting ambient temperature, ventilation failure may cause batteries to be exposed to temperatures outside of the manufacturer's recommended operating conditions or temperatures at which the cell fails. The EnerC+ is provided with a thermal management system utilizing chillers and a closed-loop liquid cooling system.

7.3.2 Barriers

The following barriers are provided to prevent thermal management system failure and reduce the consequences of a failure event:

- The TMS shall be regularly maintained to ensure it operates within its specific parameters.
- The BMS monitors the thermal management system and in the event of low coolant pressure or over-temperature, it is able to shut down power.

7.3.3 Consequences

Failure of the cooling system may expose batteries to ambient temperatures. The BMS provides redundancy and will also cut power to the affected cells and send a signal to the EMS, such that a failure will be quickly detected and remediated. The average peak ambient temperature in Watsonville, CA is 74°F and occurs in September. The peak temperature is less than the cell venting temperature; therefore, failure of the cooling system is not anticipated to lead to a thermal runaway event. In a worst-case scenario, batteries operating at elevated temperatures for extended periods of time may degrade and have a higher likelihood of failure over time, possibly leading to thermal runaway.

7.4 Voltage Surges on the Primary Electric Supply

7.4.1 Description

A voltage surge on the primary electric supply to the BESS may expose batteries to excessive voltage. This failure scenario evaluates the consequences due to a voltage surge on the primary electric supply.

7.4.2 Barriers

The following barriers are provided to minimize the consequences of a voltage surge on the primary electric supply:

- Electrical fault protection is provided.
- Battery health is monitored by the BMS and automatically shuts down power upon over voltage conditions.

7.4.3 Consequences

In the event of a voltage surge, the electrical fault protection will automatically stop electricity flow in the affected electrical circuit. The BMS provides redundancy and will also cut power to the affected cells and send a signal to the EMS, such that a failure will be quickly detected and remediated, reducing the duration an EnerC+ container is operating with a damaged electrical component/equipment.

7.5 Short Circuits on the Load Side of the ESS

7.5.1 Description

A short circuit on the load side of the BESS may result in an increased current traveling through the battery circuit. Electrical currents outside of the recommended operating range may damage batteries and lead to a thermal runaway event.

7.5.2 Barriers

The following barriers are provided to minimize the consequences of a short circuit event:

- Electrical fault protection is provided.
- Battery health is monitored by the BMS and automatically shuts down power upon over voltage conditions.

7.5.3 Consequences

In a short circuit condition, the electrical fault protection will automatically stop current in the affected electrical circuit. The BMS provides redundancy and will also cut power to the affected cells and send a signal to the EMS.

7.6 Failure of a Fire Protection System

7.6.1 Description

A failure of a fire protection system can include a smoke detection, fire detection, fire suppression, gas detection system or explosion control system. The EnerC+ has an internal fire and gas detection system monitored by the BMS but does not have an automatic suppression system that is integral to its design/construction. It is equipped with an explosion control system (emergency fans and vents). Therefore, this failure scenario evaluates the consequences associated with the failure of these systems.

7.6.2 Barriers

The fire and gas detection system and explosion control system are provided with the following features to prevent failure and minimize consequences associated with failure:

- The EnerC+ is equipped with a BMS which monitors cell health and shuts down power to modules/racks with cells operating outside of their operating conditions. The BMS operates independently from the fire and gas detection system.
- The fire and gas detection system can provide a trouble signal to the remote supervising station, such that repair operation can take place.
- Backup power is provided for the fire alarm system via backup batteries.
- Backup power will be provided for the explosion control system (to be verified by New Leaf).
- The internal BESS FACP provides a fault signal to the BMS for monitoring.
- Electrical fault protection devices are integrated into the equipment and act independently from the fire and gas detection system.

7.6.3 Consequences

Independent failure of a component of either the fire and gas detection system or the ventilation system will have no effect on the battery container and will not induce a thermal runaway event.

Failure of the detection systems may result in the inability of the system to detect fire conditions within the container and notify site personnel and activate the explosion control system. The primary potential causes for this failure would be the fault in a listed fire alarm initiating device, an initial installation error, or degradation of a fire alarm device/wiring over time. The likelihood of these occurring with a properly designed, installed, commissioned, monitored, inspected, tested, and maintained fire alarm system is historically low based on data from the National Fire Protection Association. The fire alarm system is an addressable system where the status of each device is monitored by the FACP and BMS; therefore, a failure of a component of this system would be reported and can be remediated. Periodic ITM is also performed to inspect the fire alarm system for damage/degradation and to test the devices for proper performance. All these traditional fire alarm system mitigation strategies are in place to minimize the likelihood of a fire alarm system failure over the life span of the BESS.

Similarly, failure of the explosion control system may result in the accumulation of flammable gases in the container and subsequent deflagration. The primary potential causes mirror those of component failures in the fire alarm system noted above. It is expected that the system will be properly designed, installed, commissioned, monitored, inspected, tested, and maintained to minimize likelihood of failure within these components. Ultimately, the risk associated with deflagration will be mitigated by the presence of the fire alarm system which will detect the thermal event and sound the local fire notification appliances and transmit signals off-site. These appliances can alert local site personnel and/or first responders, should any be in the area, of the hazard. The ERP and training of site personnel/first responders can then direct all personnel to evacuate from the area immediately upon activation of a fire alarm notification appliance. By immediately evacuating to a designated safe area, site personnel and first responders will be remote from the distressed EnerC+, physically separating them from the potential deflagration and explosion hazard.

7.7 Failure to Provide Spill Neutralization or Secondary Containment

7.7.1 Description

Lithium-ion batteries, because of their chemistry and architecture, do not require spill neutralization or secondary containment. Unlike other battery types, such as lead acid, there is no free-flowing liquid inside the cells that requires neutralization or containment. This distinction is also made in CFC Table 1207.6, where lithium-ion BESS is not required to provide spill neutralization and secondary containment.

7.7.2 Consequences

No consequences - failure mode is not applicable to EnerC+.

7.8 Hazard Mitigation Analysis Approval

Based on the analysis above, the Seahawk BESS meets all of the HMA approval criteria for FCO or AHJ approval per CFC §1207.1.4.2 as it has demonstrated that:

1. Fires will be contained within unoccupied ESS rooms or areas for the minimum duration of the fire-resistance rated separations identified in CFC §1207.7.4.

   The Seahawk BESS meets this requirement. The EnerC+ is installed outdoors, not within an unoccupied BESS room or area. However, it should be noted, the EnerC+ design includes a series of passive fire protection schemes (barriers) to protect it from spreading a fire from one EnerC+ container to another. As demonstrated in UL 9540A unit-level fire testing, a failure of four cells did not result in thermal runaway propagating throughout the battery module or to adjacent EnerC+ racks. Although this requirement applies to ESS rooms or areas (and not an outdoor installation), the Seahawk BESS still meets the intent of the requirement by containing a fire event to a single EnerC+ container.

2. Fires in occupied work centers will be detected in time to allow occupants within the room or area to safely evacuate.

   The Seahawk BESS meets this requirement. The EnerC+ is installed outdoors, not within an occupied work center (or any other room). However, it should be noted, the EnerC+ has a number of internal sensors including a fire detection system and local notification appliance. The fire detection system can detect fires and products of combustion inside the EnerC+ while the notification appliance will notify site personnel, should any be in the area, to evacuate. In addition, the fire detection system is monitored off site at a supervising station that can provide emergency notification to the owner/operator of the site and the fire department, if necessary. Although this requirement applies to occupied work centers (and not an outdoor installation), the Seahawk BESS still meets the intent of the requirement through the internal sensors and local notification appliance.

3. Toxic and highly toxic gases released during fires will not reach concentrations in excess of the IDLH level in the building or adjacent means of egress routes during the time deemed necessary to evacuate occupants from any affected area.

   The Seahawk Bess meets this requirement. The EnerC+ is installed outdoors, not within a building or adjacent to any means of egress. Given the Seahawk BESS is installed outdoors, where any gas release would be diluted by the entrainment of outside air, these gases, at the quantities measured during UL 9540A module level fire testing, would not be expected to have an adverse effect on individuals during the time deemed necessary to evacuate from the area (i.e., approximately 30 seconds to walk 100 ft away/evacuate from the vicinity of a burning EnerC+ based on the average (unimpeded) walking speed of 3.3 meters per second for able bodied maintenance personnel). Nor would these gases, at the quantities measured during UL 9540A module level fire testing, be expected to have an adverse effect on emergency response personnel, who will be wearing appropriate PPE while responding to an EnerC+ fire. Although this requirement applies to a building or to an installation that is immediately adjacent to a means of egress route, the Seahawk BESS still meets the intent of the requirement (i.e. does not produce toxic or highly toxic gases above the IDLH during a fire event during the time deemed necessary to evacuate from the area).

4. Flammable gases released from ESS during charging, discharging, and normal operation will not exceed 25 percent of their LFL.

   The Seahawk BESS meets this requirement. The EnerC+ utilizes listed lithium-ion cells that are hermetically sealed and do not vent during charging, discharging or normal operation. Unlike other battery types, no flammable gases are released during normal operation of the lithium-ion batteries. As such, no flammable gases exceeding

25% of their LFL will be released from the Seahawk BESS during charging, discharging, and normal operation.

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 Seahawk BESS meets this requirement. The EnerC+ is equipped with an NFPA 69-compliant explosion control system. During a thermal event, the explosion control system activates, ventilating the EnerC+ to keep the gas concentration of the container below its explosive limit. TLB performed a review of the explosion control system and CFD simulations prepared for the EnerC+ and determined the system to be in compliance with NFPA 69. In addition, CATL has issued an NFPA 69 test report that demonstrates the ability of the system to maintain a combustible gas concentration below 25% of the LFL. As such, flammable gases released from the ESS during fire, overcharging, or other abnormal conditions will be controlled via the explosion control system.

8.0 RECOMMENDATIONS

Throughout the report, FRA provided several recommendations related to the Seahawk BESS installation and emergency response to mitigate the hazards of a fire event. These recommendations are based on our review of the available materials, our background, experience, and training, the analyses performed to date described above, common industry best practices for responding to a thermal event involving lithium-ion BESS, as well as from FRA's experience with lithium-ion battery hazards, BESS hazards, and previous BESS fires. These recommendations do not provide opinions or conclusions meant to address specific circumstances or all possible scenarios of an emergency. As with all emergency events, emergency response actions should be evaluated and performed based on real-time fire conditions, observations, and data (i.e., BESS data points, air quality measurements, smoke production, wind direction/speed, fire intensity, proximity of flames to adjacent electrical equipment and structures) during the actual emergency. Below is a summarized list of the recommendations provided throughout the report:

1. **Site Design:** As the site design is finalized, FRA recommends that the following be addressed to ensure compliance with the CFC:
    a. Labels and signage must be provided for the ESS disconnecting means in accordance with CFC §1207.4.1.
    b. Signage must be provided per CFC §1207.4.8.
    c. Fire apparatus access roads must be approved by the AHJ per CFC §503.
    d. The water supply design must be provided per CFC §507.
    e. Provide backup power for the explosion control system.
2. **Minimum Approach Distance (MAD):** When responding to a battery emergency, FRA recommends that all site personnel and first responders remain at a safe distance (>100 ft), upwind from a distressed EnerC+ container, as designated in the Seahawk BESS ERP, to ensure they are not momentarily exposed to dangerous conditions. In addition, site personnel and first responders should not approach the front of distressed EnerC+ containers and all first responders should wear proper PPE when approaching a distressed EnerC+ container during a battery emergency.
3. **Plans:** FRA recommends that prior to energizing the Seahawk BESS, develop commissioning, decommissioning, operation and maintenance, and emergency response plans for the Seahawk BESS, as required by the CFC.
4. **Emergency Response Training:** FRA recommends that all site personnel and emergency response personnel, who could be responsible for responding to a Seahawk BESS emergency, be trained on the ERP prior to energizing the Seahawk BESS. Refresher training should be provided as appropriate, typically annually.

5. **<u>On-going Fire Protection System ITM:</u>** FRA recommends that all fire protection systems be installed/commissioned, inspected, tested, and maintained as required by the CFC and their respective NFPA standard.

