FIRE & RISK ALLIANCE

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TOWNSHIP OF ARMOUR

Peggs Mountain BESS

Burk's Falls, Ontario

Battery Energy Storage System

Emergency Response Plan

This plan has been developed to assist the local emergency responders with important safety and emergency response information concerning the EVLOFLEX battery energy storage system.

This site-specific document and supporting material should be consulted prior to any fire service personnel entering the Peggs Mountain BESS site or engaging in any tactical operations.

Confidential

SOLARBANK

Approved By: Solarbank

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SECTION 1 GENERAL INFORMATION

1.1 Purpose

The purpose of this Emergency Response Plan (ERP) is to provide information to battery energy storage system (BESS) subject matter experts (SME) and the members of the fire service on emergencies that can reasonably occur along with site hazards and the response tactics necessary to enhance safety and mitigate risk.

1.2 Scope

This document is an Emergency Response Plan (ERP) for the Peggs Mountain BESS facility. The ERP provides an overview of the facility, potential exposures, system equipment, safety features, site hazards and modes of failure. The document provides an in-depth view of the facility and its associated equipment that can be used as a reference guide by various stakeholders. The document also serves as a platform to develop site training. In the event of an actual incident, focus should be immediately directed to Section 9 which covers pertinent response information.

1.3 Site Owner

Solarbank

803 – 505 Consumers Road
Toronto, Ontario
Canada, M2J 4V8

Non-Emergency: 416.494.9559

1.4 Site Location

219 Peggs Mountain Road, Burk's Falls, ON
45°35'56.3"N 79°24'27.3"W

1.5 Battery Energy Storage Equipment

The battery manufacturer is EVLO. The model utilized for this application will be the EVLOFLEX which contains Cobalt-free lithium iron phosphate (LiFePO4) cells in a pouch geometry. Cells are rated for 3.6vdc at 80Ah.

1.6 Emergency Contact

Primary Contact: Solarbank (Site Operator)

24/7 Remote Operations Center (ROC): 647.581.5866

Secondary Contact: Amy Tilley, Community Emergency Management Coordinator, Township of Armour

Phone Number: 705.382.3332

1.7 First Responder Contact Information

Table 1. First Responder Contact Information

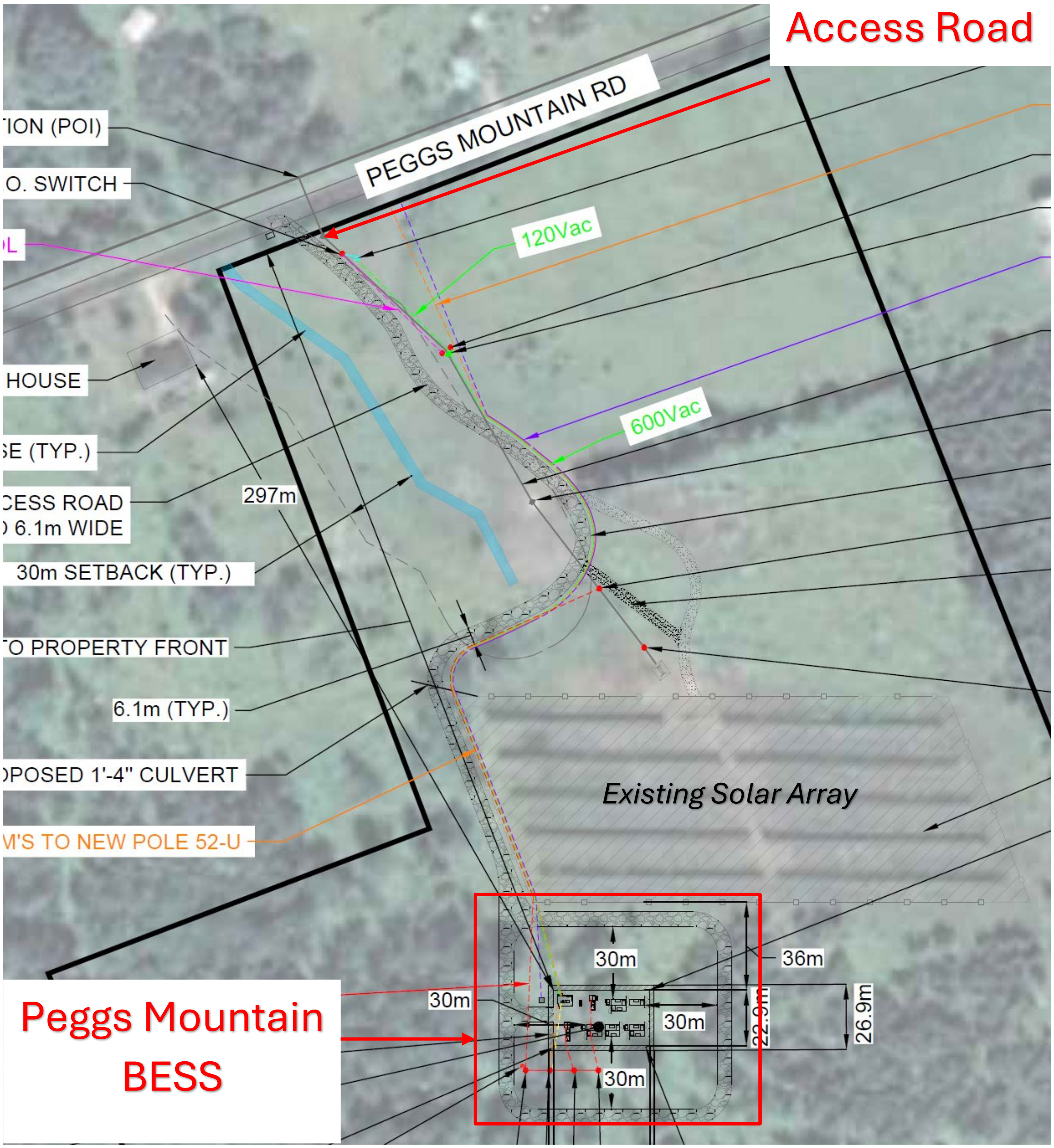
First Responder Agency	Address	Phone
All Emergencies	*Countrywide*	*911*
Burk’s Falls Fire Department	168 Ontario St, Burk's Falls, ON P0A 1C0, Canada	705.382.4010
OPP Almaguin Highlands OPP	46 ON-520, Burk's Falls, ON P0A 1C0	888.310.1122
Huntsville District Memorial Hospital	100 Frank Miller Dr, Huntsville, ON P1H 1H7	705.789.2311

SECTION 2 ENERGY STORAGE SYSTEM INFORMATION

2.1 Site Overview

The Pegg Mountain Battery Energy Storage System (BESS) is an 88.5-acre site located east of River Drive on Peggs Mountain Road in Burks Falls, ON. The site can be described as a rural area surrounded intermittently by residential homes. Access to the site will be from Peggs Mountain Road. The width and integrity of the road will conform to NFPA 1, Section 18 for apparatus access. The water supply for response operations will be provided by fire department tankers.

Figure 1 Site Overview

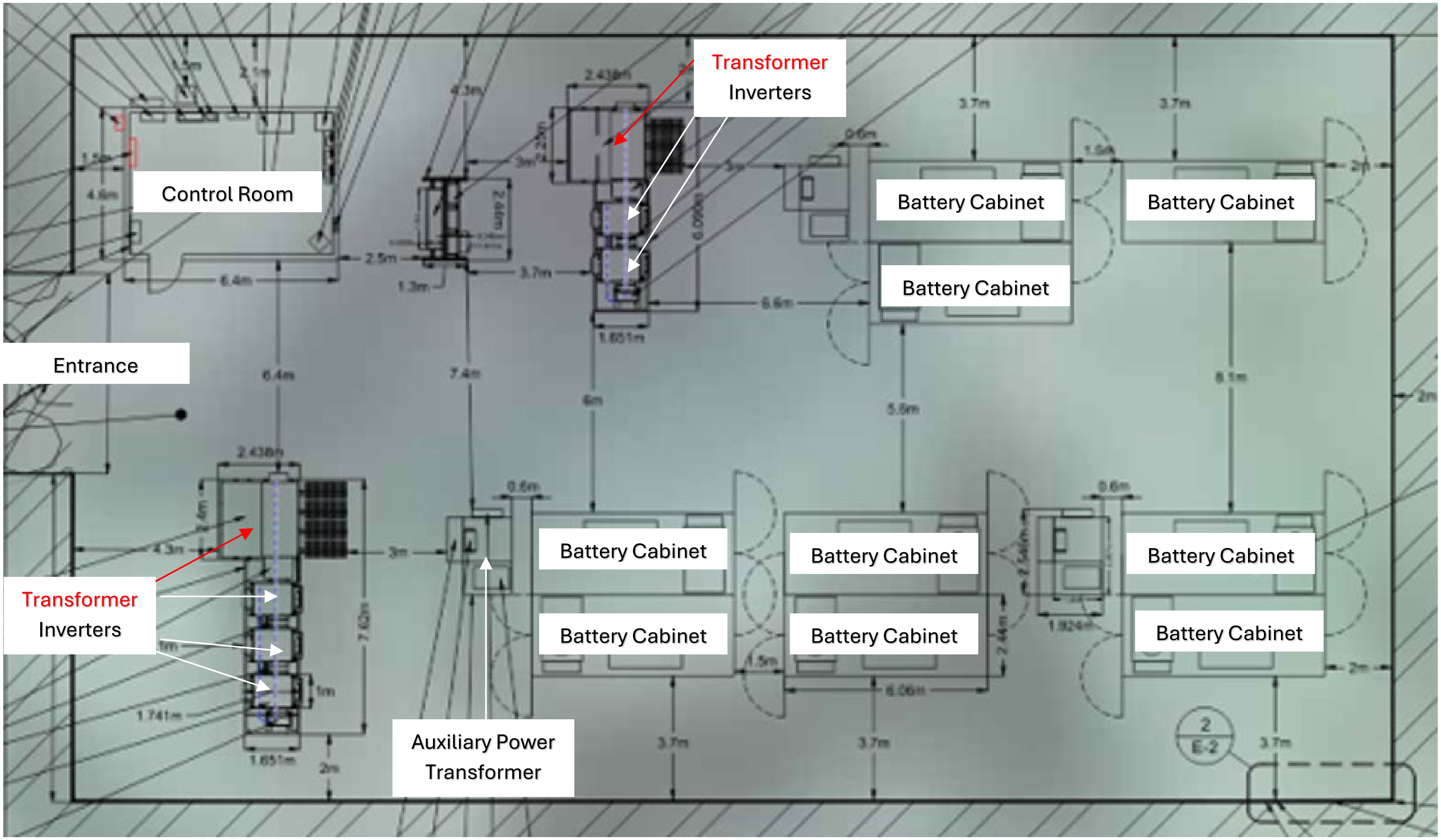


2.2 Energy Storage System Site Design

The facility will contain nine (9) EVLOFLEX battery enclosures. DC power is discharged from the battery enclosures at 1,500 volts which is routed through a power conversion system (PCS). The PCS transforms DC to AC power which then passes through a step-up transformer where voltage is increased to 44kV for grid compatibility.

Batteries will be charged from the grid during evening hours when demand is low and will be discharged during the day to support grid stability during peak load periods.

