ATTACHMENT 2

SolBank 3.0
Safety Manual

V1.1

CSI Energy Storage Co., Ltd.

This manual is verified to be accurate at the date of publication identified within Section 1.4. e-STORAGE reserves the right to make product and documentation modifications at any time to achieve the goal of “Leading the energy revolution and creating a green future”.

The images provided in this manual are for demonstration purposes only. Details vary slightly according to product version and market region. e-STORAGE has the final interpretation right for all detailed designs of the product.

e-STORAGE

A subsidiary of Canadian Solar

The information and recommendations set forth are made in good faith and believed to be accurate as of the date of preparation. e-STORAGE makes no warranty, expressed or implied, with respect to this information.

Please contact the e-STORAGE Technical Team by telephone +1-519-837-1881 for further information or to report inaccuracies or omissions in this manual.

Made in China

1 Preface

1.1 Document Purpose and Scope

The purpose of this document is to provide an overview of the electrical, chemical, and fire hazards that exist within the SolBank modular Energy Storage System (ESS). The scope of this document is limited only to equipment contained within the SolBank and does not include an analysis of all hazards existing at an ESS site. Topics covered include an overview of comprehensive site safety planning processes, SolBank safety systems and features, SolBank hazards, emergency response options, and other important system safety precautions.
This document should be made available to all field personnel participating in the design, installation, operation, and maintenance of the SolBank energy storage system in addition to project safety personnel and local emergency first responders.

This manual is to be considered supplemental to a project specific Environmental Health and Safety (EHS) plan, Failure Mode Effects Analysis (FMEA) and Hazard Mitigation Analyses (HMA), and Emergency Response Plan (ERP). Please read and understand all aspects of this document prior to initiating SolBank installation, commissioning, and operation.

Should any questions arise, please contact e-STORAGE support:

- By telephone at +1-519-837-1881.

1.2 Applicable Models

This manual covers the following models only:

- CSI-SolBank-S-5016-2h-NA
- CSI-SolBank-S-5016-4h-NA
- CSI-SolBank-S-5016-2h-EU
- CSI-SolBank-S-5016-4h-EU
- CSI-SolBank-S-5016-2h-AUS
- CSI-SolBank-S-5016-4h-AUS

1.3 Reference Documents

The SolBank Installation Manual exists as part of library of product specific documents. Please consult the following documents to ensure a comprehensive understanding of SolBank attributes.

- SolBank3.0 Installation Manual
- SolBank3.0 User Manual
- SolBank3.0 Safety Manual
- SolBank3.0 Maintenance Manual
- SolBank3.0 Commissioning Manual
- SolBank3.0 Decommissioning Manual
- SolBank3.0 Transportation Instruction Document

1.4 Version Control

This is the initial release of the SolBank Safety Manual. As part of e-STORAGE's continuous improvement process, e-STORAGE reserves the right to make technology and document changes.

Please contact e-STORAGE support to verify this manual reflects the most recent release or to report omissions or inaccuracies.

Version	Description	Date of Issuance
V1.0	Initial release	May 15th, 2024
V1.1	Add Applicable Models	August 1th, 2024

1.5 Document Safety Notices

Throughout this manual the below indicated labels are used to convey hazards associated with specific tasks and procedures. These safety notices do not represent all hazards present when performing a given task. Installers and operators of the SolBank should adhere to industry safety best practices; site specific Environmental, Health and Safety plans; and local safety requirements and regulations. ***Only properly trained and qualified personnel should be permitted to complete the installation procedures identified in this manual.***

Labels	Explanation
	CE mark of conformity.
	Indicates a hazardous situation which, if not avoided, could result in death or serious injury. Indicators are not used for property damage hazards unless personal injury risk appropriate to this level is also involved.
	Label the product as inflammable and explosive, and do not involve open flame.
	Electrical hazard sign, non-professional personnel do not approach. Professional personnel are required to perform maintenance and operation.
	Do not discard randomly
	Recycling equipment

1.6 SolBank Primary Hazards

This section summarizes the primary hazards associated with the SolBank. These hazards are discussed in detail within this guide, in addition to other notable hazards. For further guidance, please refer to the remainder of this manual, the documents identified in Section 1.3, and a project/site specific EHS plan, Hazard Analysis, and Emergency Response Plan.