9.0 CONCLUSION

Based on our review of the available materials, our background, experience, and training, and the analysis performed to date described above, the following conclusions are submitted within a reasonable degree of scientific and engineering certainty:

1. The EnerC+ and the Seahawk BESS site design can meet the CFC requirements for an outdoor remote BESS installation when it is installed in accordance with the EnerC+ Installation Manual, its listing, the approved drawings, and the CFC, provided the items in Section 8.0 are completed.
2. The HMA demonstrates the Seahawk BESS meets all the HMA performance criteria for approval outlined in CFC §1207.1.4.2, as follows:
    - Fires will be contained to a single EnerC+ as demonstrated through UL 9540A unit level testing.
    - Fires will be detected in time to allow personnel to safely evacuate via internal sensors and local notification appliance of the EnerC+.
    - Toxic and highly toxic gases released during fires will not reach concentrations in excess of IDLH levels in the area during the time deemed necessary to evacuate from the Seahawk BESS area.
    - Flammable gases released from a EnerC+ during charging, discharging and normal operation do not exceed 25% of their LFL given the listed lithium-ion cells utilized in the EnerC+ are hermetically sealed and do not vent during charging, discharging or normal operation.
    - Flammable gases released from the EnerC+ during a fire, overcharging and other abnormal conditions will be controlled through the use of ventilation of the gases preventing accumulation.
3. In addition, this HMA and the UL 9540A testing demonstrates that the size and separation and maximum allowable quantity limitations imposed by the CFC may be exceeded for the EnerC+ installation at the Seahawk BESS.
4. Based on this analysis, the Seahawk BESS may be approved by the FCO in consideration to the recommendations provided.

Appendix 3.16C

Emergency Response Plan

Seahawk BESS

Emergency Response Plan

Prepared for Seahawk Energy Storage 1, LLC

August 26, 2025

Rev D

OVERVIEW

This document is an Emergency Response Plan (ERP) for Seahawk Energy Storage 1, LLC (Client) for the Seahawk BESS site located at 90 Minto Road in Watsonville, California. This ERP has been developed to assist the local emergency responders with important safety and emergency response information concerning the CATL EnerC+ lithium-ion Battery Energy Storage Systems (BESS), intended for installation at the Seahawk BESS facility. The Seahawk BESS is originally anticipated to include 130 EnerC+ cabinets, with space to augment with an additional 30 EnerC+ cabinets in the future.

The EnerC+ is a fully integrated BESS consisting of battery modules, power electronics, control systems, a battery management system, a thermal management system, and an explosion control system all pre-assembled within a single, non-occupiable cabinet. It is meant for outdoor installations, mounted to the ground, for commercial, industrial, and utility applications. This plan includes a review of the EnerC+, its construction, design, fire safety features, listings, certifications, and UL 9540A fire test data. In addition, it includes an overview of the proposed EnerC+ installation at the Seahawk BESS Site.

This document and supporting material should be consulted prior to any fire service personnel performing firefighting operations at the Seahawk BESS.

The scope of services performed during this analysis may not adequately address the needs of other users of this document, and any re-use of this ERP or its conclusions presented herein are at the sole risk of the user. The recommendations formulated during this assessment are based on observations and information available at the time of the analysis, which has been provided to FRA by others. No guarantee or warranty as to future performance of any reviewed condition is expressed or implied.

TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

1. GENERAL INFORMATION

1.1 Scope

This document is an Emergency Response Plan for the Seahawk BESS. The scope of the ERP focuses on the hazards and response tactics associated with BESS emergencies, transformer, and switch gear failure scenarios along with post-incident guidance. The plan also outlines the training and exercise cycle that will serve to prepare personnel along with members of the first response community to respond to site emergencies.

1.2 Purpose

The purpose of this ERP is to provide guidance to battery energy storage system (BESS) subject matter experts (SME) and the members of the fire service on emergencies that can reasonably occur at the facility. Guidance contained herein will allow these groups to operate within a unified command setting to develop strategies to ensure safety and mitigate risk during an operational response to an energy storage system emergency.

1.3 Site Owner

Sequoia Energy Storage 1, LLC: 55 Technology Drive, Lowell, MA, 01851

HQ Telephone: 800.818.5249

1.4 Site Location

Seahawk Battery Energy Storage Facility: 90 Minto Road

Watsonville, Santa Cruz County, California

APN 051-101-77

1.5 BESS Product

Contemporary Amperex Technology Co., Limited: EnerC+

1.6 Emergency Contact

The Seahawk Energy Storage 1, LLC Regional Operations Center (ROC) can be reached at xxx-xxx-xxxx for any emergency conditions the occur at the Seahawk BESS.

1.7 First Responder Contact Information

First Responder Agency	Address	Phone
All Emergencies	*Statewide*	*911*
Pajaro Valley Fire Protection District	562 Casserly Rd, Watsonville, CA 95076	831.722.6188
Santa Cruz County Fire Marshal	6059 Highway 9, Felton, CA 95018	831.335.5353
Watsonville Police Department	215 Union St, Watsonville, CA 95076	831.471.1151
Watsonville Community Hospital	75 Nielson St, Watsonville, CA, 95076	831.724.4741

1.8 Incident Management Team Contact Information

Incident Management Team	Email	Contact

2. ENERGY STORAGE SYSTEM INFORMATION

2.1 Site Overview

The site is predominantly bordered by agricultural farmland on all sides. An existing substation borders the property on the northwest. Minto Rd runs through the north side of the site, which also serves as the main access point for the site. There are no sensitive areas such as schools, healthcare facilities or houses of worship within a half mile of the facility. A school is located approximately half a mile southwest of the facility, with another school and a house of worship located approximately three quarters of a mile southwest of the facility.

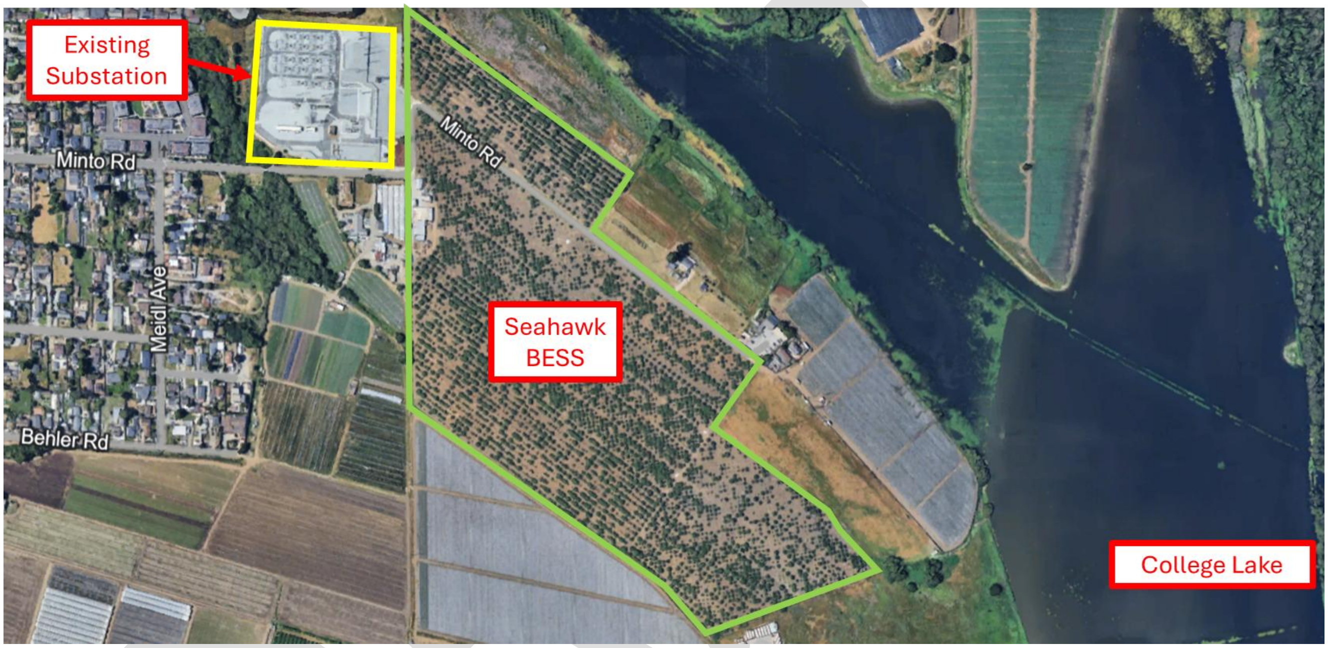


Figure 1 General Aerial View

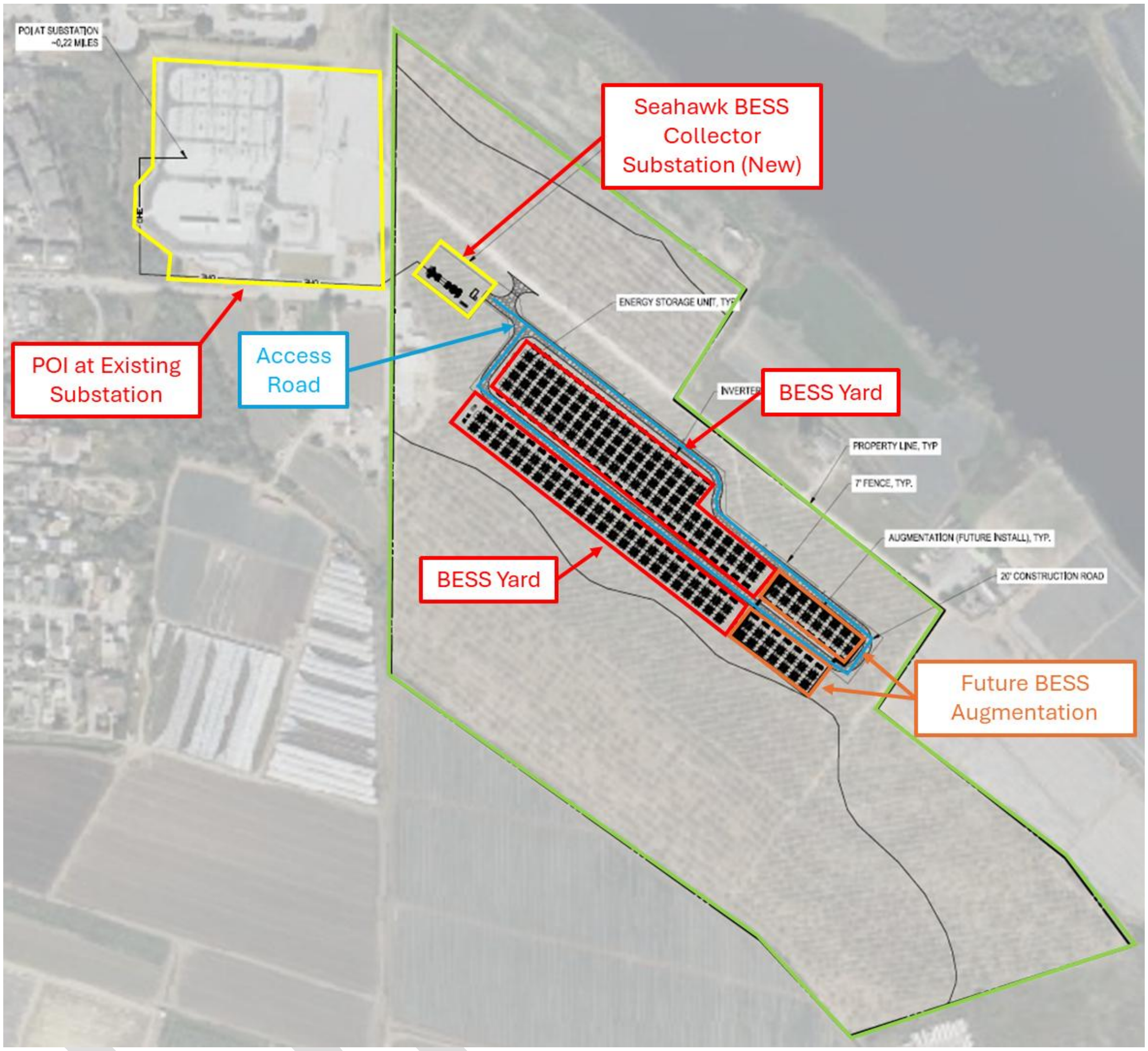


Figure 2 Proposed Seahawk BESS Site Layout

2.2 Energy Storage System Site Design

The facility will contain 65 battery blocks, with room for 15 additional battery blocks for future augmentation. Each battery block consists of two battery containers and one medium voltage skid (MV Skid) that contains an inverter and a transformer. The inverter provides power conversion from the batteries DC to AC power and the transformer is used to ramp voltage up from 1,500 volts produced by the battery blocks to 34,000 volts. Power from the battery arrays enters the grid through the sites substation where 34,000 volts is increased to a transmission level of 115,000 volts.