Figure 2. Facility Layout



2.3 Thermal Operating Range

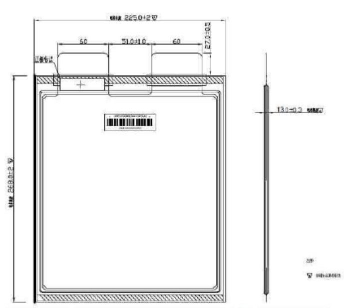
Table 2. Critical Temperature Chart

Thermal Operating Range	Celsius	Fahrenheit
Normal Operating Range	-20°C / 55°C	-4°F / 131°F
Critical Temperature: Venting (flammable electrolyte)	144°C	291°F
Critical Temperature: Thermal Runaway	215°C	419°F

2.4 Battery System Specifications

Table 3. Cell Level Test Information

Cell Information	
Manufacturer	XXXXXXX
Model name	XXXXXX
Chemistry	LiFePO4 (LFP)
Physical configuration	Pouch
Dimension (W*L*H)	13±1.0mm x 225±1.0 mm x 268±1.0 mm
Weight	1430±0.15g
Nominal voltage	3.65 V
Rated capacity	80 Ah
UL 1973 Compliant ?	Yes, Test Report #CN22470V 001
Standard charge method	
Charge current	80 A
End of charge voltage	3.65 V
Cut off current	4.00 A (0.05C)
Standard discharge method	
Discharge current	80 A
End of discharge voltage	2.5 V
Test result from cell level 9540A test report	
Cell level test report	Issued by TUV Rheinland., Report No. CB71173204EB
Diagram/Picture of Cell	



Item 项目	Specification 规格
Cell length (w/o tabs) 电芯长度（不含极耳）	268±2.0 mm
Cell width 电芯宽度	225±2.0 mm
Cell thickness 电芯厚度	13±0.3 mm

Table 4. Module Level Test Information

Module(Battery Pack) Information	
Manufacturer ....:	XXXXXX
Model name.......:	XXXXXX
Enclosure Material ....:	Plastic with Metal Components
Dimension (W*L*H).......:	612.8±1.0mm x 236.6±1.0 mm x 313.6±1.0 mm
Cells Configuration ....:	8 Series by 4 Parallel (8S4P)
Total Number of Cells.......:	32 Cells
Separation between Cells ....:	an alternance of aluminum heatsinks and thermal insulation separates cells
Rated Capacity ....:	320 Ah
Rated Energy ....:	8192 Wh
Nominal voltage ....:	25.6 V_{nom}
Standard charge method	
Charge current ....:	320 A
End of charge voltage.......:	28 V
Cut-off current ....:	N/A, Step Current Profile Used
Standard discharge method	
Discharge current.......:	320 A
End of discharge voltage.......:	20 V
Compliant with UL 1973? ....:	Yes, Report #: CN229OFO 001 (TUV Rheinland). ***Note: This product has no BMS and was partially evaluated for UL 1973 because it is not the end product, the protective circuit and controls related were not evaluated. It shall be evaluated completely in the end product.***
Manufacturer ....:	XXXXXX
Diagram/Picture of Module:	

Table 5. Unit Level Test Information

Unit Information	
Energy storage system (ESS) technologies.............:	☒ Electrochemical ☐ Chemical ☐ Mechanical
Intended use location ....:	☒ Non-residential ☐ Residential ☐ Indoor ☒ Outdoor ☒ Floor mounted ☐ Wall mounted ☐ Ground mounted ☐ Rooftop ☐ Open garage
Connection to the mains...:	☐ Pluggable equipment ☐ Direct plug-in ☒ Permanent connection ☐ For building-in
Tested Configuration ....:	☒ Representative Battery System (3x3x3 Trays) ☐ Complete BESS
Manufacturer ....:	EVLO
Model name...:	EVLO2 Representative Subassembly consisting of 9 trays in a 3x3 array
Is Unit compliant with UL 9540? ....:	No
Enclosure Material ....:	Metal
BESS Enclosure Overall Dimension (W*L*H).........:	68" x 85"
Electrical Configuration of module ....:	In each tray, there are 6 modules composed of 2x3 configuration in series.
Physical layout of modules in the BESS subassembly ....:	4P408S
Total Number of Cells ....:	408 Cells
Total Number of Modules in the BESS	51 Modules were present in the BESS subassembly
Fire protection features/detection/suppression systems within unit...:	N/A
Heating/Cooling System:	N/A
Spacing between Modules ....:	47.3mm
Rated Capacity ....:	320 Ah
Rated Energy ....:	417,792 Wh
Nominal voltage ....:	1,428 V
Manufacturer Declared charge method for the test:	
Charge current ....:	14 A
End of charge voltage..:	1,489.2V
Cut-off current ....:	<1A or 100% SOC
Standard discharge method	
Discharge current...:	N/A
End of discharge voltage ....:	N/A
Rest time between charge and discharge..............:	N/A

2.5 Battery Cabinet Overview

The EVLOFLEX BESS 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 assembled within a single, non-occupiable NEMA 3R cabinet. The EVLO BESS can be populated with up to six battery strings. Each battery string contains 51 battery modules connected in series, which are lithium iron phosphate (LFP) cells.

Note: *The power supply for the thermal management system is external to the battery cabinet.*

Figure 3. EVLOFLEX Battery Enclosure

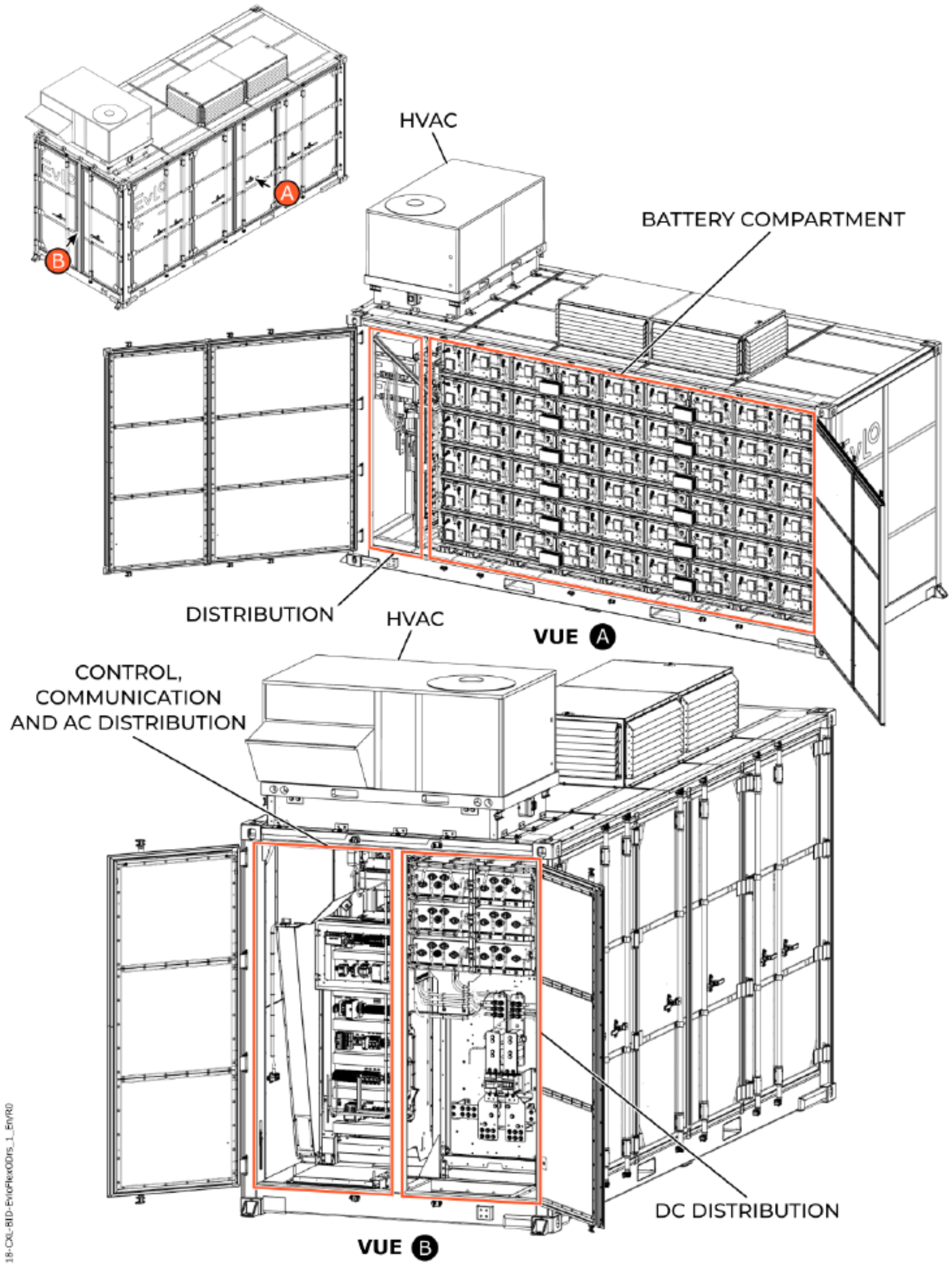
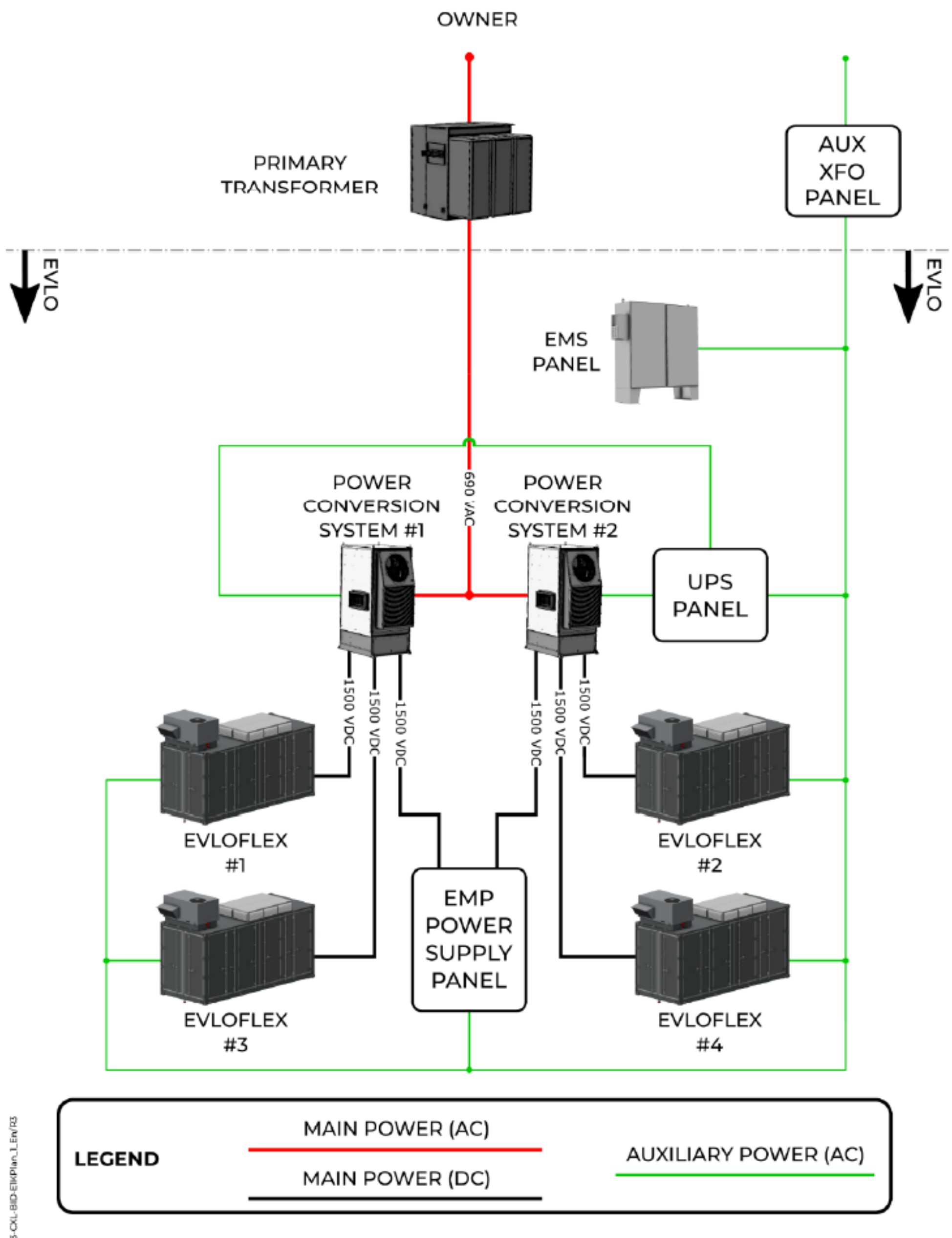


Figure 4. One-Line Diagram

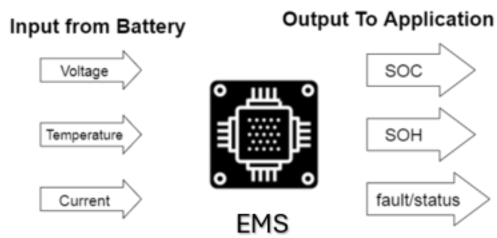


SECTION 3 DEFINITIONS & ACRONYMS

3.1 Energy Management System (EMS)

The energy-management system (EMS) is an electronic system that monitors the charging, discharging, temperature, and other factors influencing the state of cells within a module. The EMS is designed to supervise a defined set of operating parameters. If cells operate outside these set points the EMS responds in an autonomous manner to isolate trouble equipment at the module or battery enclosure level.

Figure 5. EMS Data Points



3.2 Cell

The basic functional electromechanical unit contains an assembly of electrodes, electrolyte, separators, enclosure, and terminals. It is a source of electrical energy by direct conversion of chemical energy. Each cell has a nominal capacity of 80 Ah, nominal voltage of 3.6 vdc, and is composed of Lithium-Iron Phosphate (LFP) chemistry. The cell is pouch in geometry and is certified to UL 1973.