1.6.1 Electrocution Hazard

Personnel will be exposed to voltages of max 1500 VDC from the SolBank's battery packs. Battery packs cannot be de-energized. Low and medium voltage AC is also present – exposure levels will depend on site specific conditions. Risk of arc flash and electrocution is omnipresent at an ESS site. e-STORAGE encourages full compliance with the practices and procedures indicated in NFPA 70E including use of Personal Protective Equipment (PPE) sufficient to mitigate any hazards identified in a site-specific arc flash study. Emergency Response Personnel should rely on Standard Operating Procedures (SOP) for responding to incidents at electrical generating facilities.

1.6.2 Fire and Explosion Hazard

The SolBank system contains adequate ignition sources and sufficient oxygen that may result in propagation of fire during a thermal runaway event. Fire and other sources of extreme heat, if not properly mitigated, can lead to battery cascading thermal runaway and the release of combustible gases. **These combustible gases, if present in sufficient concentrations, pose a risk of explosion.** If a fire, or other indications of thermal runaway are present within the SolBank or at the ESS site, first responders are advised to maintain a safe perimeter until it can be verified that entry into the ESS site is safe per the ERP and SOP and subject matter experts are available to lead the effort.

1.6.3 Chemical Exposure Hazard

The SolBank contains the following hazards: LFP battery electrolyte, lead acid batteries, R410a refrigerant, and Ethylene Glycol coolant. **These chemicals can be hazardous to both health and environment.** Please refer to the Safety Data Sheets (SDS) contained within Attachment A of this document for hazards and precautions specific to each chemical.

1.7 Product Certification and Compliance

The SolBank is compliant with the standards, regulations, and requirements identified in Table 1

Table 1: SolBank 3.0 Standards Compliance

Classification		Regions	Standards
System	Design regulations	ALL	NEC – National Electrical Code® IEEE C84.1 – Standard Preferred Voltage Ratings for Alternating-Current Electrical Systems IEEE 693 – Recommended Practice for Seismic Design of Substations IEEE 1584-2018 – Guide for Performing Arc-Flash Hazard Calculations NFPA 855 – Installation of Energy Storage Systems NFPA 70E® – Standard for Electrical Safety in the Workplace® NFPA 72 – National Fire Alarm and Signaling Code IEC62933-5-2 – Safety requirements for grid-integrated EES systems - Electrochemical-based systems AS3000 - Electrical installations “Wiring Rules”
	Product certification	NA	IEC 60529 – Degrees of protection provided by enclosure UL 60730-1 – Standard for safety: Automatic Electrical Controls – Part 1:General Requirements NFPA 69® – Standard on Explosion Prevention Systems NFPA 68® – Standard on Explosion Protection by Deflagration Venting UL9540A – Standard for Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems UL1973 – Standard for safety: Batteries For Use In Stationary And Motive Auxiliary Power Applications UL9540 – Standard For safety: Energy Storage Systems And Equipment UN38.3 – Recommendations on the Transport of Dangerous Goods: Manual of Tests and Criteria