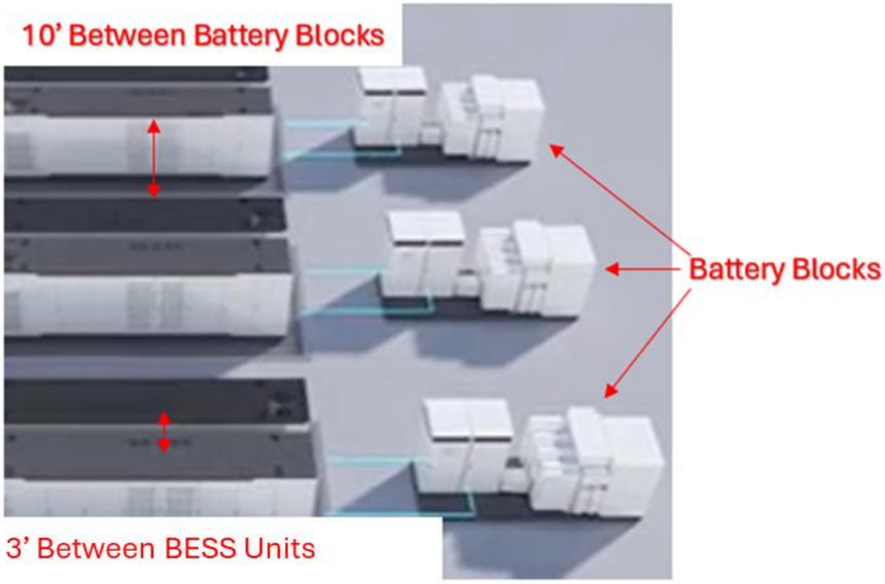


Figure 3 Battery Blocks

3. GLOSSARY OF TERMS

3.1 Battery Management System/Energy Management System

The battery-management system (BMS) is an electronic system that monitors the charging, discharging, temperature, and other factors influencing the state of cells within a module. It is used to monitor and maintain the health and capacity of a battery. BMS are now tied to fire alarm control panels to ensure fast clearing when fire-related alarms are received.

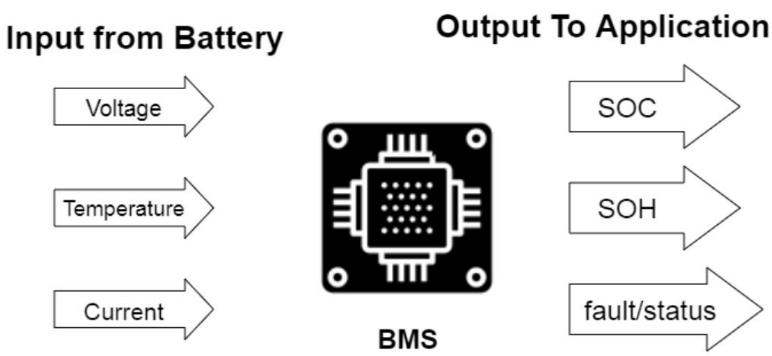


Figure 4 BMS Data Points

3.2 Critical Temperatures

Table 1 Critical Temperatures

Thermal Operating Range	Celsius	Fahrenheit
Normal Operating Range	-25°C / 55°C	-13°F / 131°F
Critical Temperature: Venting (flammable electrolyte)	154°C	309°F
Critical Temperature: Thermal Runaway	241°C	465°F

3.3 Cell

The basic functional electromechanical unit contains an assembly of electrodes, electrolyte, separators, container, and terminals. It is a source of electrical energy by direct conversion of chemical energy. Each cell has a nominal capacity of 306 Ah, nominal voltage of 3.2 Vdc, and is composed of Lithium-Iron Phosphate (LFP) chemistry. The cell is prismatic in geometry and is certified to UL 1973, and a UL 9540A cell level test has been successfully completed.

Table 2 Cell Information

Cell level information	
Cells in Module:	
•Manufacturer Name	Contemporary Amperex Technology Co., Limited
•Part Number	CBDD0
•Chemistry	Lithium Iron Phosphate
•Format	Prismatic
Ratings (Vdc, Ah) :	3.2V, 306Ah
Was the cell certified? :	Yes
Standard the cell was certified to:	UL 1973
Organization that certified the cell:	MH62898
Average cell surface temperature at gas venting, °C:	154
Average cell surface temperature at thermal runaway, °C:	241
Gas Volume:	204L
Lower flammability limit (LFL), % volume in air at the ambient temperature:	8.595
Lower flammability limit (LFL), % volume in air at the venting temperature:	7.24
Burning velocity (S_u) cm/s:	54.20
Maximum pressure (P_{max}) psig:	102.74

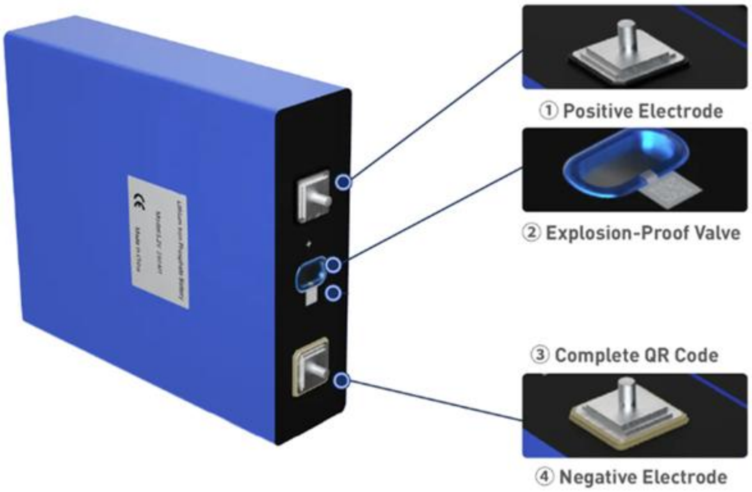


Figure 5 Battery Cell

3.4 Module

A module is a component of a BESS that consists of a group of cells connected in a series and/or parallel configuration with protective devices and monitoring circuitry. Each module is composed of 104 cells in a module. Each module has been outfitted with a fused disconnect for additional protection.

Table 3 Module Information

Module level Information	
Model No:	M02306P05L01
Ratings (Vdc, Ah) :	166.4V, 612Ah
Module cell configuration (xS/yP) ......:	52S2P
Module dimensions (W x D x H (mm)) :	830mm*2235mm * 250mm
Module weight (kgs) :	653±5kg

Figure 6 Battery Module

3.5 EnerC+ Battery Container

The EnerC+ Container is IP55 rated and has five compartments. Each compartment contains eight modules. Each compartment has a dedicated Sub-Control box with a BMS and a disconnect switch for each battery string. The container has been outfitted with two thermal management systems that provide liquid cooling to modules to ensure optimum efficiency and system safety. On the terminal end of the container double doors reveal a master disconnect to island the container, a distribution box that provides auxiliary power to operational and an FACP.

Table 4 EnerC+ Container Information

DC Side Data	
Product Model	**C02306P05L01**
P-Rate	0.5P
Cell	
Cell type	LFP
Cell capacity	306Ah
Cell Voltage range	2.5-3.65V
Cell rated Energy	979.2Wh
System	
Configuration	5P2P416S
Rated Energy	4073.47kWh
Rated Voltage	1331.2VDC
Voltage Range	1040 ~ 1500VDC
Rated Charging Current	1530A
Maximum Charging Current	1958.4A
Rated Charging Power	2036.73kW
Rated Discharging Current	1530A
Maximum Discharging Current	1958.4A
Rated Discharging Power	2036.73kW

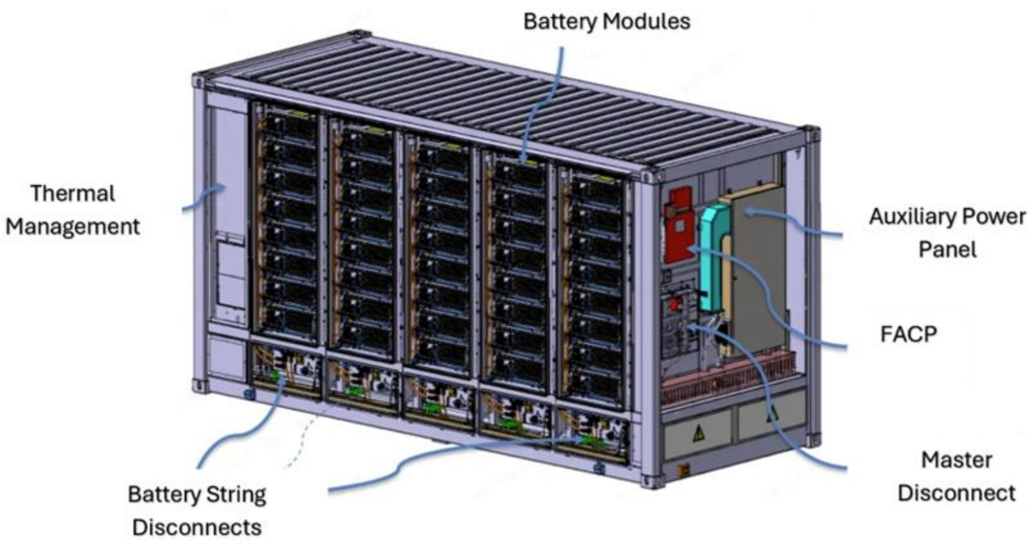


Figure 7 EnerC+ Container

3.6 Battery String

The EnerC+ has five battery compartments. Each compartment contains a rack with a string of eight modules. Racks have a dedicated sub-controller that is outfitted with a battery management system and manual disconnect switch.

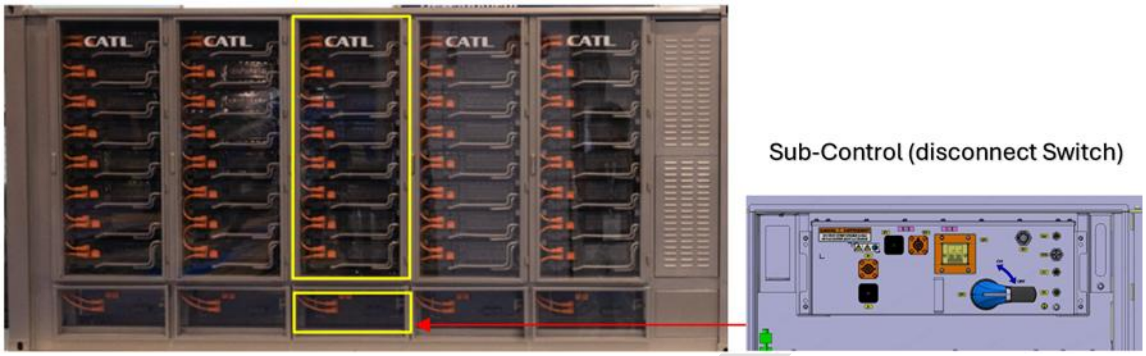


Figure 8 Battery String

3.7 Medium Voltage Skid

The Medium Voltage Skid (MV Skid) contains two PCS Inverters and one step-up transformer, auxiliary transformer along with a system disconnect switch. The PCS inverter converts DC energy from the batteries to AC. Power is then routed through a step-up transformer where 1,500 volts is ramped up to 34,000 volts. The auxiliary transformer provides basic light and power to the facility along with critical circuits to run the FACP, explosion control and thermal management system.