3.3 Module

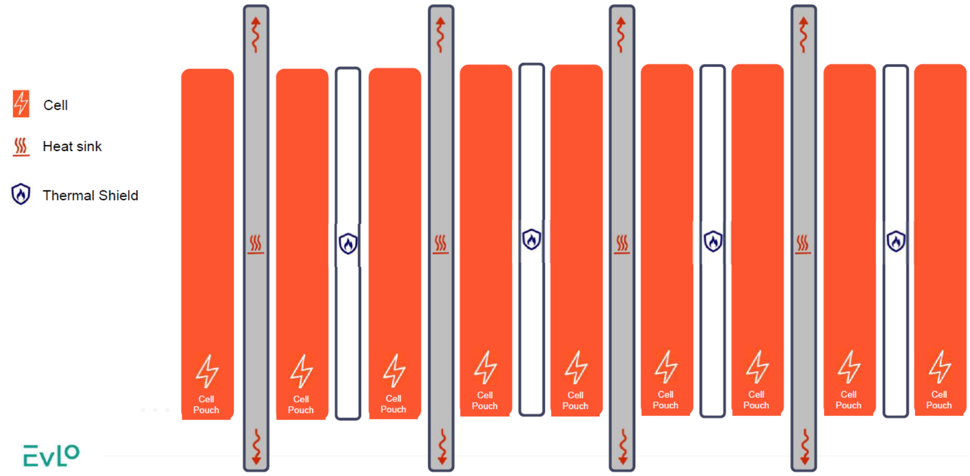
The battery module is the second smallest level of the battery assembly. The module assembly consists of four (4) trays in parallel and each tray connects eight (8) cells in series. There are six (6) modules in each rack and there are nine (9) racks in each battery enclosure.

Figure 6. Modules & Racks

3.4 Module Thermal Barriers

To prevent propagation during cell failure. Cells within the module are separated utilizing heat sink and thermal shields to guard against propagation in the event of a cell failure. The effectiveness of this strategy was validated during UL9640a Module Level Testing which demonstrated that propagation stopped at six (6) cells containing the failure to the module.

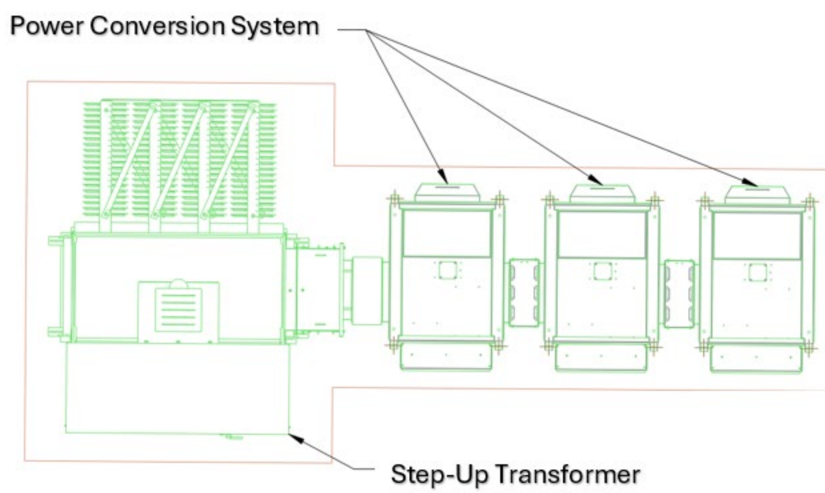
Figure 7. Module Thermal Risk Management



3.5 Power Conversion System (PCS Skid)

The Power Conversion System contains three inverters, a medium voltage transformer, and disconnect switch to island the battery block. The inverter transforms DC to AC and the medium voltage transformer ramps the 1,500 volts received from the battery enclosure to 44 kV. The transformer is cooled and insulated using FR3 ester-based oil.

Figure 8. Power Conversion System Skid



3.6 Stranded Energy

During an emergency at a BESS facility the EMS isolate trouble equipment stopping the charging and discharging of modules. However, this feature does not discharge the electrical potential remaining in the cells/modules which is known as Stranded Energy. It should be noted that during a garden variety failures 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.

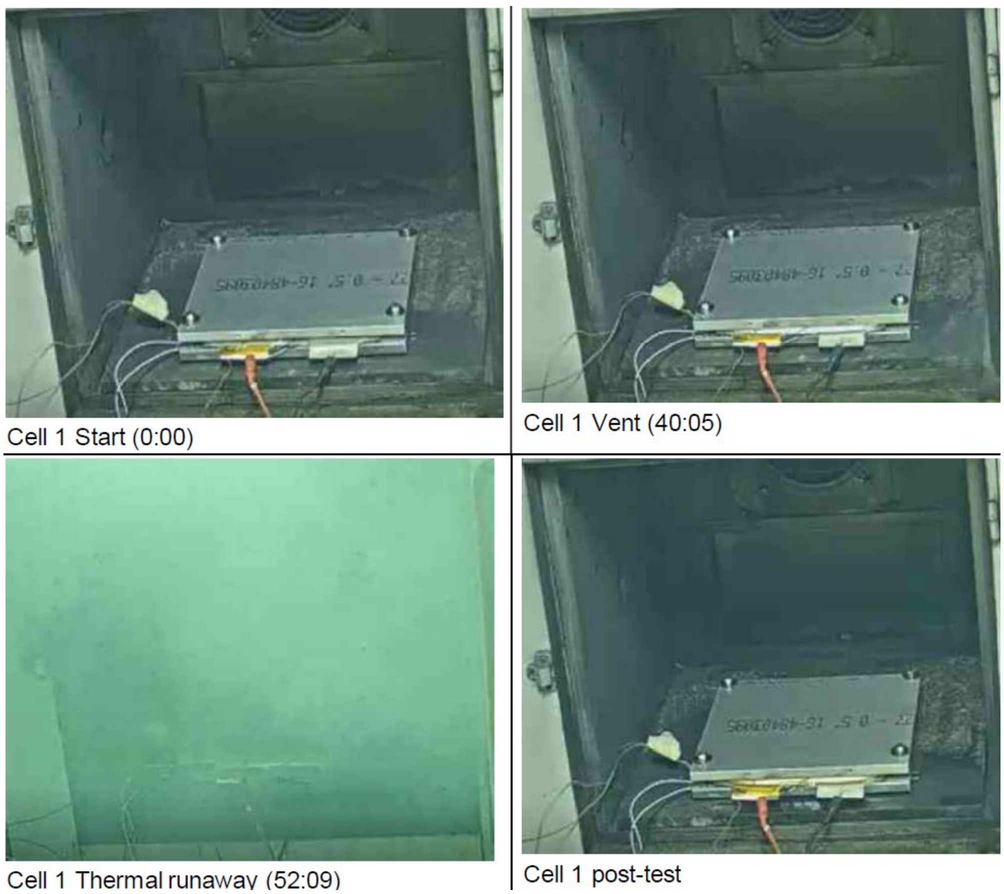
3.7 Cell Venting

In this initial stage of failure, a flammable electrolyte vents from the module in gaseous state. During UL9540a testing, the average temperature where sustained venting began was 144°C (291°F). Gas venting is often a precursor of thermal runaway.

3.8 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 215°C (419 °F) as determined by UL 9540a Cell Level Testing observed in Figure 9 below.

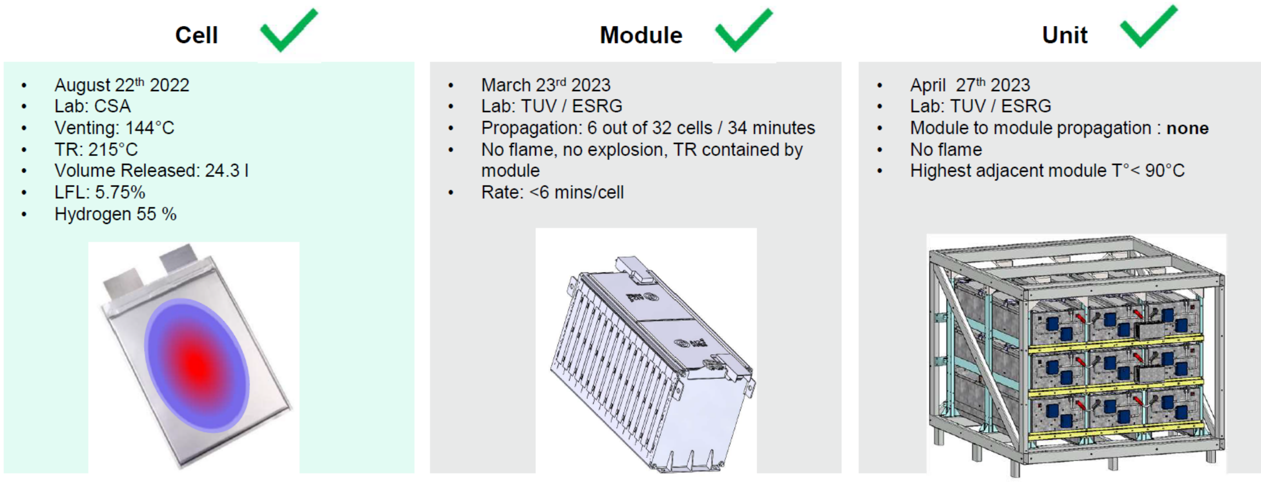
Figure 9. Cell Venting & Thermal Runaway



3.9 UL9540a Large Scale Fire Testing

UL9540a Large Scale Fire Tests were performed at the cell, module and unit levels as required by NFPA 855. The utilization of thermal barriers within the module limited cell propagation containing the failure within the module. During the until level test similar conditions were encountered. The induced failure was contained within the test module and never propagated to surrounding modules.

Figure 10. UL9540a Test Results



3.10 Alternating Current / Direct Current (AC/DC)

Energy produced by the Cells can be categorized as DC. During electrical emergencies, the fire services traditionally use non-contact voltage testers to identify energized equipment. It should be noted that non-contact voltage detectors cannot detect the presence of Direct Current (DC) and should never be used.

3.11 BESS Subject Matter Expert

NFPA 855 and IFC 1206 requires the facility owner/operator to designate and train staff to respond 24/7 within a timely manner (approximately 2-hours) to investigate all battery energy storage system (BESS) incidents. They will serve as the site subject matter expert (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.

SECTION 4 ENERGY MANAGEMENT SYSTEM

The EMS has wide reaching oversight to control charging, discharging fault detection and equipment isolation. The EMS 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 EMS can isolate trouble modules or strings as necessary to contain failure events. The EMS exists at a module level, rack level and system level for layered control.

To make informed decisions during system emergencies the EMS 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.

In this application, the EMS serves as the default EMS. System alarms are received through the EMS, trouble equipment is cleared autonomously, and notifications are sent to our ROC which evaluates alarms and follows the notification matrix found in Section 7 based on their assessment.

Figure 11. EMS Capabilities

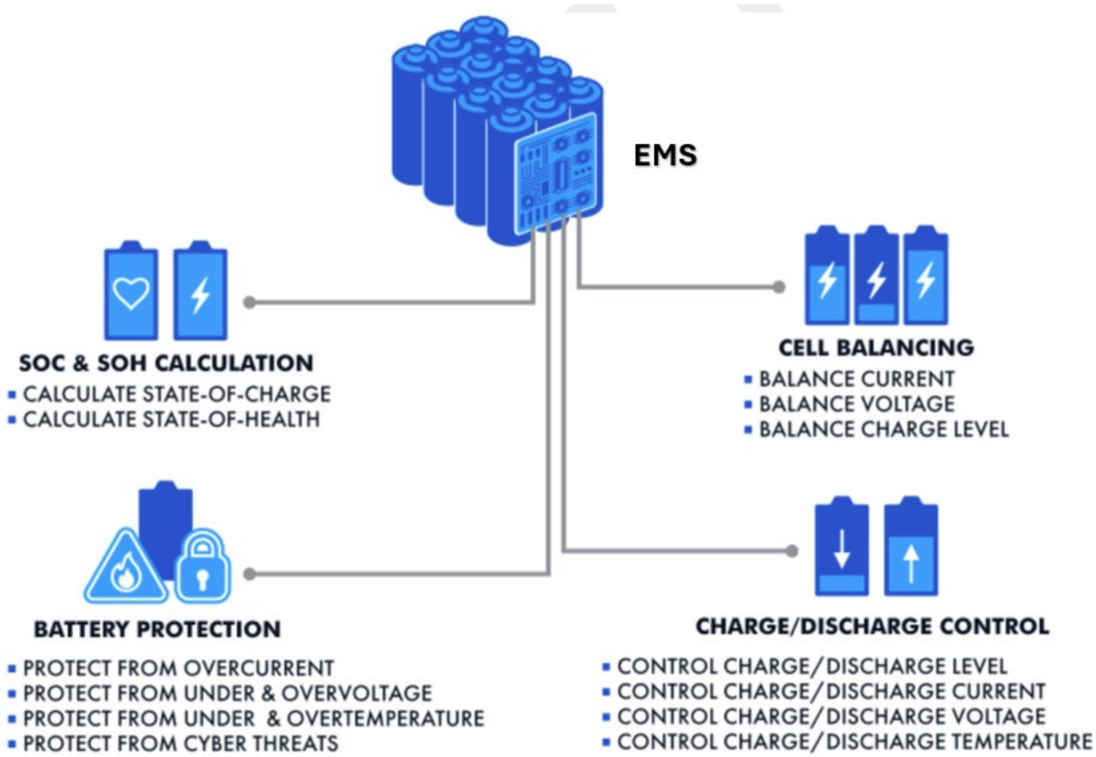
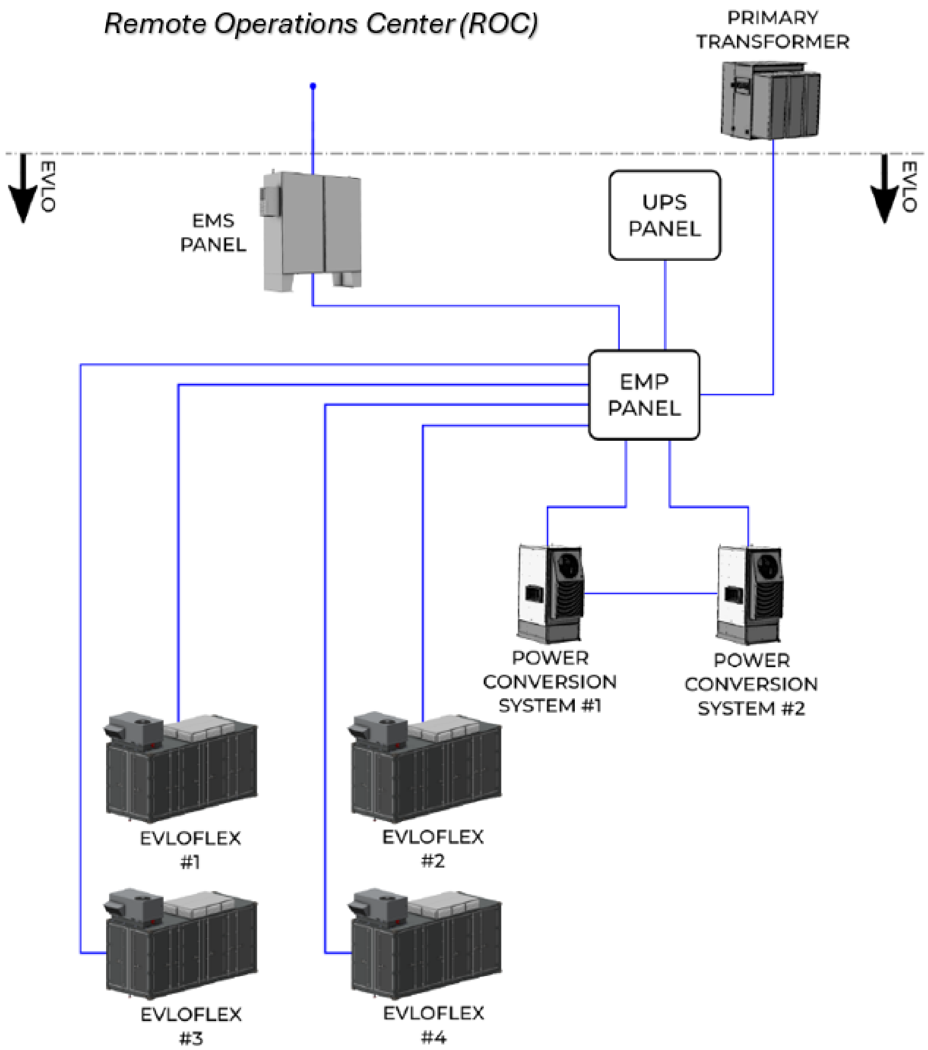