	Product certification	EU	IEC62619 – Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries, for use in industrial applications IEC63056 – Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries for use in electrical energy storage systems IEC/EN 62477-1 – Safety requirements for power electronic converter systems and equipment - Part 1: General IEC/EN 61000 – Electromagnetic compatibility (EMC)
Fire Protection and Safety	Design regulation	NA	NFPA 2001 – Standard on Clean Agent Fire Extinguishing Systems NFPA 15 – Standard for Water Spray Fixed System for Fire Protection NFPA 2-2023 – Hydrogen technologies code
		EU	BS 5839-1 – Fire detection and fire alarm systems for buildings BS 7273 -1 – Code of practice for the operation of fire protection measures BS EN 54 Pt1- 21 – series for equipment BS EN 15004-1:-2019 – Fixed firefighting systems. Gas extinguishing systems. Design, installation and maintenance. BS EN 15004-2:2020 – Fixed Firefighting Systems-Gas Extinguishing Systems FK-5-1-12 BS 6266:2011 – Fire protection for electronic equipment installations– Code of practice BS EN 12094-1:2003 – Fixed firefighting systems. Components for gas extinguishing systems Requirements and test methods for electrical automatic control and delay devices
		AUS	AS 4487-2013 – Condensed aerosol fire extinguishing systems – Requirements for system design, installation and commissioning and test methods for components AS 7240– Fire Detection and Alarm Systems

			AS1670 – Fire detection, warning, control and intercom systems – System design, installation and commissioning AS 1851-2012 – Routine service of fire protection systems and equipment

2 Contents

3 Acronyms and Abbreviations

AC – Alternating Current
AHJ – Authority Having Jurisdiction
BMS – Battery Management System
BOL – Beginning of Life
DC – Direct Current
SolBank Controller – LOCAL Energy Management System (Battery system)
EOR – Engineer of Record
ESS – Energy Storage System
COG – Center of Gravity

IFC - Issued for Construction
LFP – Lithium Iron Phosphate
LOTO – Lock-Out-Tag-Out
NFPA – National Fire Protection Association
PCS – Power Conversion System
PPE – Personnel Protective Equipment
SPD – Surge Protection Device
UPS – Uninterruptible Power Supply
EPC – Engineering, Procurement and Construction contractor
CapEx - Capital Expenditures

4 Introduction

4.1 Comprehensive Site Safety and Emergency Response

Development of effective and comprehensive safety procedures and emergency response guidelines requires, among other things, i) analysis of project specific ESS architecture and all components within, ii) site specific risks and hazards, iii) engagement with project stakeholders, iv) and a clear understanding of both customer and fire department Standard Operating Procedures (SOP). e-STORAGE has provided this Safety Manual as an input to these processes and the development of the below recommended project specific documents.

- Environmental, Health, and Safety (EHS) Plan: A living project safety plan which serves as an instructional tool for personnel working on a project, notifying them of hazards as well as procedures required to ensure personnel safety and environmental protections in consideration of such hazards.
- Failure Modes and Effects Analysis (FMEA): A bottom-up analysis which identifies the worst-case effect of component (software and hardware) failure on system performance and safety. An FMEA is similar to a Hazard Analysis. Reference International Electrotechnical Commission (IEC) 60812 for guidelines on how to perform an FMEA.
- Emergency Response Plan (ERP): An ERP leverages the FMEA, EHS Plan, SOPs, and other inputs to develop a project specific plan which dictates the actions to be taken by key project stakeholders in response to an emergency at an ESS site. A copy of the ERP should be kept at the ESS site, at a location accessible to emergency first responders.

4.2 System Overview

The SolBank 3.0 System integrates all power electronics, controls, and safety features required to support the DC side of a battery energy storage system. An overview of the SolBank 3.0 layout and key features is shown in Figure 1 and further described in Table 2.