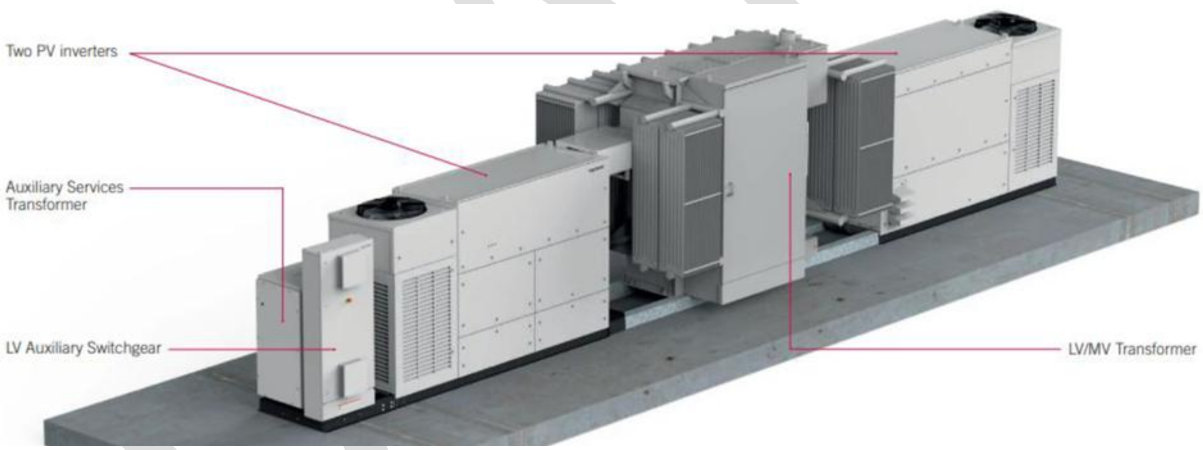


Figure 9 Medium Voltage Skid

3.8 E-Stop

This device is designed to stop the charging and discharging of system batteries. The operation of an E-Stop will NOT remove the stranded energy hazard from cells/modules. E-Stops are located at the terminal end of the EnerC+ container and on the PCS, inverter located on the MV Skid.

3.9 Stranded Energy

During an emergency at a BESS facility, E-Stops may be operated to stop charging and discharging of modules. However, the E-Stop feature does not discharge the electrical potential remaining in the cells/modules which is known as stranded energy. It should be noted that during the garden variety failure of electrical equipment, power sources can be isolated. This is not the case with batteries which must be discharged over time to remove their electrical potential.

3.10 Cell Venting

In this initial stage of failure, a flammable electrolyte vents from the module in gaseous state. The critical temperature where sustained venting begins is 154°C (309°F) as determined by UL 9540A Cell Level Testing. Gas venting is often a precursor of thermal runaway.

Figure 10 Cell Venting

3.11 Thermal Runaway

The incident when an electromechanical cell's temperature increases at an accelerating rate in an uncontrollable fashion sufficient to result in damage to the cell. The thermal runaway progresses when the cell's generation of heat is at a higher rate than the heat it can dissipate. Based on UL 9540A testing, thermal runaway begins at 241°C (461°F) as determined by UL 9540A Cell Level Testing.

Figure 11 Thermal Runaway

3.12 Alternating Current/Direct Current

Energy produced by the cells can be categorized as DC. During electrical emergencies, the fire service traditionally uses non-contact voltage testers to identify energized equipment. It should be noted that non-contact voltage detectors cannot detect the presence of DC and should never be used.

3.13 Subject Matter Expert

NFPA 855 requires the facility owner/operator to designate and train staff to respond 24/7 within a timely manner to investigate all BESS incidents. They will serve as the site SME and work closely with the fire services to investigate and mitigate conditions while ensuring the safety of fire service members operating at the scene.

4. BATTERY MANAGEMENT SYSTEM

The BMS has wide-reaching oversight to control charging, discharging, fault detection, and equipment isolation. The BMS has design parameters that evaluate the state of charge & state of health for batteries along with critical temperature thresholds that generate alarms accordingly. The system plays a key role in the timely response to system emergencies such as cell venting and thermal runaway. The BMS can isolate trouble modules or strings as necessary to contain failure events. The BMS exists at a module level, rack level and system level for layered control.

To make informed decisions during system emergencies the BMS should be reviewed with an emphasis on the state of charge for cells/modules on the trouble string. A full state of charge will increase the duration of the emergency. In addition, the temperature of cells will be an indication of fire propagation within the trouble module or adjacent modules.

Table 5 BMS Capabilities

BMS Function	 Module BMS (BMU)  Rack BMS (BCMU)  System BMS (BAMS)
Conditions Monitoring	State of Change, SOC
State of Health, SOH	Discharge Control
Thermal Management	Fault Alarms
Balancing	Protection

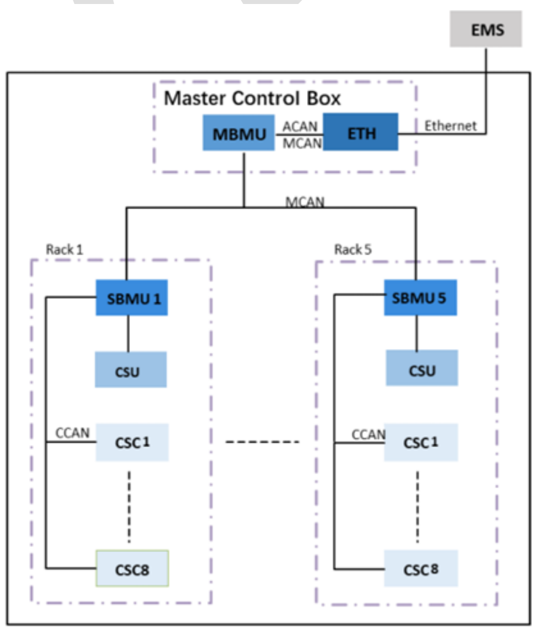


Figure 11 EnerC+ Container Architecture

5. FIRE DETECTION AND SUPPRESSION

5.1 Fire Alarm Control Panel

Each EnerC+ container is provided with an addressable intelligent fire alarm control panel (FACP) model Potter ARC-100. The FACP is equipped with a notification appliance circuit (NAC) module capable of initiating local visual/audible notification appliances. Alarms received by the FACP are routed to (central station?).

Figure 12 Fire Alarm Control Panel

5.2 Fire Detection

Smoke Detection: There are three smoke detectors in each EnerC+ container. Two in the battery compartment and one in the electrical compartment. The generation of a smoke alarm within the container will be received at the FACP. The FACP would notify the ROC through SCADA and isolate the trouble container through the BMS.

Heat Detection: There are two heat detectors the battery compartment in each EnerC+ container. The generation of a heat alarm within the container will be received at the FACP. The FACP would notify the ROC through SCADA and isolate the trouble container through the BMS.

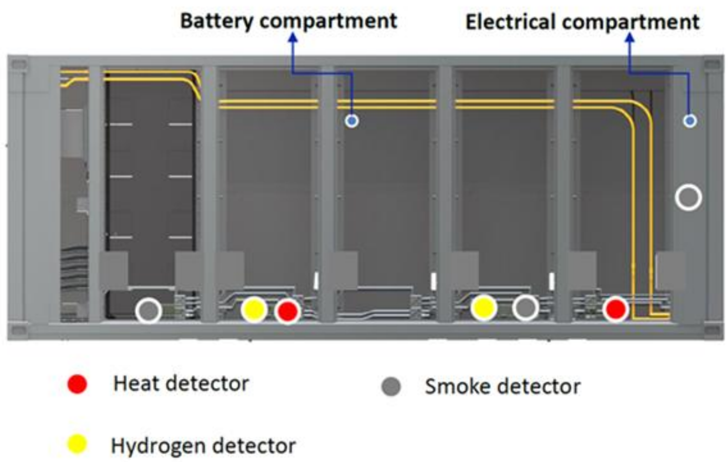


Figure 13 Fire Detection Devices

Hydrogen Gas Detection: Two Hydrogen (H_2) gas detectors have been installed in each EnerC+ container. The devices are designed to detect H_2 at 10 % LFL. This would generate an alarm at the FACP and activate the NFPA 69 explosion prevention system to maintain H_2 below 25% of the LFL. The FACP would notify the ROC through SCADA and isolate the trouble container through the BMS.

Figure 14 Hydrogen Detector

5.3 Alarm Annunciation

Alarms received at the FACP will generate audible and visual alarms on the exterior of the battery container to alert staff and first responders as to the location of the trouble equipment.

5.4 Apparatus Access

Site access for fire apparatus conforms to the requirements of CFC, Section 503. The main entry to the facility will be from Minto Road. The private access road is a 20-foot-wide gravel drive lane that travels through the center and around the north side of the facility. Figure 15 illustrates the fire access road highlighted in green.

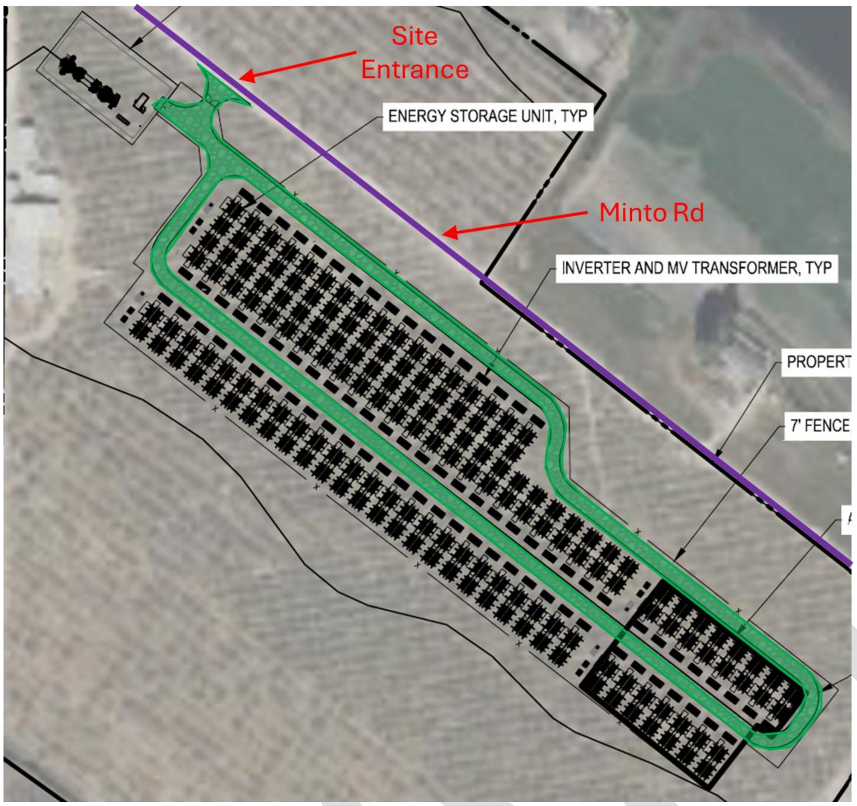


Figure 15 Fire Access Road

5.5 Water Supply

A 10,000 gallon fire water storage tank is planned for the site. The tank will be located near the site entrance. Additional information will be provided when available.

6. HAZARDS

In this section the following hazards will be covered:

- Chemical
- Electrical
- Arc Flash
- Explosion

6.1 Chemical

This section will outline the predominate chemicals hazards along with the recommended actions and personal protective equipment.

- LFP Cells
- Hydrogen
- R134a, R410a, and R513a Refrigerants
- Transformer Oil
- Carbon Monoxide

6.1.1 LFP Cells

Toxicity: LFP cell gases are evaluated during UL 9540A Large Scale Fire Testing to identify the production of IDLH conditions. Carbon monoxide was the only target IDLH gas identified. The risk from carbon monoxide under this situation does not pose a health hazard since the battery container cannot be occupied. In addition, carbon monoxide is simply managed through administrative controls such as staging upwind and engineering controls in the form of an SCBA to manage the respiratory hazard.

Note: There are no dermal hazards posed by carbon monoxide.

Table 6 UL9540A Cell Gas Analysis

Gas		Measured %
Carbon Monoxide	CO	11.086
Carbon Dioxide	CO_2	33.290
Hydrogen	H_2	35.698
Methane	CH_4	10.075
Acetylene	C_2H_2	0.164
Ethylene	C_2H_4	5.259
Ethane	C_2H_6	1.089
Propadiene (Allene)	C_3H_4	0.000
Propyne	C_3H_4	0.000

UL 9540A Data: Cells are outfitted with a vent that ejects flammable electrolyte during elevated thermal conditions. This safety feature serves to manage the risk of internal pressurization resulting in a catastrophic failure. LFP batteries are more stable than other battery chemistries and are less likely to undergo thermal runaway and are not susceptible to violent failures of the outer shell. Test data indicates that cell failure will not propagate beyond the module level. There was no indication of flying debris, explosive discharge of gas or sparks and electrical arcing.

Hazards of Vented Electrolyte: Cell vent gas composition will depend upon several factors, including cell composition, cell state of charge, and the cause of cell venting. Vent gases may include volatile organic compounds (VOCs) such as alkyl-carbonates, methane, ethylene, and ethane; hydrogen gas; carbon dioxide; carbon monoxide; soot; and particulates containing oxides of nickel, aluminum, lithium, copper, and cobalt. Additionally, phosphorus pentafluoride, POF3, and HF vapors may form. Vented gases may irritate the eyes, skin, and throat. Cell vent gases are typically hot; upon exit from a cell, vent gas temperatures can exceed 600°C/1,110°F. Contact with hot gases can cause thermal burns. Vented electrolyte is flammable and may ignite on contact with a competent ignition source such as an open flame, spark, or a sufficiently heated surface. Vented electrolyte may also ignite on contact with cells undergoing a thermal runaway reaction.