Figure 12. EMS Communication & Control Logic

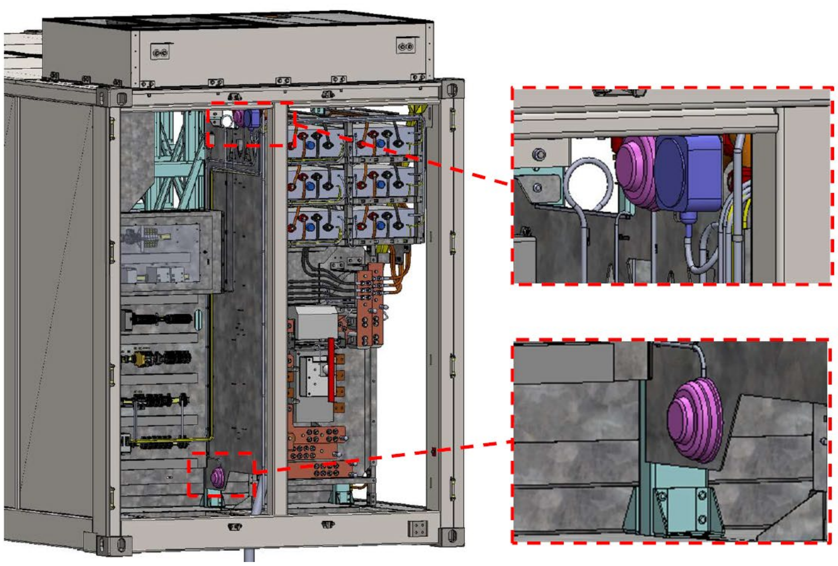


SECTION 5 DETECTION AND SUPPRESSION SYSTEM

5.1 Fire Detection System

Each battery enclosure has been outfitted with two (2) smoke/heat detectors located at the top and bottom of the enclosure. The prevalent flammable gas emitted during thermal runaway is Hydrogen. In response a hydrogen detector has been positioned at the top pf the container based on the properties of the gas. The hydrogen detector's range of alarm is 0-1000 ppm. Alarms are captured through a safety relay outlined in Figure 14. This relay interfaces with the EMS to isolate trouble equipment. Alarms received through the EMS are routed to the ROC for assessment and notifications. The fire detection and alarm system is connected to backup power that will allow the system to function in the event of a power failure.

Figure 13. Fire Alarm Detection Features



- Hydrogen Sensor
- Honeywell
- Sensepoint XCL H2 0-1000ppm
- PN: SPLCG1BARCXNZZ

- Smoke & Heat Detector
- Honeywell
- PN: 4WTR

Figure 14. Safety Relay

INPUT

- Smoke/heat detector 1
- Smoke/heat detector 2
- Gaz/H2 sensor
- Thermal managment

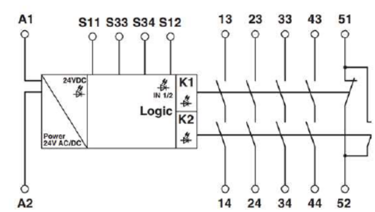


Figure 3 Block diagram

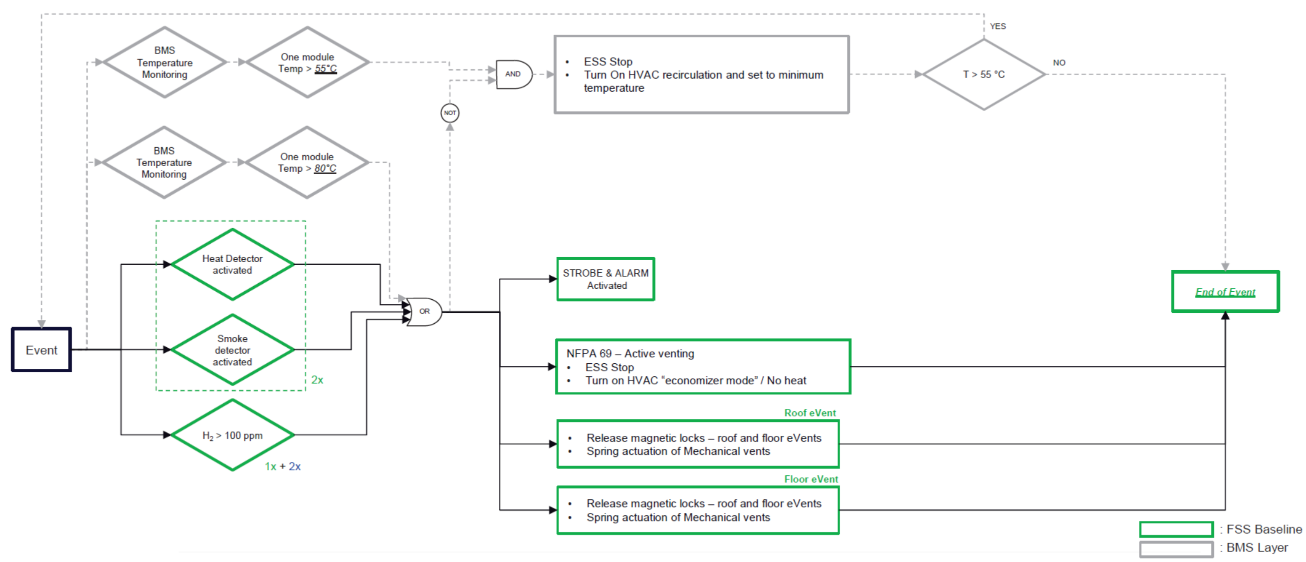
Key:

A1	24 V AC/DC power supply
A2	0 V power supply
S11	Sensor circuit output
S12	Input sensor circuit
S33/S34	Start and feedback circuit
13/14 ... 43/44	Undelayed enabling current paths
51/52	Signaling current path, undelayed

5.2 Alarm Response

The EMS monitors cell temperature alarms: temperature variations above 55C will isolate the trouble equipment and engage the thermal management system to address the over-temperature risk. Temperatures in excess of 80C will activate the annunciation system and enable the active and passive ventilation system in anticipation of a cell failure. Smoke, heat or a gas alarm > 100 ppm will also initiate this sequence of events.

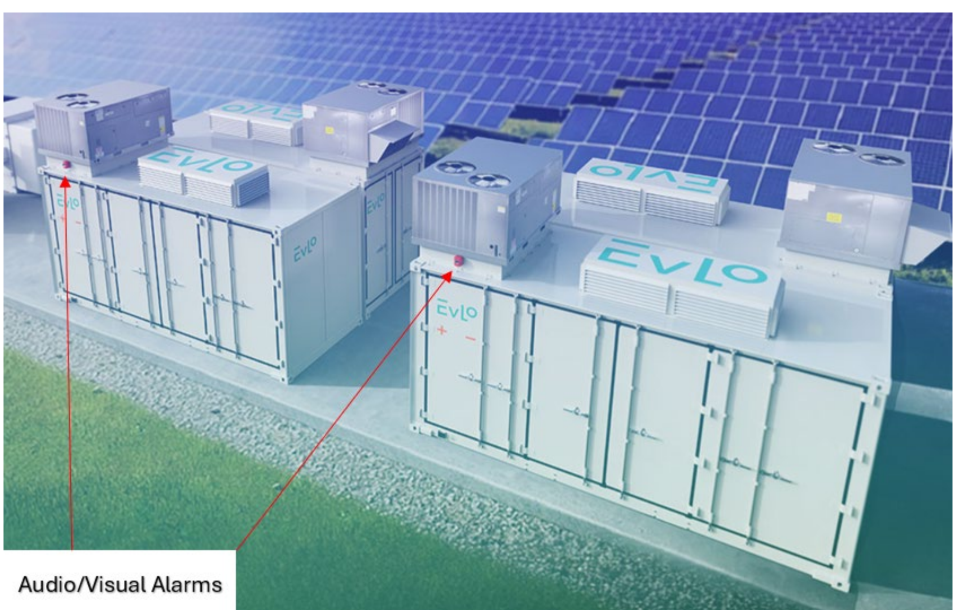
Figure 15. Site Access & Fire Command Center



5.3 Alarm Annunciation

Audio / visual alarms will be received locally from the trouble container. Notification devices have been located just below the thermal management unit on each battery enclosure.

Figure 16. Alarm Annunciation Devices



SECTION 6 HAZARDS

In this section the following hazards will be covered:

- Chemical
- Electrical
- Explosion

6.1 Chemical

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

- Lithium-Iron Phosphate (LFP)
- Hydrogen
- R410a (refrigerant)
- Transformer Oil - FR3
- Carbon Monoxide

6.1.1 Lithium-Iron Phosphate (LFP)

Toxicity: LFP cell gases are evaluated during UL 9540a Large Scale Fire Testing to identify the production of IDLH conditions. Carbon Monoxide and Carbon Dioxide were the only target IDLH gases identified. To fully sustain the impact of these gases at an IDLH level personnel would need to be within arm's length of the trouble battery enclosure. The hazards associated with these gases are managed through administrative controls such as staging upwind and/or engineering controls in the form of an SCBA while operating downwind.

Table 6. UL 9540A Cell Gas Analysis

Cell Design	Pouch li-ion construction; 1430 g; 3.65 V Nominal; 80 Ah (256 Wh)
TR Methodology	Flexible film heater; ramp rate of 4 to 7°C/min)
Surface Temp at Venting	144 °C
Surface Temp at TR	215 °C
Gas Volume Produced	24.3 L
Gas Composition	CO_2: 15.27%; CO: 4.69%, H_2: 54.47%; UHC: 13.75%
Lower Flammable Limit at Ambient	5.75
Vent Pmax (kPa)	739.1
Burning Velocity (S_U)	71.8 cm/s ;
UL 1973 Report	CU 72226550 01U

Manufacturer	XXXXXX
Module Design	Module consists of a single row 32 XXXXXXX cells arranged in a 8 series 4 parallel electrical configuration.
Mass Loss	2.366 kg
Rated Voltage	25.6 V
Rated Capacity	320 Ah
TR Propagation	Thermal runaway initiated with film heaters on initiating cell. Propagated to adjacent cells
External Flaming	No visible combustion.
Flying Debris	No observation of flying debris.
Explosion Hazards	No observed explosion.
Gas Production	CO_2: Below Range%; CO: 25.1 L, H_2: 162.7 L; UHC: 231.7 L
UL 1973 Report	CN229OFO 001

UL 9540A Data: LFP cells are more stable than other battery chemistries and are less likely to undergo thermal runaway. 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 hydrogen gas, carbon dioxide, and carbon monoxide 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 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).