Figure 1: Layout and features of the SolBank 3.0

Table 2: Description of SolBank 3.0 Safety Equipment and Features

NO.	Name	Remarks
1	Standard Enclosure and Rack	All models of the SolBank3.0 utilize a standard IP55 rated 20'ft HC container and battery rack design allowing for enhanced system modularity.
2	Pack	The SolBank3.0 contains 48 Lithium Iron Phosphate (LFP) battery packs, each consisting of 104 series wired battery cells.
3	Fire Protection System	The SolBank3.0 combines heat, smoke and gas detection with an deflagration and ventilation system.
4	BMS Box	The SolBank3.0 contains 12 BMS boxes. These are easily accessed for installation and maintenance within the middle line of the container. The BMS ensure optimal battery functionality and safety.
5	Liquid Cooling piping	The liquid-cooling piping connecting the chiller to the packs.
6	Cable & Wire	High-voltage connection and low-voltage communication power cable.
7	DMC	The Distribution and Control Cabinet houses all aux power distribution equipment including 2-hour backup UPS; system communication, control, and monitoring hardware including network switch, and Local EMS,and all required customer communication, signal, and aux power interfaces.
8	Chiller	The SolBank3.0's liquid cooling/heating system facilitates improved battery temperature management efficiency relative to traditional forced air systems. Each battery pack is liquid cooled, allowing for greater heat dissipation and uniform cell temperature management. During charge and discharge, cell temperature is maintained between 20°C - 35°C.

5 SolBank 3.0 Safety Systems and Features

5.1 Battery Pack Chemistry and Design

The SolBank contains 48 Lithium Iron Phosphate (LFP) battery packs, each containing 104 LFP cells. During transportation and maintenance, the power harness in series between the battery packs needs to be disconnected. When the power harness is disconnected, the DC voltage in the battery box is only 332.8V, which greatly reduces the risk of fatal electric shock. Note that during normal operation and fully installed, the battery pack nominal voltage can exceed 1331.2Vdc.

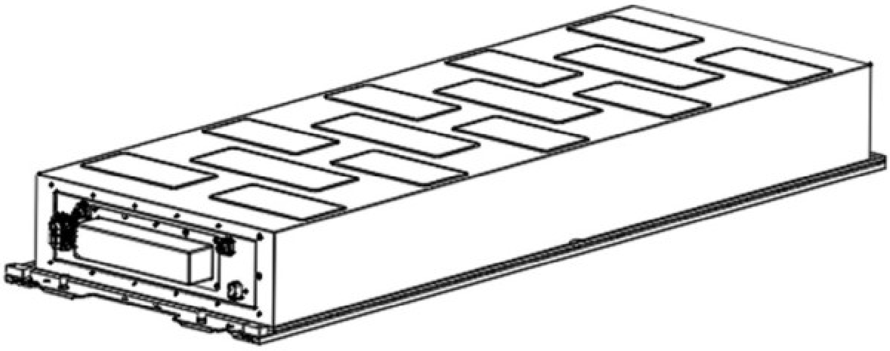

Figure 2: SolBank battery pack. Each battery pack contains 104 battery cells.

5.2 Battery Management System

The SolBank's battery packs are wired as 12 strings of 4 packs, as shown in Figure 3. Each string is controlled and monitored by a dedicated Battery Management System (BMS). The BMS constantly monitors cell and pack level voltage, temperature, State of Charge (SOC), and other parameters to ensure early detection of pre fault conditions, and immediate detection of fault events. Should any parameter exceed a permissible value, the BMS will disconnect the effected string and surface an alarm to the site EMS.