Hazards of Leaked Electrolyte: Leaked electrolyte solution is flammable and corrosive / irritating to the eyes and skin. If a liquid is observed that is a suspected electrolyte, ventilate the area and avoid contact with the liquid until a positive identification can be made and sufficient protective equipment can be obtained (eye, skin, and respiratory protection). Chemical classifier strips can be used to identify the spilled liquid (electrolyte will contain petroleum/organic solvent and fluoride compounds).

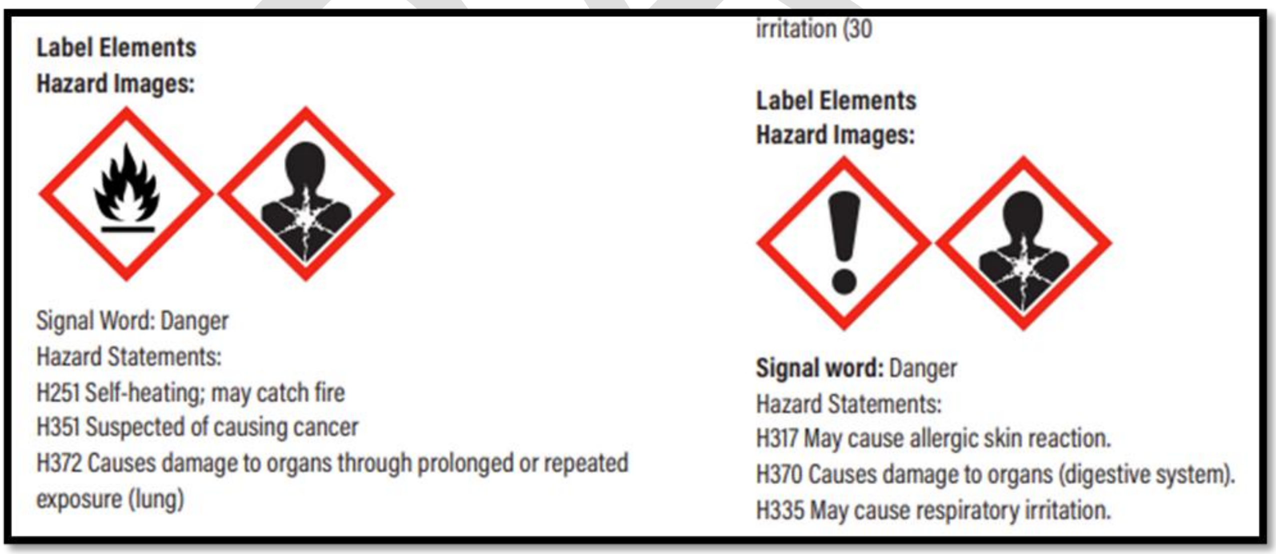


Figure 16 LFP SDS Hazards

6.1.2 Hydrogen

When the temperature of a cell reaches the venting stage, the primary hazard is the production of Hydrogen Gas (H_2). The gas is odorless & colorless which requires internal sensors or external meters for detection. It is an extremely flammable gas which is lighter than air. Any H_2 Gas accumulation within the cabinet will be found in the upper third of the unit.

Table 7 Hydrogen Characteristics

Appearance	Colorless Gas
Odor	Odorless
LFL	4 %
UEL	76 %
Auto Ignition	500°C / 932°F
25% LFL	1%
25% LFL (ppm)	10,000 ppm
Vapor Density	0.07 (Air = 1)

6.1.3 Refrigerants R-134a, R-410a, and R-513a

In the event a battery container becomes fully involved in fire, conditions may extend to the liquid cooling system. Thermal decomposition of R-134a, R-410a, or R-513a can result in the production of hazardous by-products outlined in SDS data.

HAZARDS IDENTIFICATION

CLASSIFICATION: Gases under pressure, Liquefied Gas
SIGNAL WORD: WARNING
HAZARD STATEMENT: Contains gas under pressure, may explode if heated
SYMBOL: Gas Cylinder
PRECAUTIONARY STATEMENT: STORAGE: Protect from sunlight, store in a well ventilated place

EMERGENCY OVERVIEW: Colorless, volatile liquid with ethereal and faint sweetish odor. Non-flammable material. Overexposure may cause dizziness and loss of concentration. At higher levels, CNS depression and cardiac arrhythmia may result from exposure. Vapors displace air and can cause asphyxiation in confined spaces. At higher temperatures, (>250°C), decomposition products may include Hydrofluoric Acid (HF) and carbonyl halides.

Figure 17 R-134a SDS Hazards

HAZARDS IDENTIFICATION

CLASSIFICATION: Gases under pressure, Liquefied Gas
SIGNAL WORD: WARNING
HAZARD STATEMENT: Contains gas under pressure, may explode if heated
SYMBOL: Gas Cylinder
PRECAUTIONARY STATEMENT: STORAGE: Protect from sunlight, store in a well ventilated place

EMERGENCY OVERVIEW: Colorless, volatile liquid with ethereal and faint sweetish odor. Non-flammable material. Overexposure may cause dizziness and loss of concentration. At higher levels, CNS depression and cardiac arrhythmia may result from exposure. Vapors displace air and can cause asphyxiation in confined spaces. At higher temperatures, (>250°C), decomposition products may include Hydrofluoric Acid (HF) and carbonyl halides.

Figure 18 R-410a SDS Hazards

HAZARDS IDENTIFICATION

CLASSIFICATION:	**Gases under pressure, Liquefied Gas, Simple Asphyxiant**
SIGNAL WORD:	**WARNING**
HAZARD STATEMENT:	**Contains gas under pressure, may explode if heated** **May displace oxygen and cause rapid suffocation**
SYMBOL:	**Gas Cylinder**
PRECAUTIONARY STATEMENT:	**STORAGE: Protect from sunlight, store in a well ventilated place**

EMERGENCY OVERVIEW:
CAUTION! This product is a clear, colorless, liquefied gas with a slight ether-like odor. Contents under pressure. Cylinders may rupture and rocket under fire conditions. Thermal decomposition can produce toxic and corrosive gases. Vapors are heavier than air. May cause asphyxia. Liquid splashes or spray may cause freeze burns (frostbite). High vapor concentrations may cause an abnormal heart rhythm and prove suddenly fatal. Very high atmospheric concentrations can cause anesthetic effects progressing from dizziness, weakness, nausea, to unconsciousness. It can act as an asphyxiant by limiting available oxygen. Read the entire SDS for a more thorough evaluation of the hazards.

Figure 19 R-513a SDS Hazards

6.1.4 Transformer Oil

Oil is used to insulate and cool the MV Skid and auxiliary power transformer. During the failure of a transformer, elevated temperature arcing, coupled with fire conditions causes heat retention in the windings and metal cabinet of the transformer. This condition keeps oil above its autoignition point making transformer fires persistent in nature. Quantity of oil in each bank and type of oil used – FR3 / mineral?

Table 8 Transformer Oil Characteristics

Appearance	Clear Yellow Mineral Oil
Odor	Mild Petroleum
Flash Point	145°C / 293°F
Auto Ignition	315°C / 599°F
Specific Gravity	0.89 (1= water)
Auxiliary Transformers	530 Gallons

6.1.5 Carbon Monoxide

Carbon monoxide (CO) is an odorless, colorless flammable gas formed by the incomplete combustion of fuels. The failure and subsequent arcing/burning of electrical components and cables can readily produce carbon monoxide.

Table 9 Carbon Monoxide Characteristics

Appearance	Colorless Gas
Odor	Odorless
LFL	10.9 %
UEL	74.2%
Auto Ignition	607°C (1125°F)
25% LFL	2.7%
25% LFL (ppm)	27,000 ppm

Vapor Density	0.97 (Air = 1)

6.1.6 Recommended PPE

All chemicals associated with the failure of BESS equipment and ancillary electrical components present dermal and respiratory hazards. The failure of a BESS or electrical components can produce smoke and liquid runoff during fire suppression operations. The recommended PPE for the hazards discussed is NFPA 1971 structural firefighting gear and the use of an SCBA.

Note: The PPE recommendation is for emergency response operations/life safety. PPE recommendations for the post-fire removal of damaged modules will be defined by conditions found at the time of decommissioning. In addition, structural firefighting ensembles are not designed to provide protection from arc flash hazards.

Figure 20 Minimum PPE Requirements for Emergency Response

6.2 Electrical

Shielded Conductors: Basic equipment at a BESS, such as battery cabinets, PCS inverters and step-up transformers have electrical conductors housed within that are shielded from contact by the exterior enclosure of each. Shielding eliminates the potential for casual contact or the need to maintain safe standoff distances.

Unshielded Conductors: The use of unshielded or exposed conductors in a BESS facility is limited to the overhead electrical service connecting the facility to the surrounding grid or dedicated substation.

Required Safe Standoff Distance: OSHA requires a safe standoff distance of 10 feet from exposed energized conductors 50,000 or less to prevent casual contact. OSHA (29CFR 1910.333) requires 4” of clearances for each 10,000 volt increments over 50kV.

Stranded Energy: ESS products contain lithium-ion batteries that are ALWAYS energized and present an electrical hazard even when disconnected from an electrical source.

Voltages of up to 1,500 (DC) can be present within the battery containers. This may pose a shock or electrocution risk if the outer cabinet of the battery container has been damaged during installation, inadvertent contact with transportation equipment or equipment failure. Even when disconnected, powered off, or in a discharged condition, a substantial electrical charge is possible within the batteries, which can cause injury or death if mishandled.

Electrical Current Effect: Current is the flow of electricity which is measured in amperage. Table 10 below outlines the OSHA study on the effects of current on the human body. It should be noted that between 1 and 4 amps is likely to cause a cardiac condition leading to death. The smallest breaker in most residential homes is 15 amps. Inadvertent contact with conductors can create conditions resulting in shock or electrocution which is explained below.

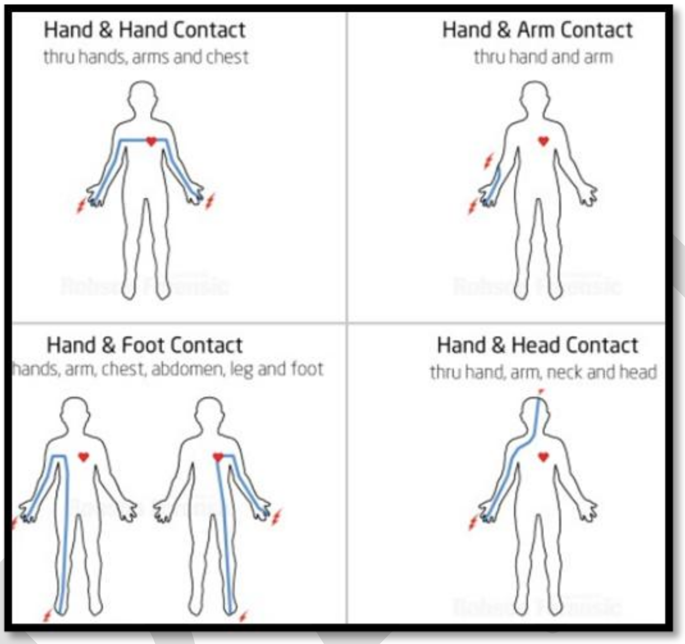
Table 10 OSHA Effects of Current on the Human Body

Current	Reaction
Below 1 Milliamp	Generally not perceptible
1 Milliamp	Faint Tingle
5 Milliamps	Slight shock felt. Not painful but disturbing. Average individual can let go. Strong involuntary reactions can lead to other injuries.
6 to 25 Milliamps (women)	Painful shocks. Loss of muscle control.
9 to 30 Milliamps (men)	The freezing current or “let go” range. If extensor muscles are excited by shock, the person may be thrown away from the power source. Individuals cannot let go. Strong involuntary reactions can lead to other injuries.
50 to 150 Milliamps	Extreme pain, respirator arrest, severe muscle reactions. Death is possible.
1.0 to 4.3 Amps	Rhythmic pumping action of the heart ceases. Muscular contraction and nerve damage occur; death is likely.
10 Amps	Cardiac arrest, severe burns, death is probable.