Table 7. LFP SDS Hazard Information

Label Elements
Hazard Images:

Signal Word: Danger
Hazard Statements:
H251 Self-heating; may catch fire
H351 Suspected of causing cancer
H372 Causes damage to organs through prolonged or repeated exposure (lung)

irritation (30

Label Elements
Hazard Images:

Signal word: Danger
Hazard Statements:
H317 May cause allergic skin reaction.
H370 Causes damage to organs (digestive system).
H335 May cause respiratory irritation.

Exposure: The exposure risk outlined in Table 8. is associated with personnel who handle battery cells in the manufacturing or decommission stages without the use of required personal protective equipment.

6.1.2 Hydrogen

When the temperature of a cell reaches the venting stage, the primary hazard is the production of Hydrogen Gas (H2). 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 H2 Gas accumulation within the container will be found in the upper third of the unit.

Table 8. 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 Refrigerant R-410a

In the event a battery container becomes fully involved in fire conditions may extend the thermal management system. Thermal decomposition of R410a freon can result in the production of hazardous by-products outlined in the SDS data in Figure 17.

Figure 17. R410a SDS Data

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.

6.1.4 Transformer Oil – FR3

FR3 is used to insulate and cool the PCS transformer. During the failure of a transformer, elevated temperature arcing coupled with fire conditions causes heat retention in the windings and metal enclosure of the transformer. This condition keeps oil above its autoignition point making transformer fires persistent in nature.

Table 9. Transformer Oil – FR3 Characteristics

FR3 Ester-Based Oil	Characteristics
Odor	Slight Vegetable Oil Odor
Flash Point	265°C / 509°F
Auto Ignition	401°C / 754°F
PCB	No
Step-up Transformers	xxx 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 10. Carbon Monoxide Characteristics

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 1970 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, NFPA 1970 structural firefighting ensembles are not designed to provide protection from arc flash hazards.*

6.2 Electrical

Shielded Conductors: Basic equipment at the BESS facility such as battery enclosures, PCS inverters and 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: OHSA requires a safe standoff distance of 10 feet from exposed energized conductors 50,000 volts or less to prevent casual contact. OHSA O. Reg. 213/91, Section 182. The maximum voltage found in the BESS is 44kV.

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

Voltages: Up to 1,500 (DC) can be present within the battery enclosures. This may pose a shock or electrocution risk if the outer enclosure 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.

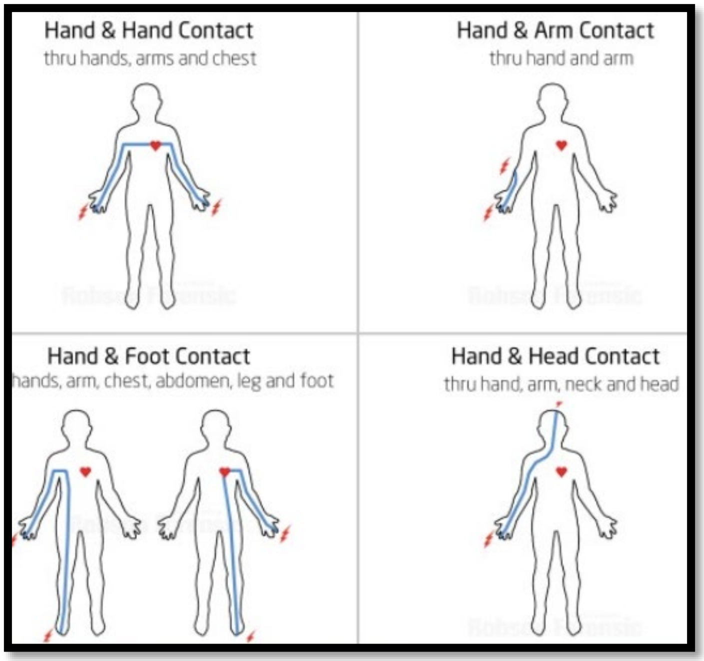
Electrical Current Effect: Current is the flow of electricity which is measured in amperage. Table 11 below outlines the OSHA study on the effects of current on the human body. It should be noted that between 1 and 4 amps is likely to cause a cardiac condition leading to death. The smallest breaker in most residential homes is 15 amps. Inadvertent contact with conductors can create conditions resulting in shock or electrocution which is explained below.

Table 11. 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.

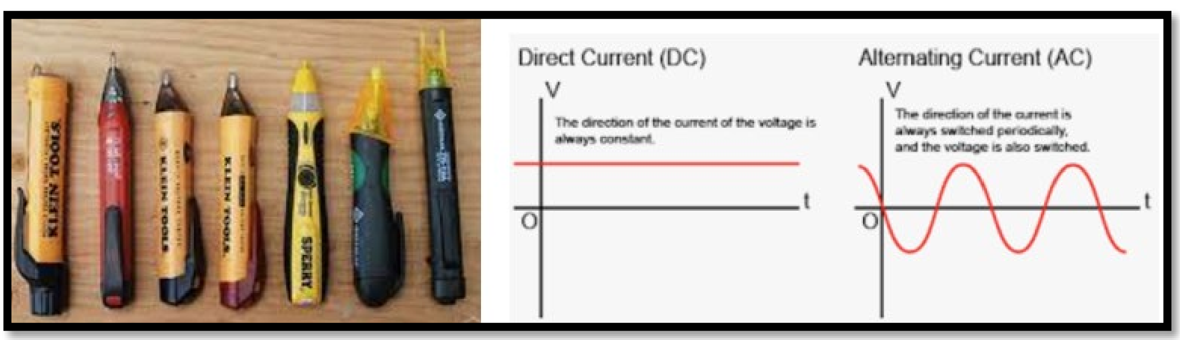
Shock & Electrocution: These terms are often misunderstood. Shock is an injury that can either be minor or major which results from inadvertent contact with an electrically energized object. Whereas electrocution results in death from contact with an energized conductor. The difference between shock 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 18. Electrical Contact Illustration



Non-Contact Voltage Tester: E-field detectors are commonly used in the fire services to identify energized equipment/objects. However, these devices are only capable of identifying equipment/objects energized by Alternating Current (AC) wave form. To assess a surface for the presence of Direct Current (DC) a traditional multi-meter will be required along with a ground reference. Note: Do not use a non-contact voltage detector at a BESS facility without guidance from a BESS subject matter expert.

Figure 19. E-Field Detectors & AC/DC Illustration

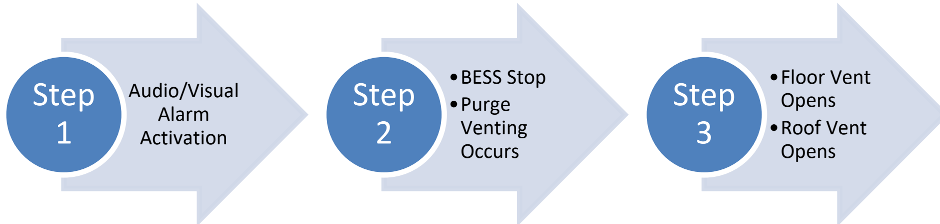


Equipment NOT Normally Energized: In a post fire scenario, protective shielding or insulation may be damaged resulting in equipment/objects that are not normally energized to become energized. Examples may be the metal battery enclosure, battery racks and modules. In a post-fire scenario DC stray voltage testing should be conducted on such components until stray voltage from stranded energy can be safely ruled out. ***Note:*** *Acceptable reading must be below the OSHA perception standard of 1mA/900 micro-amps.*

6.3 Explosion

Risk Scenario: During a thermal runaway event, failed cells will produce a flammable electrolyte. Within an enclosed space, this condition presents a potential for a deflagration to occur.

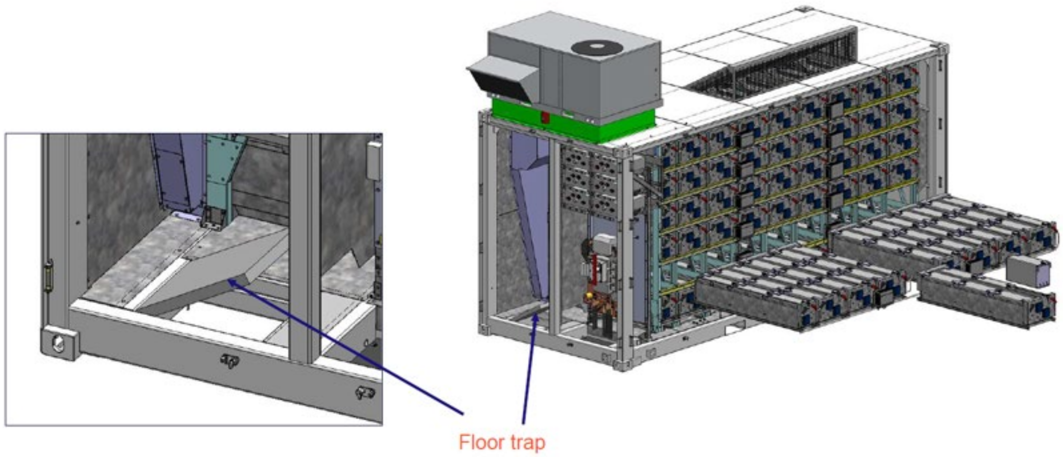
Risk Mitigation: EVLO has designed an NFPA 69 compliant system with enhancements to mitigate the risk of deflagration. Once the gas sensor threshold of 100 ppm has been exceeded the following steps occur:



NFPA 69 Concept Illustration: The thermal management system (HVAC) provides purge capabilities through the economizer feature once an H2 gas alarm has been received. Air is introduced to the HVAC and is discharged through the spring-loaded roof vent which is magnetically released. Simultaneously, the spring-loaded floor vent is also opened to promote passive airflow. This passive feature has been installed in excess of code requirements and will serve as a contingency method to guard against a deflagration in the event of an HVAC system failure or loss of auxiliary power supply.

Figure 20. Purge Venting

Figure 21. Passive Venting – Spring Loaded Floor Vent



SECTION 7 NOTIFICATIONS

7.1 Notification Matrix

The illustrated matrix outlines the linear notification process for receipt of an Energy Management System (EMS) alarm.

Table 12. Notification Matrix

EMS **NOTIFIES**	Central Station **NOTIFIES**	ROC **NOTIFIES**	911 **NOTIFIES**
Central Station	911	BESS SME	Town Mass Notification System
	Remote Operations Center (ROC)	O&M Team	
		EVLO SME	

SECTION 8 UNIFIED COMMAND

8.1 Subject Matter Expert (SME)

Typically, a BESS SME is a person or group familiar with the DDDD, the site layout and equipment, installation guides and manuals, the BMS architecture, passive and active protection systems, notification sequencing, and this ERP.