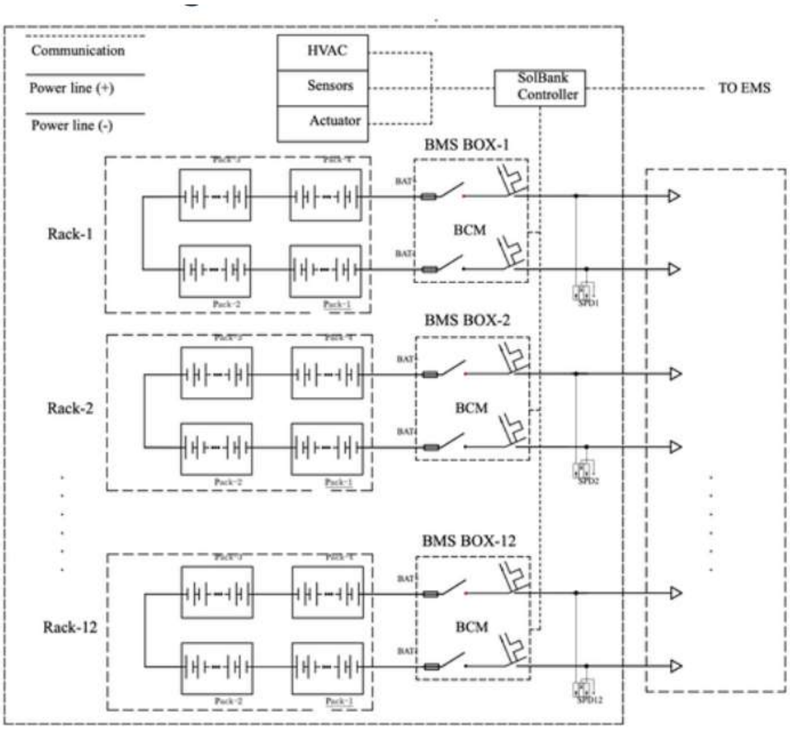

Figure 3: SolBank String Wiring. Each string consists of 4 battery packs and a single BMS.

5.3 Access Door Travel Switch

The external access door on the SolBank has integrated position sensors. When the external access door is opened during system operation, the SolBank will immediately shut down and all BMS will isolate their battery strings from the main system bus.

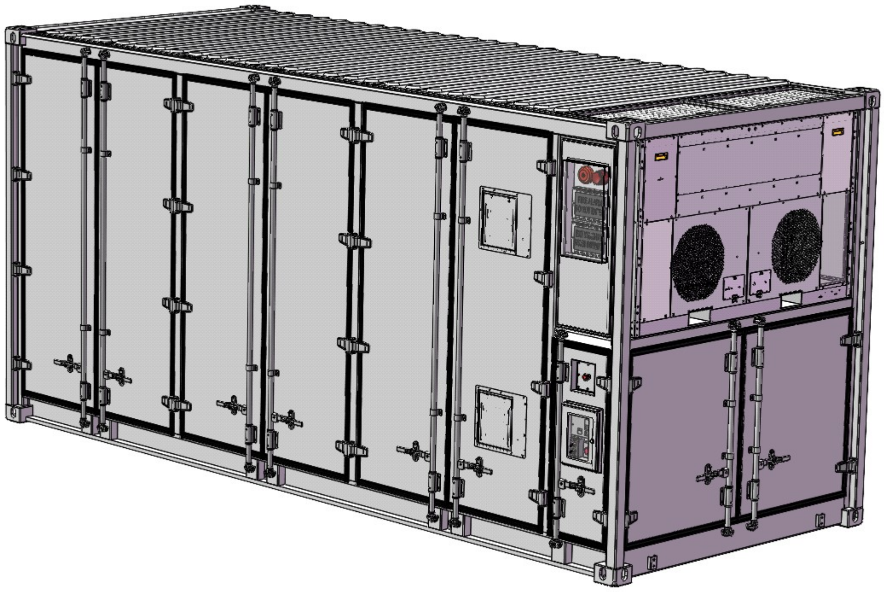

Figure 4: The position of external access door

5.4 F-Stop

Each SolBank contains two F-Stop buttons on each end of the enclosure. When pushed, the SolBank will immediately commence shut down, and all BMS will isolate their battery strings from the main system bus. See Figure 7 and Section 7.1.1 for additional details.

5.5 Fire Detection and Alarming

The SolBank is equipped with smoke and heat detectors calibrated to detect early signs of fire within the SolBank. The spot-type smoke detector is calibrated to 3.5%/ft. The temperature threshold of the heat detector is 85°C. Both detectors are ceiling mounted as indicated in Figure 7. The SolBank contains both an audible fire alarm and visual fire strobe. If the smoke and heat detectors are triggered, both alarms will activate, and corresponding alarms will be sent to the ESS EMS.
The fire alarm logic is shown in the Table 3.
The SolBank is equipped with combustible gas detection sensor and two off-gassing valves. The combustible gas detector is calibrated to 10%-20% LEL. If the combustible gas sensor is triggered, both alarms will activate, and the two off-gassing valves will be opened for exhaust. Corresponding alarms will be sent to the EMS.