Shock & Electrocution: These terms are often misunderstood. Shock is an injury that can either be minor or major which results from inadvertent contact with an electrically energized object. Whereas electrocution results in death from contact with an energized conductor. The difference between shock and electrocution is defined by several factors such as how well the victim was grounded which facilitates current flow through the body, the path the current flows such as across the heart, and duration of contact with the energized object.

Figure 21 Electrical Contact Illustration

Non-Contact Voltage Tester: E-field detectors are commonly used in the fire services to identify energized equipment/objects. However, the devices are only capable of identifying equipment/objects energized by AC wave form. To assess a surface for the presence of DC a traditional meter will be required along with a ground reference.



Note: Do not use a non-contact voltage detector at a BESS without guidance from a BESS SME.

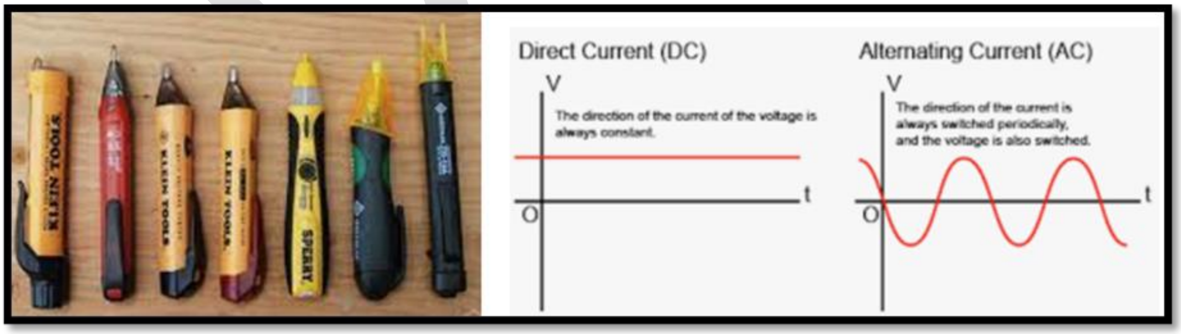


Figure 22 E-Field Detectors and AC/DC Illustration

Equipment NOT Normally Energized: In a post fire scenario, protective shielding or insulation may be damaged resulting in equipment/objects that are not normally energized to become energized. Examples may be the metal cabinet, battery racks and modules. In a post-fire scenario DC stray voltage testing should be conducted on such components until stray voltage from stranded energy can be safely ruled out.

6.3 Explosion

Flammable Gas: During the venting stage, the prevalent flammable gas is hydrogen (H_2). Hydrogen gas is detected at 10% LFL, at which time an alarm is generated and transmitted to the FACP. The FACP initiates the NFPA 69 explosion prevention system to maintain the quality of flammable gas < 25% of the LFL. The FACP will communicate with the BMS to isolate the trouble container and generate an alarm to the ROC. The system has a low side air inlet and a high side discharge outlet rated for 820 CFM.

Note: During an incident personnel should maintain a minimum of 100 feet from the trouble battery container doors.

Figure 23 NFPA 69 Explosion Prevention System

7. NOTIFICATIONS

7.1 Notification Flow

The following notification matrix will define the scalable response posture to alarms received by the BMS and/or FACP.

FACP Notifies	Central Station Notifies	ROC Notifies
Central Station	911	BESS SME
	ROC	O&M
		Decommissioning Vendor

Figure 24 Notification Matrix

A communication plan should be developed in the event that parties outside of first responders need to be notified of any condition occurring on site or specific incident management directives, such as shelter-in-place, evacuation, or road closure. Notifications also might need to be made to local emergency management agencies or local mass notification systems for the public.

8. COMMAND AND CONTROL

8.1 Subject Matter Expert

The Battery Energy Storage System SME will play a critical role guiding chief officers of the fire services through a "Scene Size-Up" which will allow them to better understand the hazards and develop the appropriate response tactics. This will be discussed further in Section 9.3. The SME will fall under the Unified Command structure where they will collaborate with members of the fire services to bring the incident under control. The SME will be responsible for coordinating the following:

- Ensure security of the site and limit access to only authorized personnel
- Ensure accountability of non-fire department personnel inside the facility through use of written or electronic logs
- Ensure that authorized personnel have PPE that is appropriate to their assigned role/task
- Notify the chief officer of the fire services if plume conditions have impacted neighboring residential and commercial areas to support decision making in terms of seal in place or evacuation orders.
- Review and interpret BMS data, such as state of charge (SOC) state of health (SOH) temperature along with service status of equipment. Focus should be on identifying conditions that would suggest conditions are deteriorating.
- Locate & isolate trouble equipment. Trouble equipment should be islanded from the facility grid where it is safe to do so. Do not engage in manual switching operations that would require access into the exclusion zone.
- Ensure a 100' exclusion zone has been established around the trouble battery cabinet.
- Review the FACP to identify the presence of any H_2 gas alarms. Then examine the NFPA 69 purge vent to ensure flammable gas is being discharged as designed. An alarm without the presence of flammable gas may suggest that the explosion prevention system failed and there is an increased chance of deflagration.
- Identify any internal exposures that may need to be protected. The decision to engage in intervention tactics is influenced by heat alarms and/or BMS cell temperature alarms in adjacent Cabinets, if the façade of an adjacent Cabinets reached 50% of a cell vent temperature (155°F) or direct fire impingement.
- Post-Incident Operations: As conditions stabilize
- Administering Decommissioning Plan

8.2 Unified Command Structure

Low frequency/high hazard incidents such as a BESS emergency will not be managed by one individual Incident Commander. The command structure will include all the stakeholders necessary to mitigate risk and ensure the safety of first responders.

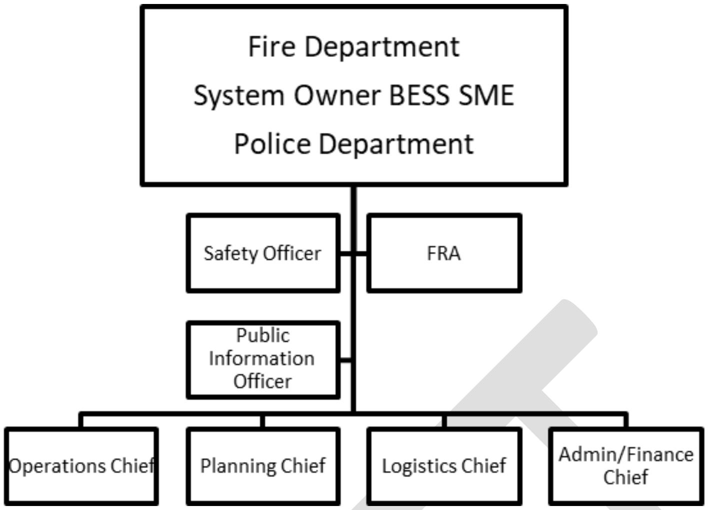


Figure 25 Unified Command Structure

8.3 Incident Command Structure

Below is an example of the command structure that may be used by the owner to manage the incident through the decommissioning phase. The is a malleable concept that can be scaled to meet the operational needs of the response.

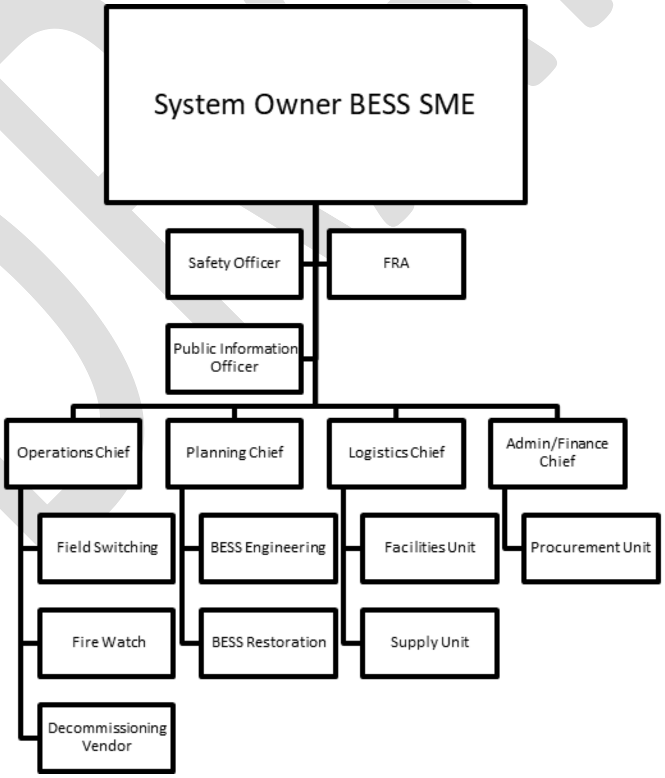


Figure 26 Incident Command Structure

9. RESPONSE TACTICS

9.1 Personal Protective Equipment (PPE)

Electrical Switching: OSHA requires a hazard assessment under 29 CFR 1910.269 to identify FR clothing and insulated PPE required to conduct switching operations.

Fire Operations: Fire services personnel engaged in operations that can expose members to heat, flame, flammable gas and chemical hazards shall use NFPA 1971 structural firefighting equipment along with an SCBA for respiratory protection.

9.2 On Arrival

DO NOT FORCE ENTRY

Fire Department: Personnel should not encroach within 100 feet of the facility fence line until the trouble battery cabinet has been identified.

9.3 Initial Status Briefing

Upon arrival, the fire officer should contact the 24/7 Remote Operations Center (ROC) to obtain a status briefing which should at a minimum should cover the following:

- Accountability
    - The ROC must provide an accurate status of accountability. This will ensure there is no unnecessary entry by the fire services
    - (Company / site specific policy should be developed for unescorted access to rescue missing personnel. The success of this process weighs heavily upon guidance from the Remote Operations Center (ROC). Should we include guidance on this process?)
- Location of Equipment in Alarm
    - Can the equipment be observed for active smoke, fire or purge vent operation without entering the site. If these active conditions are observed, focus should be shifted to monitoring for alarms on exposure battery cabinets to determine if asset protection will be required.
    - **(**A map should be developed and made available to the fire department that numerically identifies major site equipment such as battery cabinets, PCS skids, auxiliary power transformers, along with a first responder station and control room as applicable. The ROC shall reference the map to identify the number associated with the trouble equipment.)
- Alarm Type
    - What type of alarm has generated the initial response and has any other alarm been received that would suggest conditions are deteriorating.
- Isolation of Trouble Equipment

- The ROC should verify that trouble equipment has been isolated from the facility grid.

9.4 Size-Up

BESS/SME: Upon arrival of the BESS /SME they will collaborate with officers from the fire services to conduct a "Size-Up" which is a basic assessment to develop the appropriate response tactics. There are eight tasks to evaluate. This will allow chief officers to make an informed decision in terms of the response posture.

1. **Community Air Monitoring:** During an active fire scenario consideration may be given to conducting air monitoring to ensure safety and address community concerns. The properties of the gases generated during fire conditions indicate that they will rise vertically and dissipate. However, it is recommended based on wind direction that air monitoring for gases identified in UL9540a testing be conducted to determine if a seal in place or an evacuation order is appropriate. Table 11 illustrates CDC threshold values for IDLH substances Table of IDLH Values | NIOSH | CDC along with the actual quantity of gases measured. Gases that exceeded the IDLH threshold value are highlighted in red. Field sampling should focus on the presence of those gases to determine the need for public displacement. If any air monitoring results meet or exceed the CDC IDLH threshold levels, consider if shelter-in-place or evacuation orders need to be made to nearby residents.

Table 11 CDC IDLH Thresholds

Gas Name	Chemical Structure	IDLH (PPM)
Carbon Monoxide	CO	1,200
Carbon Dioxide	CO_2	40,000
Hydrogen	H_2	N/A
Methane	CH_4	N/A
Acetylene	C_2H_2	
Ethylene	C_2H_4	N/A
Ethane	C_2H_6	N/A
Propylene	C_3H_6	N/A
Propane	C_3H_8	2,100*
1-Heptene	C_7H_{14}	N/A
Styrene	C_6H_6	700
Toluene	C_7H_8	500
Dimethyl Carbonate	$C_3H_6O_3$	N/A
Ethyl Methyl Carbonate	$C_4H_8O_3$	N/A

2. **Fire Alarm Control Panel (FACP):** What alarms are present in the trouble battery container. For example, smoke/heat without an H_2 alarm would suggest a cable fire while smoke, heat and H_2 gas would suggest a cell failure.