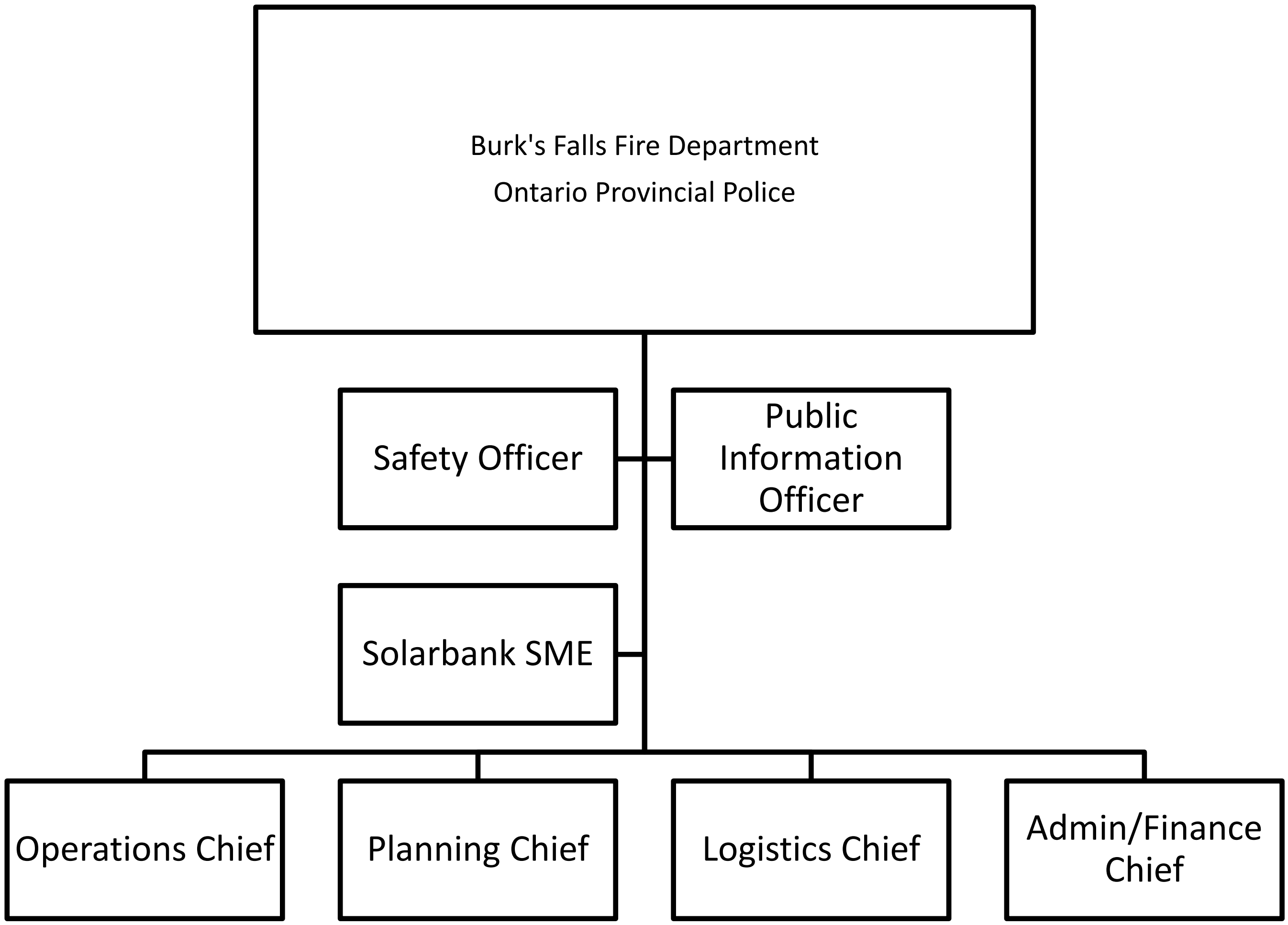
The Battery Energy Storage System subject matter expert (BESS SME) will play a critical role guiding chief officers of the fire services through a “Scene Size-Up” which will allow them to better understand the hazards and develop the appropriate response tactics. This will be discussed further in Section 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 BESS SME, equipment owner, and site operator play a critical role guiding fire department personnel responding to a BESS emergency by coordinating the following:

1. Ensure security of the site and limit access to only authorized personnel
2. Ensure accountability of non-fire department personal inside the facility through use of written or electronic logs
3. Ensure authorized personnel have PPE that is appropriate to their assigned role/task.
4. Review and interpret EMS data, such as state of charge (SOC), state of health (SOH), temperature, and service status of equipment. Focus should be on identifying deteriorating conditions.
5. Locate & isolate trouble equipment. Trouble equipment should be isolated 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 (hot) zone.
6. SME shall identify to the fire services all exposed electrical conductors within the site that would require a standoff distance to ensure safety.
7. Ensure a 100’ exclusion (hot) zone has been established around the trouble battery enclosure to ensure the safety of members operating at the scene should a deflagration occur.
8. Evaluate the status of the deflagration prevention system. The presence of smoke or flames emanating from the roof would suggest that cell failure has occurred.
9. Identify any internal exposures that may need to be protected. The decision to engage in intervention tactics is influenced by heat alarms and/or EMS cell temperature alarms in adjacent battery enclosures, if the façade of an adjacent battery enclosure has reached 50% of a cell vent temperature (63 C) or direct fire impingement.
10. Post-Incident Operations (battery enclosure access)
11. Administering Decommissioning Plan

8.2 Unified Command Structure

Sample 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 and that of the surrounding community.

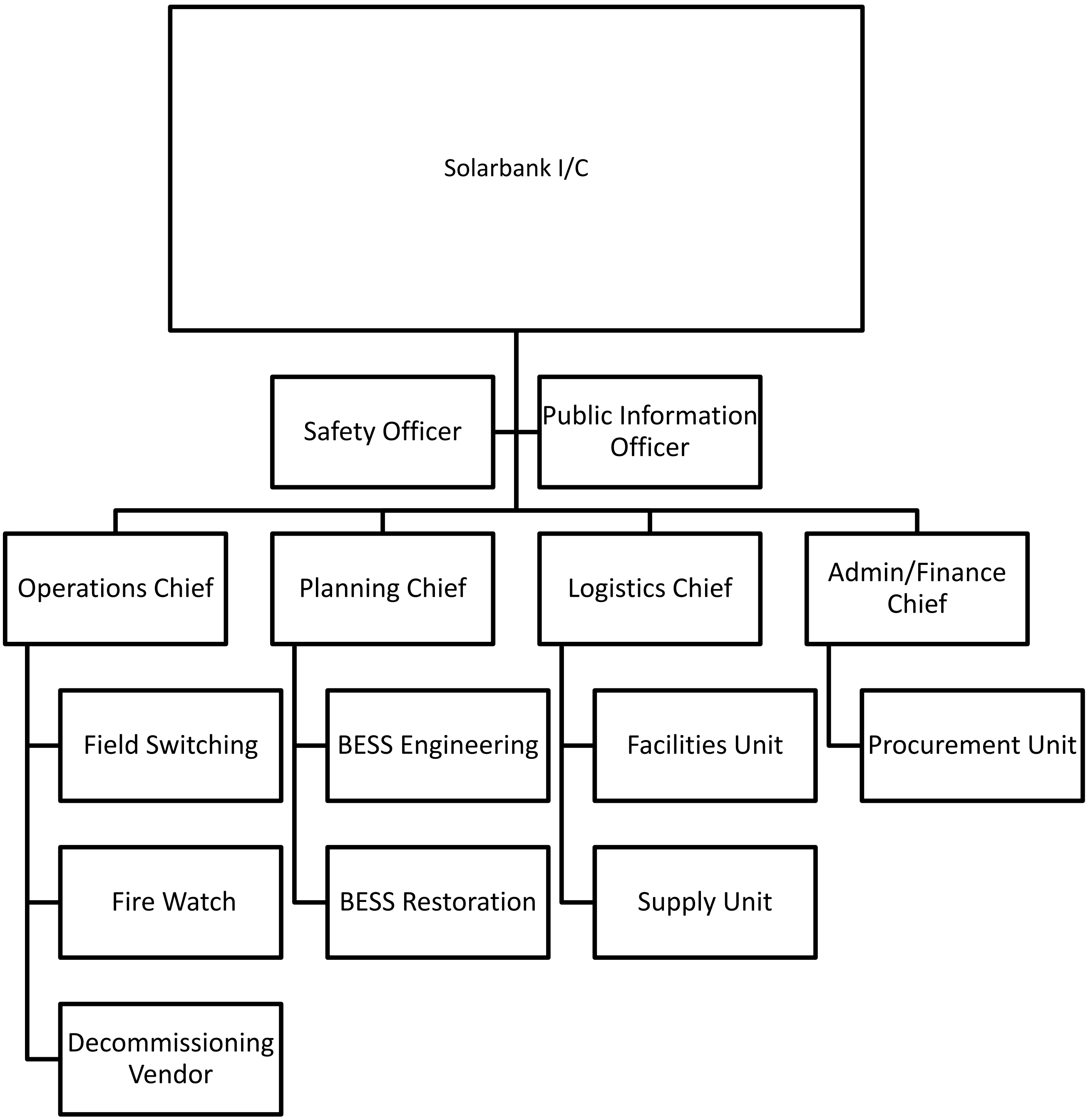
Figure 22. Sample Unified Command Structure



8.3 Incident Command Structure

A sample Incident Command Structure is outlined below that may be used to coordinate the Company's response to a site emergency or during the decommissioning process. The scope of staffing is scalable to the needs of the event. The fire department retains full command authority over any incident, although it is highly recommended that operational decisions are coordinated with the BESS SME and site personnel on scene.

Figure 23. Sample Incident Command Structure



SECTION 9 RESPONSE TACTICS

9.1 Personal Protective Equipment (PPE)

Electrical Switching: The OESC requires a hazard assessment under 2-300(1) 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 1970 structural firefighting equipment along with an SCBA for respiratory protection.

9.2 On Arrival

Fire Department: Personnel should not encroach within 100 feet of the facility fence line until the trouble battery enclosure has been identified. Staging shall be at the First Responder Station.

Emergency Response Information: Upon arrival, response information, emergency contacts, site maps, and safety data sheets shall be available and stored in a lock box accessible to the fire services.

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

- Accountability
- Location of Equipment in Alarm
- 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
  - Trouble equipment should be cleared autonomously. Control center should verify the equipment has been isolated from the facility grid.

9.3 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 based on the failure scenario. The fire department retains full command authority over any incident, although it is highly recommended that operational decisions are coordinated with the BESS SME and site personnel on scene. There are ***eight steps*** associated with conducting a scene size-up. Note: Size-up steps that can occur from outside the facility may be initiated by the fire department in advance of the arrival of the BESS SME.

EVLOFLEX battery enclosures have been outfitted with robust safety systems, intervention is limited in most cases to exposure protection or a fire watch that will monitor data points until conditions have stabilized. These facilities are generally unstaffed and any equipment that has failed cannot be saved.

1 **Community Air Monitoring:** Air monitoring should always be conducted 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 hazardous levels of any gases are measured, consider if evacuation or shelter-in-place orders need to be made to nearby residents. The town mass notification system should be utilized to

distribute information to the public.

Table 13. CDC IDLH Thresholds

Gas Name	Chemical Structure	% Measured	PPM	IDLH (PPM)
Carbon Monoxide	CO	15.27	152,700	1,200
Carbon Dioxide	CO2	4.69	46,900	40,000
Hydrogen	H2	54.47		N/A
Ethyl Methyl Carbonate	C4H8O3	0.121		N/A

2 **Detection Alarms:** The trouble battery enclosure and the surrounding battery enclosures should be evaluated for the presence of any active alarms. Active alarms should be reviewed and recorded. This will provide a baseline for existing conditions. The receipt of any additional alarms may suggest deteriorating conditions or thermal impact on a neighboring battery enclosure.

3 **Energy Management System (EMS):** If an emergency involves the battery enclosure, the EMS shall be reviewed to determine the following information:

- State of Charge: State of charge should be interpreted as fuel; a low state of charge suggests the event will be shorter in duration. A SOC of 30% indicates a low probability event. Whereas an SOC of 80% would suggest an event of longer duration.
- Rise in Temperature: If additional cells in the trouble module or additional modules around the trouble module begin to show signs of increased temperature this would be an indication of propagation within the unit.

Table 14. State of Charge vs. Voltage

Percentage (SOC)	3.2V
100% Charging	3.65V
100% Rest	3.40V
90%	3.35V
80%	3.32V
70%	3.30V
60%	3.27V
50%	3.26V
40%	3.25V
30%	3.22V
20%	3.20V
10%	3.00V
0%	2.50V

4 **Isolation of Trouble Equipment:** Trouble equipment will be isolated from the facility grid autonomously by the EMS and relay protection schemes as appropriate. Where possible, disconnects should be opened to isolate the trouble equipment so as to prevent the cycling of breakers that may reclose into trouble/faulted equipment.

5 **Exclusion Zone:** A 100-foot exclusion (hot) zone should be established based on the location of the trouble

battery enclosure. Doors are the primary risk for becoming projectiles in the event that the explosion prevention system fails to operate to design criteria. Battery enclosures have doors on two sides. The front and the side with the thermal management system above it. Figure 24 establishes an exclusion (hot) zone on trouble battery enclosure 6 (star) as an example. Figure 25 shows an example of how hazard zones would be set up for a BESS incident, with the 100 ft. radius exclusion zone as the hot zone, and an additional 50 ft. of radius around the hot zone as the warm zone. ***Note:*** *Apparatus or appliances used for asset protection to deliver water shall be placed outside the exclusion (hot) zone.*