Combustible gas level 1 alarm	Combustible gas level 2 alarm	Smoke detector alarm	Heat detector alarm	ventilation Fan	Alarm Bell	Alarm Horn-Strobe	Aerosol Based Fire Suppression[1]	Running status of the energy storage system
×	×	×	×	Close	Close	Close	Close	No fire alarm, the system runs normally

√	×	×	×	Open	Open	Close	Close	Combustible level 1 alarm, the system does not charge and discharge, auxiliary AC switch and DC contactor are closed
√	√	×	×	Open	Open	Close	Close	Combustible level 2 alarm, the system does not charge and discharge, auxiliary AC switch and DC contactor are disconnected
×	×	√	×	Close	Open	Close	Close	Fire alarm level 1, the system does not charge and discharge, auxiliary AC switch and DC contactor are closed
√	×	√	×	Open	Open	Close	Close	Combustible, fire alarm level 1, the system is prohibited to charge and discharge, auxiliary AC switch and DC contactor are closed
√	√	√	×	Open	Open	Close	Close	Combustible alarm level 2, fire alarm level 1, the system is forbidden to charge and discharge, auxiliary AC switch and DC contactor are disconnected
×	×	×	√	Close	Open	Close	Close	Fire alarm level 1, the system does not charge and discharge, auxiliary AC switch and DC contactor are closed
√	×	×	√	Open	Open	Close	Close	Combustible, fire alarm level 1, the system is prohibited to charge and discharge, auxiliary AC switch and DC contactor are closed
√	√	×	√	Open	Open	Close	Close	Combustible alarm level 2, fire alarm level 1, the system is forbidden to charge and discharge, auxiliary AC switch and DC contactor are disconnected
×	×	√	√	Close	Open	Open	Open	Fire alarm level 2, the system does not charge and discharge, auxiliary AC switch and DC contactor are disconnected

√	×	√	√	Open	Open	Open	Close	Combustible level 1, fire level 2 alarm, the system forbid charging and discharging, auxiliary AC switch and DC contactor are disconnected
√	√	√	√	Open	Open	Open	Close	Combustible level 2, fire level 2 alarm, the system forbid charging and discharging, auxiliary AC switch and DC contactor are disconnected

Table 3: Fire alarm Sequence of Operations

Note: (1) Applicable to aerosol solution only

6 SolBank Hazards

The primary hazards associated with installation and operation of the SolBank are indicated in Table 4 and discussed in the following sections.

Table 4: SolBank primary hazards

Classify	HAZARD	DESCRIPTION	QUANTITY	RISK
Electrical hazards	DC voltage	Primary voltage of storage system	1500VDC	Electrocution
	AC voltage	Primary voltage of auxiliary power supply	480VAC(US) 400VAC(EU)	Electrocution
Chemical hazards	Ethylene Glycol	Coolant used in battery liquid cooling system	200L (52.8gal)	See Attachment
	R134a(R513a optinal) Refrigerant	Refrigerant used in Chiller system	8kg (17.6lbs) of R134a (R513a optional) refrigerant	See Attachment
	Li-ion Electrolyte	Battery electrolyte used in LFP battery cells	4575L (1208.6gal)	See Attachment
	Lead Acid Electrolyte	Battery electrolyte used in UPS	0.3L(0.079gal)	See Attachment
Fire & Explosion Hazards	Electrical Fire	Fire caused by cable fault or component failure		Fire
	Thermal Runaway	Thermal runaway from battery fault or heat		Fire, off-gassing
	Battery off-gassing	Off-gassing resulting from thermal runaway		Explosion

6.1 Electrical Hazards

Please refer to site level arc flash study and arc flash label for site specific details. Following with product generic notes.