3. **Explosion Prevention System:** The presence of an H_2 gas alarm and a corresponding alarm for cell temperature in the BMS would suggest a cell failure and the release of the flammable electrolyte in the form of Hydrogen. At 10% (H_2 alarm threshold) of the LFL the explosion prevention system should be autonomously activated. The flammable electrolyte appears as a dense white vapor cloud. The absence of this may suggest that the explosion prevention system is not operating to design criteria and there is an increased risk of a deflagration to occur. Members of the fire service shall remain 100-feet or more from the trouble battery cabinet out of direct line of site to guard against projectiles.
4. **Battery Management System:** The BMS shall be reviewed to determine the following information:

<u>Rise in Temperature:</u> If additional cells in the trouble module or additional module around the trouble module begin to show signs of increased temperature this would be an indication of propagation within the rack.

<u>Status of Trouble Electrical Equipment:</u> Trouble equipment should be autonomously isolated by the BMS at the string, rack or container level and should be verified through the BMS system.

<u>Current Detection Alarms:</u> Have any additional alarms been generated after arriving at the facility? If so, do they suggest there may be an active fire condition in terms of Smoke and/or Heat Detection?

5. **Locate & Isolate Trouble Equipment:** Ensure that E-Stops have been operated and if safe to do so open disconnect switches that would island trouble equipment from the facility grid.
6. **Exclusion Zone:** Establish an exclusion zone of 100 feet from the doors of the troubled BESS Container using caution tape to manage the safety of members if an explosion should occur. BESS Containers have been outfitted with an explosion control measure however, we must assume if this system were to fail the doors on the BESS Container can become projectiles.
7. **Smoke/Fire Conditions:** Identify any active smoke or fire conditions that have extended from the failed equipment. In most cases non-intervention is the recommended tactic, however we must consider exposure impact which is greatly enhanced with wind conditions. Begin monitoring adjacent battery cabinets for BMS and FACP alarms.
8. **Exposures:** An exposure assessment will determine if intervention is appropriate for asset protection. Evaluate the following risks:
   - BMS Alarms: Cell temperature rise, or alarms will be an indication that intervention will be necessary for asset protection.

- Thermal Imaging Assessment: Battery cabinets surrounding a fully involved cabinet should be assessed using thermal imaging camera. Intervention temperature is 155F which is 50% of battery cells vent temperature as determined by UL9540a testing.
- Direct Fire Impingement: UL9540a Unit Level testing indicates that a fully involved batter cube should not propagate to the sister cube. However, if wind influences fire conditions placing the sister cube at risk intervention for asset protection is recommended.

Water Use in a Class C Environment: During the application of water streams for exposure protection, the potential exists to contact energized electrical components in the trouble cabinet. In response, Table 13 below should be followed for the application of water on/near energized electrical equipment. The safe standoff distance for asset protection will be driven by the risk of explosion not the electrical hazard. As such the position of the apparatus or appliances to provide asset protection will be outside the exclusion zone far exceeding the required 25 feet. Water should not be applied using a straight stream, a rain down effect will be more useful in providing cooling and protecting a larger portion of the asset.

Table 12 Safe Standoff Distances - Handlines

Agent	Voltage	Spray Pattern	Pressure	Min Distance
Potable Water	< 50 kV	30-Degree Fog	100psi	25 feet

Safe Staging: The application of water for exposure control should be made from outside of the exclusion zone as illustrated in Figure 27.

Note: If alarms are received in the battery container being protected the exclusion zone should be expanded to include the doors on this battery container.

Figure 27 Safe Staging for Asset Protection

Note: Fire Department personnel should never operate any equipment or controls within the site. The BESS SME will coordinate all operational requests.

Strategies and Tactics: Follow Section 9.5 below.

9.5 Response Scenarios

9.5.1 Cable Failure

Figure 28 Cable Fire

	Cable Failure Response Matrix
Hazards	Cables are used to link cells and modules; cables connect to the electrical bus and provide power to ancillary equipment in the battery cabinet. Cable fires in an enclosed space such as a battery cabinet can create an accumulation of CO resulting in an explosive atmosphere.
Alarm	A cable fire will generate a smoke alarm. A gas alarm may also be received because of carbon monoxide as there is a history of cross-sensitivity between H_2 & CO. However, cell venting can be ruled out after a review of the BMS. Cells vent at 309°F. Damage to cable from a fire will also generate a BMS alarm that will correlate to the equipment / module(s) associated with the trouble cable. The BMS will initiate the E-Stop to isolate the trouble equipment.
Fire Classification	This will be considered a Class C Fire, energized electrical fire. Even after the battery container has been isolated stranded energy remains in the cells/modules and associated battery cables. Auxiliary Power cables can be deenergized and isolated.
Switching	Ensure the E-Stop has been activated and the battery container disconnects are open. Isolate the auxiliary power supply for 1 hour. If conditions do not improve restore auxiliary power. This will rule out auxiliary power as the fire source.
Exposure Control	None required, however if the cable fire extends to the battery's modules proceed to section 9.5.2 below.

Assessment	Doors shall remain closed. Review FACP to monitor for additional alarms such as H_2 gas. Review the BMS to determine if cells/modules are involved. If conditions indicate there is no involvement of cells/modules and there is no active smoke or fire conditions move to the next step – Access. If conditions visually or through data points suggest cells/modules are involved move to Section 9.5.2 Cell Failure.
Access	Follow guidance in Section 10 Post Incident Operations.
Suppression	CO_2: Should a cable fire occur after doors have been opened. CO_2 is the recommended agent. CO_2 has a Class Listing for use up to 100kV. Maximum BESS container voltage is 1,500 v.
Safe Standoff Distance	There is no required standoff distance for leakage current when using CO_2. Standoff distance is driven by the potential for arc flash. • Personnel wearing arc flash protection: Apply agent from no closer than 5 feet. • Personnel wearing NFPA 1971 structural firefighting ensemble: 10 feet.

9.5.2 Cell Failure

Figure 29 Failed Module

	Cell Failure Response Matrix
Hazards	The potential for a fire exists when a cell enters thermal runaway impinging adjacent cells within the module. The temperature of vent gas can exceed 600°C/1,100°F causing thermal burns. In addition, vent gas (H_2) is extremely flammable and given its low ignition range can be quickly ignited if the gas encounters a competent ignition source. In addition, the accumulation of flammable gas in an enclosed space such as the battery containers presents a risk for an explosion. During a cell failure personnel and fire service members must maintain a 100-foot clearance from the doors on the EnerC+ container.
Alarm	The failure of a cell will generate an H_2 gas alarm, and the characteristics of the gas discharge may generate a smoke alarm. Both conditions will result in the operation of the E-Stop isolating the trouble EnerC+ container from the facility grid. Alarms will be routed back to the ROC. At 10% of

	the LFL the explosion prevention system will activate to maintain gas accumulation below 25% of LFL.
Fire Classification	This will be considered a Class C Fire, energized electrical fire. Even after the battery container has been isolated stranded energy remains in the cells/modules and associated cables.
Switching	Ensure the E-Stop on the PCS inverter has been depressed. Do NOT open the disconnects on the trouble container given the potential for explosion.
Exposure Control	None until such time fire conditions have extended from the battery container.
Assessment	Review the BMS to determine if propagation is occurring or the failure is contained to one module. If conditions appear to have stabilized move to Access step. **ACTIVE FIRE:** If a fire were to occur non-intervention is recommended given the fact that there are no listed suppression agents capable of stopping thermal runaway. Batteries should be allowed to consume themselves until they reach a zero state of charge (SOC). For active fire condition proceed to step 9.5.3 Fully Involved Container.
Access	Follow guidance in Section 10 Post Incident Operations.
Suppression	After Access guidance in Section 10 has been followed any remaining pockets of fire that have not been suppressed may be extinguished with dry-chemical agent or Purple-K.
Safe Standoff Distance	There is no required standoff distance for leakage current when using dry-chemical agent or Purple-K. Standoff distance is driven by the potential for arc flash. • Personnel wearing Arc Flash Protection: Apply agent from no closer than 5 feet. • Personnel wearing NFPA 1971 structural firefighting ensemble: 10 feet.

9.5.3 Fully Involved EnerC+ Container

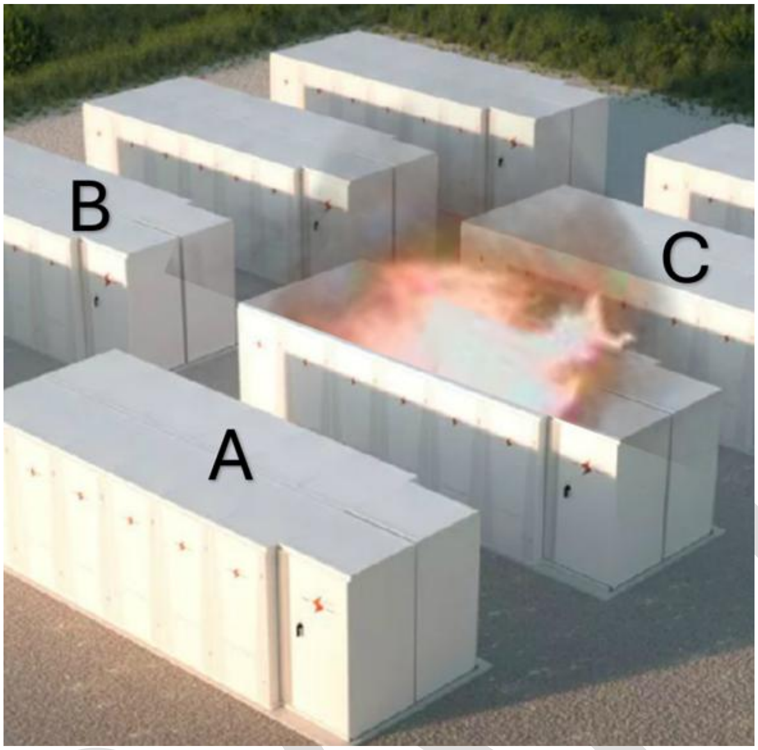


Figure 27 Fully Involved Container Exposure Control

	Fully Involved EnerC+ Container
Hazards	The main hazard associated with a fully involved container is the potential for propagation to adjacent containers. UL940a Unit Level Testing suggests that the fire will be contained to the trouble container, however wind conditions may enhance the risk of additional failures. Radiant heat may cause the failure of cells/modules in adjacent containers presenting the potential for an explosion. Figure 29 serves as a reminder to be vigilant and monitor conditions surrounding containers A, B & C for deteriorating conditions that may suggest cell failure, fire, and the risk of an explosion which will increase the size of the exclusion zone.
Alarm	Once a container becomes fully involved in fire there will be no reliable data points such as FACP or BMS alarms.
Fire Classification	This will be considered a Class C Fire, energized electrical fire. Even after the battery container has been isolated stranded energy remains in the cells/modules and associated cables.
Switching	Ensure the E-Stop on the PCS inverter has been depressed. Do NOT open the disconnects on a fully involved container.
Exposure Control	UL 9540A fire testing and the hazard mitigation analysis provided guidance on the spatial separation of containers necessary to ensure fire will not communicate between a fully involved container and surrounding exposures. However, during extreme wind conditions the adjacent battery containers should be evaluated to determine if exposure control is warranted. Water should only be applied intermittently following the guidance provided in section 9.3. – Table 13. Intervention should occur under the following circumstances:

	• BMS alarm for excessive temperature received in adjacent battery container(s) • The exterior temperature of adjacent battery container(s) exceeds 50% of the vent temperature of the cells. Therefore, the exterior intervention temperature is 155°F.
Assessment	**ACTIVE FIRE:** There are no listed agents capable of suppressing a Lithium-Ion fire or interrupting thermal runaway. Cells should be allowed to consume themselves until they reach a ZERO state of charge (SOC). At this point there is no fuel left to support fire conditions. While observing non-intervention strategies on the fully involved container, conditions on the surrounding EnerC+ contains must be closely monitored for alarms, specifically anything related to temperature. Alarms that would suggest additional failures have occurred in surrounding containers will require the expansion of the exclusion zone. Consideration may also be given to the preemptive isolation of surrounding containers as a conservative measure.
Access	Follow guidance in Section 10 Post Incident Operations.
Suppression	After access guidance in Section 10 has been followed any remaining pockets of fire may be extinguished with dry-chemical agent or Purple-K or CO_2.
Safe Standoff Distance	There is no required standoff distance for leakage current when using dry-chemical agent or Purple-K. Standoff distance is driven by the potential for arc flash. • Personnel wearing arc flash protection: Apply agent from no closer than 5 feet. • Personnel wearing NFPA 1971 structural firefighting ensemble: 10 feet.