Figure 24. Exclusion (Hot) Zone

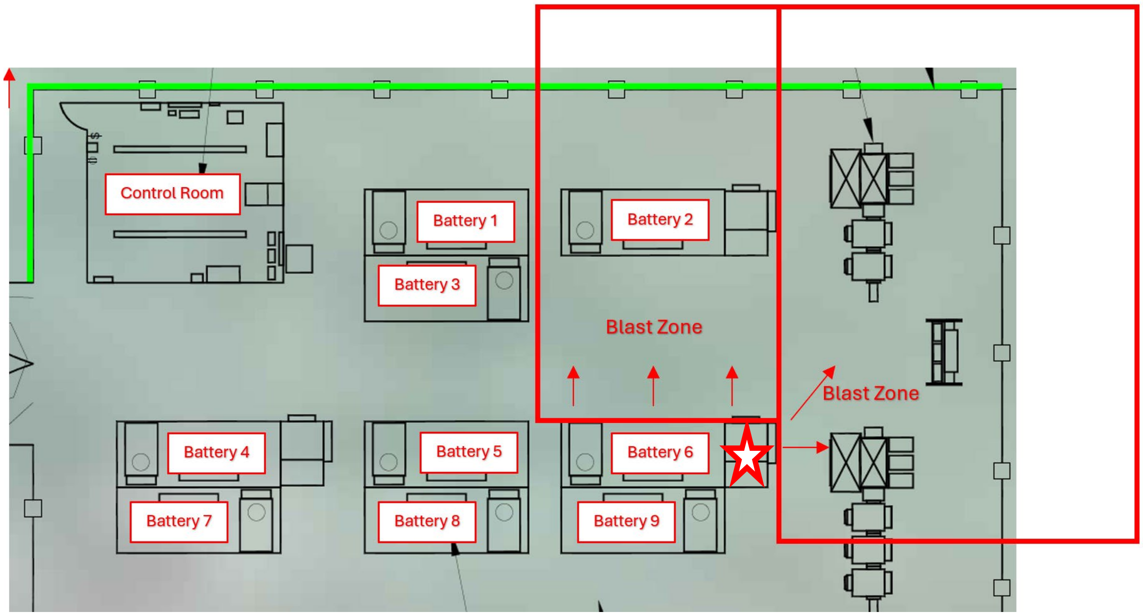
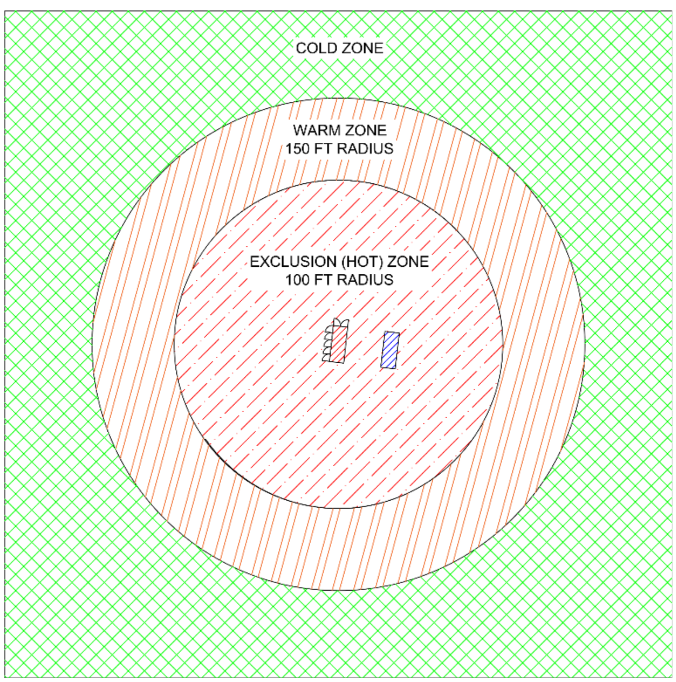


Figure 25. Hazard Zones



6 **Explosion prevention System:** LFP cells in thermal runaway will emit a white flammable gas which presents with the appearance of smoke. This can be validated by concentrating a thermal imaging camera on the NFPA 69 explosion prevention system vent. Thermal runaway gases measure approximately 1,000 F. These conditions should be monitored without intervention and if the volume of gas appears reduced over time the trouble cell has reached a zero state of charge.

7 **Smoke / Fire Conditions:** The internal safety features of a battery energy storage system are designed to contain equipment failure to the battery enclosure. If conditions extend from the trouble enclosure, surrounding equipment may be at risk of failure from thermal conditions or direct fire impingement. See Exposures next.

8 **Exposures:** An exposure assessment will determine if intervention is appropriate for asset protection. Evaluate the following risks:

- EMS Alarms: Cell temperature rise, or alarms will be an indication that intervention will be necessary for asset protection.
- Thermal Imaging Assessment: Battery enclosures surrounding a fully involved unit should be assessed using thermal imaging camera. Intervention temperature is 63C 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 battery enclosure should not propagate to the sister enclosure (backside). However, if wind influences fire conditions placing the sister enclosure 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 battery enclosure. 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 (hot) 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. A single handline intermittently flowing up to 250 gpm should be sufficient to provide adequate exposure cooling for the facility. In extreme situations, a second handline may be needed to protect additional exposures.

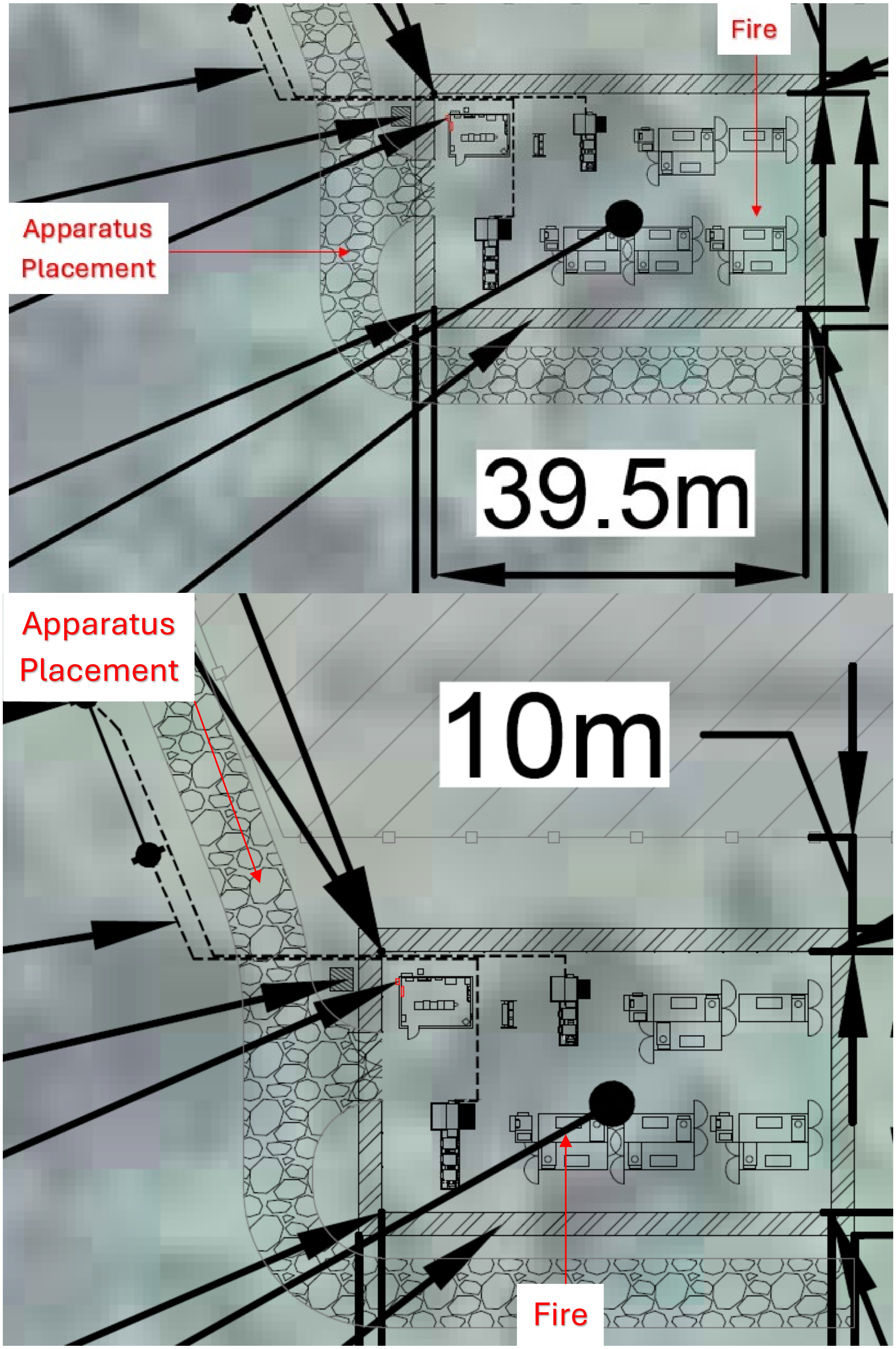
Note: See Draft Water Analysis dated 11-20-2024. Table 13 does not apply to Salt Water.

Table 15. Safe Standoff Distance – Handlines

Agent	Voltage	Spray Pattern	Pressure	Min Distance
Potable Water	< 50 kV	30-Degree Fog	100psi	25 feet
Draft Water	< 50 kV	Multiversal – No Straight Streams	100 psi	100 feet

Safe Staging: The safe standoff distance for the application of water for asset control shall be based on explosion as the primary hazard. In response, Figure 24 illustrates that water should be delivered from the side of the battery enclosure without the doors. Positioning of the appliance /apparatus should use an uninvolved array as a buffer zone. As an example, a hose illustrates the location where asset protection would occur if a battery enclosure was fully involved.

Figure 26. Safe Staging for Exposure Protection



Electrical Hazards: Where applicable, the BESS SME shall ensure that trouble electrical equipment other than batteries is deenergized and isolated from all electrical sources.

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 9.4 below.

9.4 Response Scenarios

9.4.1 Cable Failure

Figure 27. 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 enclosure. Cable fires in an enclosed space such as a battery enclosure can create an accumulation of CO resulting in an explosive atmosphere. Fire department members operating at the scene shall maintain a 100' exclusion (hot) zone as outlined in Section 9.3 – Figures 23. This tactic is employed as a conservative measure in the event that the explosion protection system fails to operate to design criteria.
Alarm	A smoke alarm will be routed to the EMS. The EMS will isolate the trouble battery enclosure. The EMS will also notify the ROC. The ROC will follow the notification matrix outlined in Section 7 as appropriate.
Fire Classification	This will be considered a Class C Fire, energized fire. Even after the battery enclosure has been isolated stranded energy remains in the cells/modules and associated battery cables.
Switching	Upon receipt of a smoke alarm the trouble battery enclosure should be isolated autonomously through the EMS. This can be verified through SCADA rather than approaching the Battery enclosure. If this cannot be validated the battery core connected to the PCS should be isolated as a conservative tactic.
Exposure Control	None required, however if the cable fire extends to the battery's modules proceed to section 9.4.2 below.

Assessment	Doors shall remain closed until such time the smoke condition subsides. Review the EMS to determine if cells/modules are involved. Cell temperature alarms will be a clear indication of battery involvement. If conditions indicate there is no involvement of cells/modules move to the next step – Access. If conditions visually or through data points suggest cells/modules are involved move to Section 9.4.2 Cell Failure.
Access	Follow guidance in Section 10 Post Incident Operations.
Suppression	After Section 10 has been completed and Battery enclosure doors are open Co2, dry chemical agent or Purple-K may be used to extinguish any remaining pockets of fire. These agents have a Class C Listing and are rated for use up to 100,000 volts. The maximum voltage found in a Battery enclosure is 1,500 Vdc.
Safe Standoff Distance	There is no required standoff distance for leakage current when using the prescribed agents. 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 1970 structural firefighting ensemble: 10 feet.

9.4.2 Cell Failure

Figure 28. 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. The accumulation of flammable vent gas from thermal runaway presents the risk for an explosion in an enclosed space. The NFPA 69 explosion prevention system is designed to mitigate that risk. However, fire department members operating at the scene shall maintain a 100' exclusion (hot) zone as outlined in Section 9.3 – Figure 23. This tactic is employed as a conservative measure in the event that the explosion prevention system fails to operate to design criteria.
Alarm	A gas (H2) alarm will be routed to the EMS. The EMS will isolate the trouble battery enclosure. The EMS will also notify the ROC. The ROC will follow the notification matrix outlined in Section 7 as appropriate.
Fire Classification	This will be considered a Class C Fire, energized fire. Even after the Battery enclosure has been isolated stranded energy remains in the cells/modules and associated cables.
Switching	Upon receipt of an H2 gas alarm the trouble battery enclosure should be isolated autonomously through the EMS. This can be verified through SCADA rather than approaching the battery enclosure. If this cannot be verified the battery block should be disconnected connected at the PCS.
Exposure Control	None until such time fire conditions have extended from the battery enclosure.
Assessment	Review the EMS to determine if propagation is occurring or if the failure is contained to the 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 conditions proceed to step 9.4.3 Fully Involved Battery enclosure.
Access	Follow guidance in Section 10 Post Incident Operations.
Suppression	After Section 10 has been completed and Battery enclosure doors are open Co2, dry chemical agent or Purple-K may be used to extinguish any remaining pockets of fire. These agents have a Class C Listing and are rated for use up to 100,000 volts. The maximum voltage found in a Battery enclosure is 1,500 Vdc.
Safe Standoff Distance	There is no required standoff distance for leakage current when using the prescribed agents. 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 1970 structural firefighting ensemble: 10 feet.