6.1.1 DC Voltage

Hazard: Exposure to 1500VDC
As shown in Figure 3, the SolBank's 48 battery packs are wired as 12 strings of 4 packs. Each SolBank pack has a maximum DC voltage of 379.6 VDC. When wired in a series string of 4 packs, the total voltage increases to 1331.2 VDC. Charging voltage can be as high as 1500VDC. Risk of electrocution exists.
Location: When system is shutdown, high DC voltage is present at the terminals of each battery and BMS. When the system is started or on-line, each BMS will close the string disconnect, and energize the main DC bus of the SolBank. If the system primary disconnect is closed, the conductors between the SolBank and DC terminals of the PCS will also be energized.

6.1.2 AC Voltage

Hazard: Exposure to 480VAC (400VAC(EU))
The SolBank's auxiliary power system, which includes Chiller systems, control systems, and other system support equipment, operates of 480VAC(400VAC(EU)). Risk of electrocution exists.
Location: 480VAC(400VAC(EU)). aux power feed is routed into the bottom of the SolBank Distribution

Management Cabinet shown in Figure 1. 480VAC supplies Chiller loads contained in the Chiller cabinet as well as a 480VAC/277VAC step-down transformer, which in turn supplies other loads through the SolBank.

6.2 Chemical Hazards

6.2.1 Ethylene Glycol Coolant

Hazard: Exposure to hazardous chemicals
The SolBank's liquid cooling and heating system circulates an Ethylene Glycol solution from the Chiller cabinet to each battery pack in the system. The solution consists of 40% water and 60% Ethylene Glycol. which is not combustible but does pose a health risk when exposed to personnel in sufficient quantity. See the safety data sheet (SDS) contained in Attachment for further details.
Location: Ethylene Glycol circulates throughout the supply and return lines shown in Figure 5.