9.5.4 MV Skid Failure

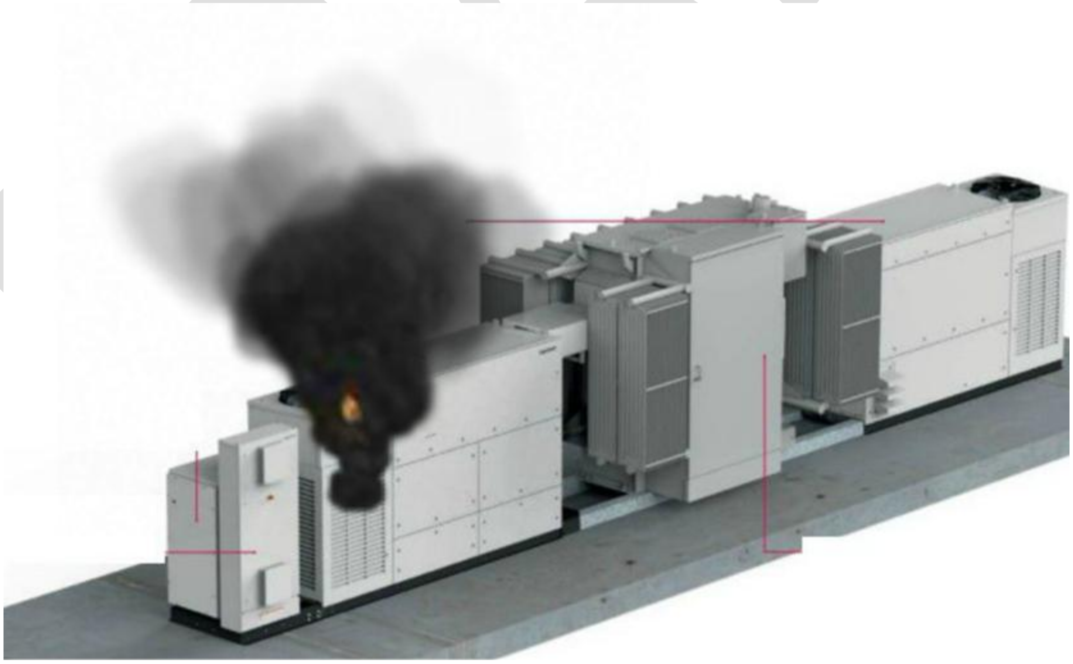


Figure 30 Inverter Failure

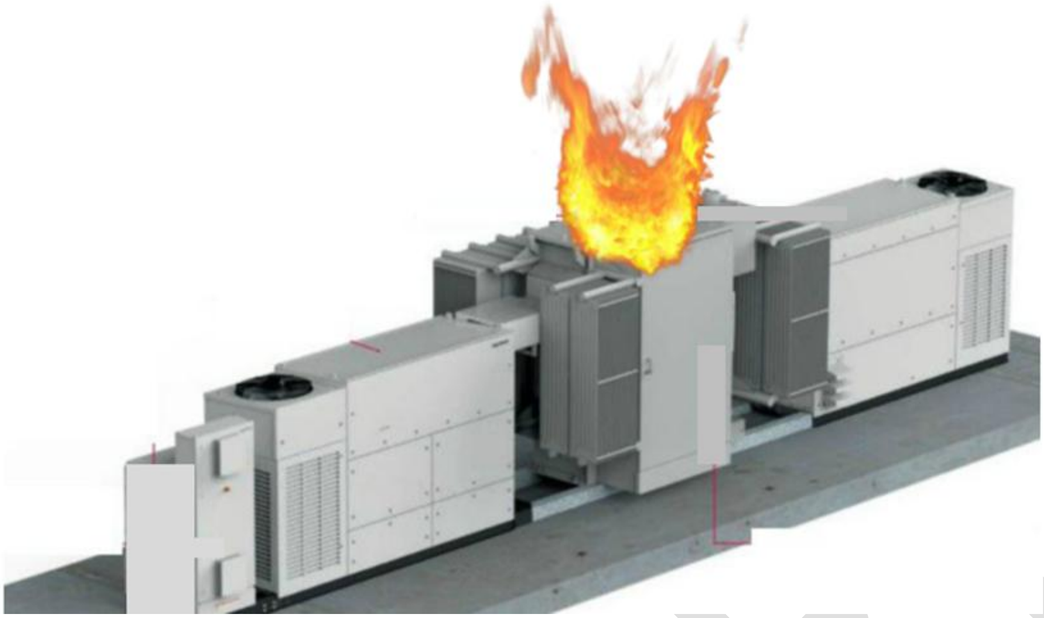


Figure 31 Transformer Failure

	MV Skid Failure Response Matrix
Hazards	Inverter Failure: The failure of a cable or electrical component within the inverter can result in a fire. These failure scenarios associated with a PCS Inverter can be classified as a Class C fire. There are no batteries associated with the Inverter so once the electrical source is removed the incident can be classified as Class A. Transformer Failure: The MV Skid also contains an oil insulated step-up transformer. The elevated temperature arc associated with the failure causes heat retention in the windings and metal enclosure of the transformer which keeps oil above its autoignition temperature making transformer fires persistent in nature.
Alarms	The failure of either the transformer or the inverter will result in a trip of the battery block. Alarms generated by the isolation of equipment will be routed back to the ROC.
Fire Classification	**Inverter:** Class C fire until the unit is confirmed deenergized. **Transformer:** Fires are considered Class B/C fires until the electrical source has been removed. Never attempt to suppress an energized electrical fire.
Switching	Depress the E-Stop on the battery containers associated with the battery block and open the disconnect switches to island the MV Skid from the battery containers. Open the load disconnect switch on the high side of the transformer.
Exposure Control	None required however, if the incident management team believes exposure control is appropriate follow Section 9.5.3
Assessment	**Inverter:** Once the inverter fails it will be automatically isolated from the system. Once the energy source is removed minor pockets of fire may exist from insulation materials. These fires can be suppressed with a gaseous suppression agent. **Transformer:** CO_2 is the recommended agent for transformer fires. The use of other gaseous agents such as dry-chemical and Purple-K have no cooling value. A transformer fire may be unresponsive to these agents. The use of foam-based products is not advised. The transformer cannot be salvaged after a failure event. If the fire is unresponsive to the

	recommended agent, the unit should be allowed to burn off and consume the insulating oil. The use of foam will result in environmental impact with no value added.
Suppression	**Inverter:** Fire conditions will be limited to burning insulation. The use of dry-chemical or Purple-K is recommended for extinguishing isolated pockets of fire. **Transformer:** CO_2 is the recommended agent. CO_2 has a Class C Listing and is rated to 100kV.
Standoff Distance	Do not touch any of the skid equipment until it has been deenergized, and isolated. At that time approach is limited to fire tolerance.

10. POST INCIDENT OPERATIONS

10.1 Personal Protective Gear (PPE)

While operating near trouble equipment, the fire services personnel should remain in NFPA 1971 structural firefighting gear. If cabinet doors are open, fire service members must maintain a 10-foot standoff distance to guard against arc flash hazard. Facility personnel should don the appropriate PPE for arc flash hazards associated with potential stranded energy conditions until a Post-Fire Assessment has been completed. If cells are at a zero SOC PPE may be downgraded.

10.2 Under Control

The fire department has three strategic objectives at a fire, life safety, incident stabilization and property conservation. Once these objectives have been achieved the incident can be placed under control. Section 10 describes similar strategies for placing a BESS emergency under control. Each step focuses on personal safety, favorable results in these steps indicate incident stabilization which allows the process to advance toward opening the battery cabinet doors. Once all battery cabinet doors have been opened a final assessment will be completed utilizing thermal imaging and air monitoring to ensure there is no active fire or thermal runaway conditions. This step validates that the incident is contained to the trouble cabinet with no potential for extension into neighboring cabinets thus achieving the final objective of property conservation.

Note: Fire department personnel must remain cognizant of the hazards posed by stray voltage and the potential for an explosion. The failure associated with batteries can be broken down into three scenarios. Select the guidance that is applicable to the existing conditions. Begin the assessments outlined in Section 10.2 once there is no active fire for a period to 24-hours.

10.2.1 Roof Breached or Pressure Vents

Existing Conditions: The roof of the battery cabinet is breached from fire conditions. This will alleviate the accumulation of any flammable gases within the space. The properties of the target gases that present the primary risk to responders is Hydrogen (H_2) and Carbon Monoxide, (CO). These gases are lighter than air and would escape the breached roof thus removing/reducing the explosion risk.

24-Hour Safety Stand-Down: Assign a fire watch for a 24-hour period to observe and record hourly thermal readings over the breached roof for the 24-hour safety assessment period. The vent temperature of cells is 309 F. A thermal imaging camera should be used to assess the thermal column above the breached sections of the roof to determine the temperature of any existing vent gases. Evaluate conditions until vent gases are sustained below <155 F (50% of the vent temperature) for a period to 12 hours. If conditions comply with guidance in Section 10.2.1 proceed to Section 10.3 Lock Out/Tag Out.

Scenario 2: Roof Intact & Data Points Available

Existing Conditions: BMS shows no signs of propagation. No active or additional FACP alarms.

48-Hour Safety Stand-Down: Assign a fire watch for a 48-hour period to observe and record hourly thermal readings over the trouble container. The ROC will be required to observe and record all trouble alarms generated by the trouble battery cabinet once the safety stand-down period commences.

- Firewatch: The fire watch should focus thermal imaging readings above the NFPA 69 vent. The time that the safety stand-down begins (day/night) will influence baseline temperature readings. In response there should be no observed readings above 155F for the duration of the stand-down. Temperatures above 155F or a sustained rise in temperature shall be reported immediately to the Battery SME.
- ROC: No additional alarms should be received over the course of the stand-down. Any additional alarms received will be relayed to the BESS SME for guidance and will result in a restart of the 48-hour safety stand-down period.
- Upon conclusion of the 48-hour safety stand-down data from the fire watch and ROC will be reviewed by the Battery SME. If conditions comply with guidance in Section 10.2.2 proceed to Section 10.3 Lock Out/Tag Out.

Scenario 3: Roof Intact – No Data Points Available

Existing Conditions: Overpressure vents have not lifted and the BMS is not reporting.

1-Week Safety Stand-Down: Assign a fire watch for a 24/7 one-week period to observe and record hourly thermal readings over the trouble container. The ROC will be required to observe conditions on the trouble battery cabinet in the event that BMS reporting reoccurs.

- Firewatch: The fire watch should focus thermal imaging readings above the NFPA 69 explosion prevention system discharge outlet. The time that the safety stand-down begins (day/night) will influence baseline temperature readings. In response there should be no observed readings above 160F for the duration of the stand-down. Temperatures above 160F or a sustained rise in temperature shall be reported immediately to the Battery SME.
- Upon conclusion of the 1-week safety stand-down data from the fire watch and ROC will be reviewed by the Battery SME. If conditions comply with guidance in Section 10.2.3 proceed to Section 10.3 Lock Out/Tag Out.

10.3 Lock Out/Tag Out

Once emergency conditions have concluded and prior to accessing the trouble battery container or removing any modules, E-Stops and disconnects associated with the trouble array shall be locked or tagged out as required by OSHA 29 CFR 1910.147. Once completed, a transition should be made to the decommissioning phase.

11. TRAINING AND FAMILIARIZATION TOURS

Training shall be conducted for members of the first response community prior to batteries arriving on location. Training and familiarization tours on the hazards and response tactics associated with BESS facilities will be provided annually. The following topics will be covered in the training program:

- System Overview
- Equipment & Definitions
- Battery Types, Chemistry & Geometry
- Battery Management System
- Detection & Suppression
- Emergency System Shutdown
- Hazards
    - Chemical
    - Electrical
    - Radiant Heat
    - Arc Flash
    - Explosion
- Response Tactics
    - Size Up
    - Safe Standoff Distances
    - Suppression & Exposure Control
    - Cable Fire
    - Module Venting/Fire
    - Transformer Fire
- Post Incident Operations

12. REVISION SHEET

Rev. No.	Date	By	Notes
Rev B	12/9/24	FRA	Revisions based on Seahawk LLC Comments
Rev C	2/5/25	FRA	Revisions based on Seahawk LLC Comments
Rev D	8/26/25	FRA	Revisions based on OR3 Comments