9.4.3 Full Involved Battery enclosure

Figure 29. Fully Involved Non-Intervention

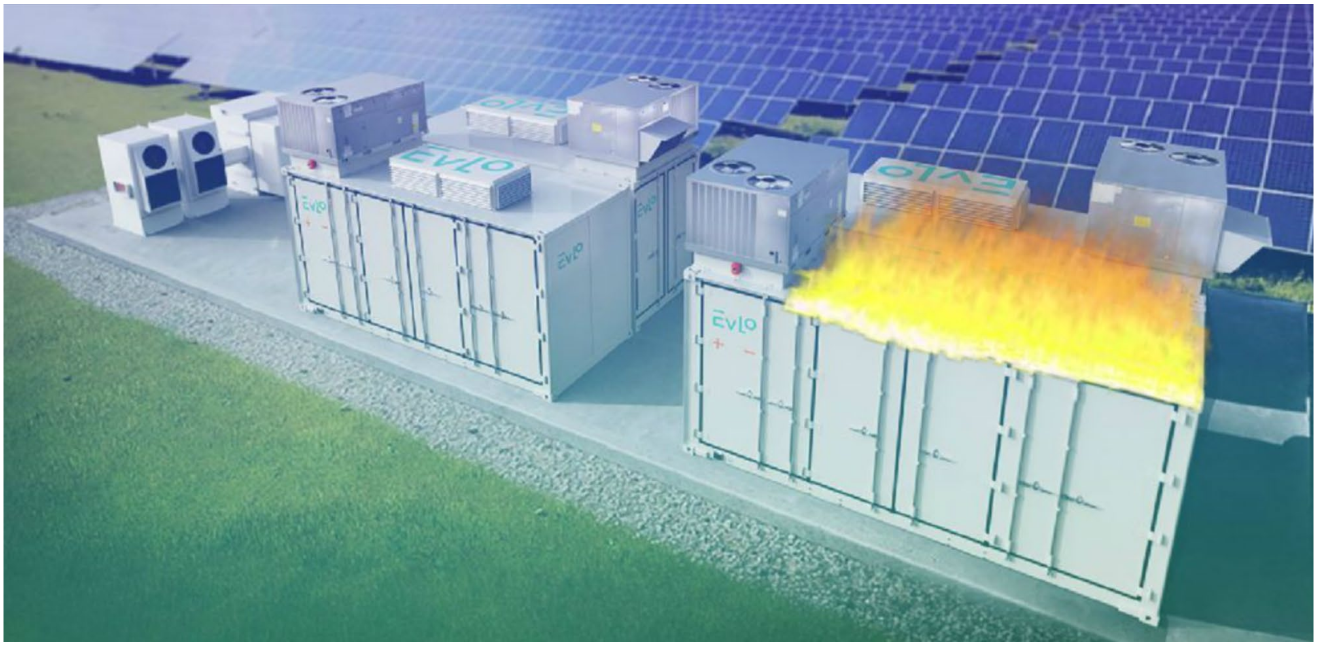


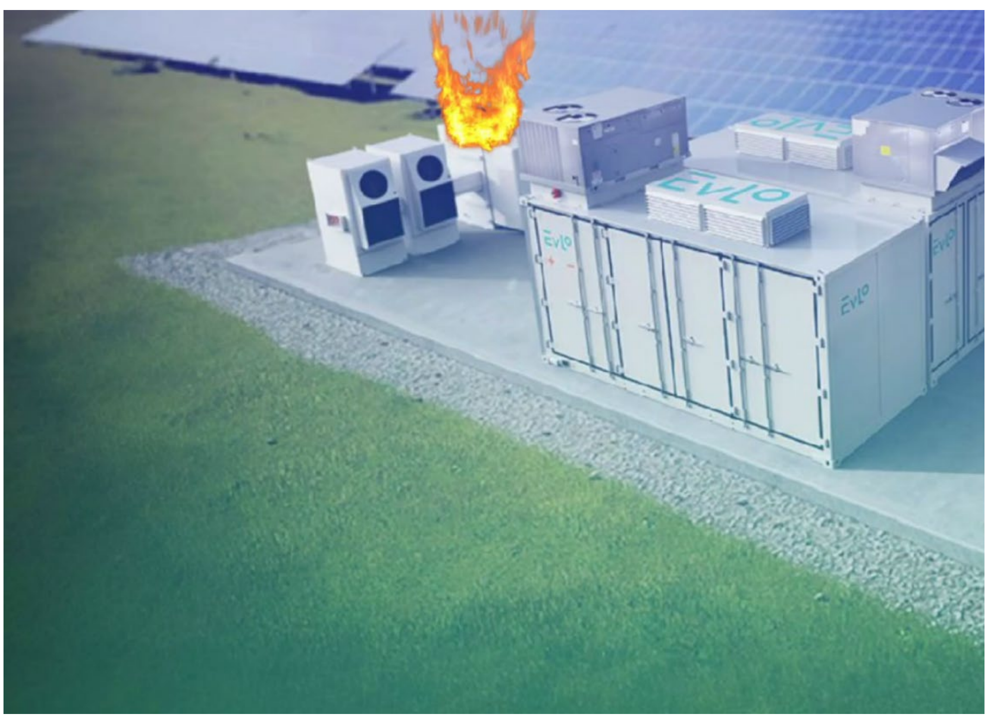
Figure 30. Fully Involved Intervention Required

	Fully Involved Battery Enclosure Response Matrix
Hazards	The main hazard associated with a fully involved battery enclosure is the potential for propagation to adjacent enclosures. Thermal heat transfer expands the explosion potential risk. In response fire department members operating at the scene shall maintain a 100' exclusion (hot) zone as outlined in Section 9.3 – Figure 23. This tactic is employed as a conservative measure in the event that the explosion prevention system fails to operate to design criteria.
Alarm	The initial failure event will generate smoke, H2 and EMS alarms. The battery enclosure will be isolated via EMS. Once the battery enclosure is involved in fire all internal detection devices serving as data points will be considered compromised and not relied upon for decision making. Focus should be shifted to monitoring surrounding battery enclosures for alarms which would highlight the expansion of thermal conditions.
Fire Classification	This will be considered a Class C Fire, energized fire. Even after the battery enclosure has been isolated stranded energy remains in the cells/modules and associated cables.
Switching	Isolate the entire battery block associated with the PCS along with any other battery enclosures (outside the block) that may have generated alarms or sustained direct fire impingement.
Exposure Control	UL 9540a Unit Level Fire testing has indicated fire will not propagate to the adjacent battery enclosures. Figure 27 serves as an illustration for non-intervention and monitoring of surrounding battery enclosures for cell temperature alarm, radiant heat or direct fire impingement. Figure 28 illustrates the effects of extreme wind conditions on the adjacent battery enclosure. Water should only be applied intermittently following the guidance provided in section 9.3 Table 13. Intervention should occur under the following circumstances: • EMS Alarm: EMS alarm for cell temperature received in adjacent battery enclosure(s) • Thermal Imaging Assessment: The exterior temperature of adjacent battery enclosure(s) exceeds 50% of the vent temperature of the cells. Therefore, the exterior intervention temperature is 63C. • Fire Impingement: Observable direct impingement of fire.
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 a zero state of charge there is no fuel left to support fire conditions. While observing non-intervention or asset protection strategies. Conditions on the surrounding battery enclosures must be closely monitored for alarms, specifically anything related to temperature. Alarms that would suggest additional failures have occurred in surrounding enclosures and will require the expansion of the exclusion (hot) zone. Consideration may also be given to the preemptive isolation of surrounding enclosures as a conservative measure.
Access	Follow guidance in Section 10 Post Incident Operations.
Suppression	After Section 10 has been completed and battery enclosure doors are open Co2, dry chemical agent or Purple-K may be used to extinguish any remaining pockets of fire. These agents have a Class C Listing and are rated for use up to 100,000 volts. The maximum voltage found in a battery enclosure is 1,500 Vdc.
Safe Standoff Distance	There is no required standoff distance for leakage current when using the prescribed agents. 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 1970 structural firefighting ensemble: 10 feet.

9.4.4 PCS Equipment Failure

Figure 31. Inverter Failure

Figure 32. Transformer Fire



	PCS Equipment Failure Response Matrix
Hazards	Inverter Failure: An electrical fault is the primary cause of failure for an inverter. This will result in an arc-flash resulting in the disconnect of electrical source through protective devices such as breakers, fuses and switches. The inverter housing is metal-clad so there are no combustibles to sustain fire conditions. Isolated pockets of fire may result from electrical insulation material which will self-consume. Transformer Failure: The Step-up transformer contains insulating oil which is ignited in the failure of the unit. 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 these fires persistent in nature. The primary hazard in this case is the sustained thermal condition on the adjacent Battery enclosures or direct fire impingement of the Battery enclosures as a result of wind conditions. A 100-foot exclusion (hot) zone should be established from the Battery enclosure door(s) as a measure to guard against injuries associated with a potential explosion.
Alarms	The failure of the transformer will trip the collector circuit and isolate the battery enclosures in the core block. These conditions will be received through SCADA alarms remotely at the ROC.
Fire Classification	Transformer fires are considered Class B/C fires until the electrical source has been removed. Never attempt to suppress an energized fire.
Switching	Verify open the collector circuit and isolate the Battery enclosures in the block.
Exposure Control	Asset protection will be driven by any cell temperature alarm received from the adjacent Battery enclosures, a thermal imaging assessment (>63C) or the direct impingement of fire on the surrounding Battery enclosures.
Assessment	In the absence of any alarms in the adjacent Battery enclosures CO2 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	Prior to engaging in suppression, the Battery SME should verify that the trouble transformer has been deenergized and isolated as described in “Switching”. CO2 is the recommended agent. CO2 has a Class C Listing and is rated to 100kV.
Standoff Distance	Approach is limited to fire tolerance; however, the transformer is not grounded so a no contact rule should be observed.

9.4.5 *Wildfire*

	Wildfire Response Matrix
Hazards	The potential exists for a wildfire originating outside the BESS facility to endanger the facility. If the wildfire enters the facility, it could result in failure and subsequent fire within BESS components or other facility equipment.
Fire Classification	A wildfire is considered a Class A fire and can be extinguished with water.
Exposure Protection	Attempt to protect the perimeter of the facility utilizing conventional wildland firefighting tactics such as creating fire breaks, pre-wetting ground and nearby vegetation using hoselines or backpack tanks, and removing vegetation.
Switching	If the wildfire enters the BESS facility, ensure all BESS equipment is remotely isolated from other equipment and the grid.
Suppression	If a wildfire enters the BESS facility, attempts can be made to extinguish the fire from outside the facility perimeter utilizing hoselines. Follow response guidelines from Section 9.4.1 through 9.4.4 if BESS equipment becomes involved in fire, when it is safe to do so.
SOPs	Follow existing SOPs for wildfire response and tactics where they differ from this response matrix.

SECTION 10 POST INCIDENT OPERATIONS

10.1 Personal Protective Equipment (PPE)

While operating near trouble equipment, the fire services personnel should remain in NFPA 1970 structural firefighting gear. If enclosure 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. Post-incident decontamination of personnel and PPE is recommended based on the severity of the incident. Follow jurisdictional standard operating procedures (SOPs).

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 enclosure doors. Once all battery enclosure 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 enclosure with no potential for extension into neighboring enclosures thus achieving the final objective of property conservation.

Note: We 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 Passive Vent Open

Existing Conditions: The roof of the battery enclosure is breached from fire conditions, or the passive vent is open. 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 (H2) 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 215C. 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 <63C (50% of the vent temperature) for a period to 12 hours. If conditions comply with guidance in Section 10.2.1 proceed to step 10.3 LOTO.

10.2.2 Passive Vent Closed / Data Points Available

Existing Conditions: EMS shows no signs of propagation. No active or additional EMS 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 enclosure once the safety stand-down period commences.

- Firewatch: The fire watch should focus thermal imaging readings above the NFPA 69 vents. The time that the safety stand-down begins (day/night) will influence baseline temperature readings. In response there should be no observed readings above 63C for the duration of the stand-down. Temperatures above 63C 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 Evlo 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 step 10.3 LOTO.

10.2.3 Passive Vent Closed / No Data Points Available

Existing Conditions: Magnetic vents have not lifted, and the EMS 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 enclosure in the event that EMS reporting reoccurs.

- 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 63C for the duration of the stand-down. Temperatures above 63C 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 step 10.3.

10.3 Lock Out / Tag Out

Once emergency conditions have concluded, prior to accessing the trouble enclosure 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.

10.4 Decommissioning

Once lock-out / tag-out has been completed the decommissioning plan should be implemented to define the process for safe access of the battery enclosure. Access will provide a means to conduct a final negative exposure assessment prior to removing modules for evaluation and disposal.

SECTION 11 TRAINING

Classroom training shall be conducted for members of the first response community, specifically the fire service, prior to batteries arriving on location. Training and familiarization tours on the hazards and response tactics associated with BESS facilities will be provided annually. Training should be provided by at least Level II ProBoard certified instructors. The following topics will be covered in the training program:

- Energy Storage System Concept
- Site Overview & Exposures
- Equipment & Definitions
- Battery Management System
- Detection & Suppression
- Emergency System Shutdown
- Hazards
  - Chemical
  - Electrical
  - Explosion *(NFPA 69)*
- Lithium-Ion Battery Fires
- Exposure Control
- On Arrival
- Scene Size-Up
- Response Tactics
  - Cable Fire
  - Cell Venting/Fire
  - Fully Involved
  - PCS Equipment Failure
- Post-Incident Operations

SECTION 12 REVISION SHEET

Rev. No.	Date	Developed By	Reviewed By	Approved By	Notes
Rev 0	11/25/2024	AJN	AJN	KS	Initial ERP
Rev 1	8/21/2025	AJN	AJN	AJN	Revised based on comment responses