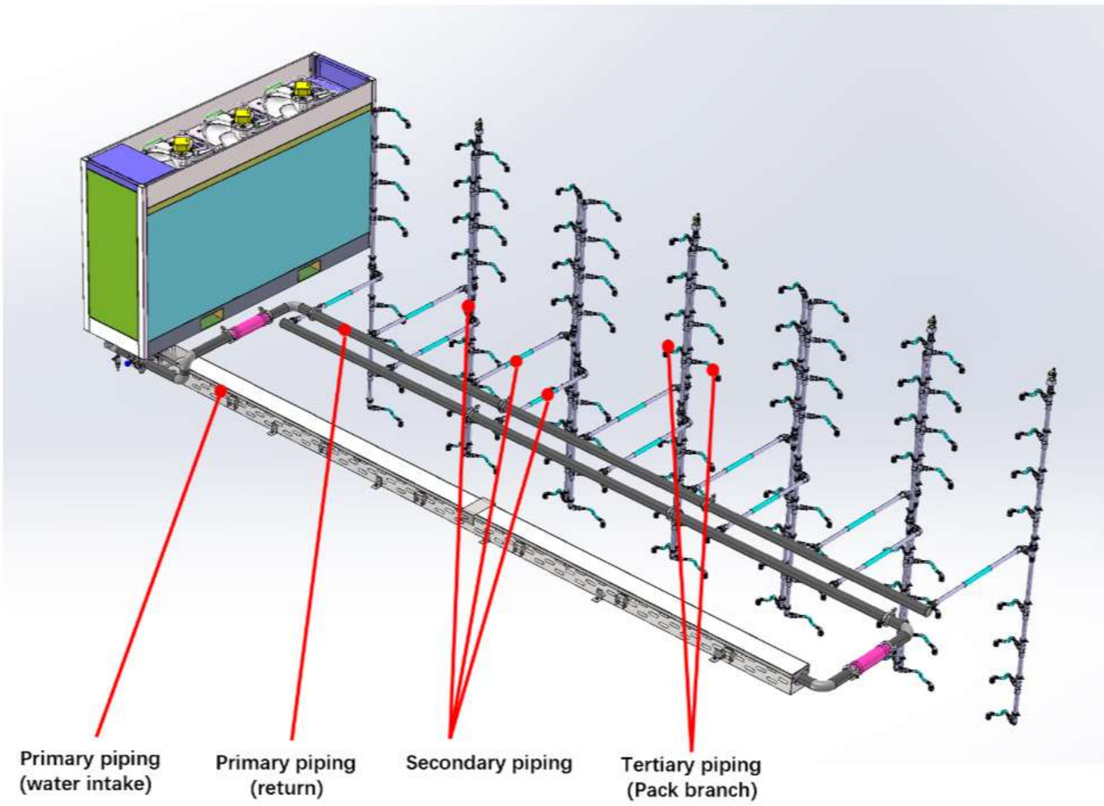

Figure 5: Coolant distribution schematic

6.2.2 R134a (R513a optional) Refrigerant

Hazard: Exposure to hazardous chemicals
The SolBank's air conditioning system circulates R134a (R513a optional) refrigerant to the entire Chiller system. R134a (R513a optional) can be combustible under certain circumstances and does pose a health risk when exposed to personnel in sufficient quantity. See the safety data sheet (SDS) contained in Attachment A for further details.

Location: R134a (R513a optional) circulates throughout the Chiller shown in Figure 6. Compressor and other supporting equipment can be found in the Chiller cabinet.

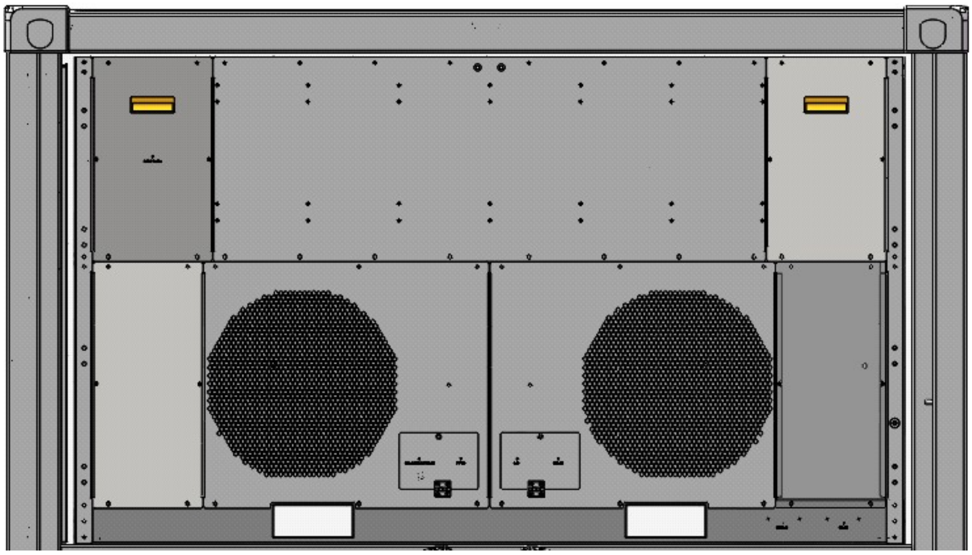

Figure 6: SolBank's Chiller system

6.2.3 Lithium-Ion Electrolyte

Hazard: Exposure to hazardous chemicals

The electrolyte contained within the SolBank battery packs consist of a volatile hydrocarbon-based liquid and a dissolved lithium salt such as lithium hexafluorophosphate. The electrolyte solution can be combustible under certain circumstances and does pose a health risk when exposed to personnel. See the safety data sheet (SDS) contained in Attachment for further details. Additional materials used in the construction of the LFP battery pack are indicated in Table 5.

Location: 4575L (1208.6gal) of electrolyte is contained within the SolBank's 48 battery packs (4992 battery cells). The battery packs are located within the 6 steel racks shown in Figure 1.

Table 5: Non-electrolyte materials incell

No.	Materials/Ingredients	Approx. % by wt.
1	Carbon	12%
2	Lithium Iron Phosphate	40%
3	Aluminum	3%
4	Copper	7%

6.2.4 Lead Acid Electrolyte

Hazard: Exposure to hazardous chemicals

The electrolyte contained within the SolBank's UPS and fire panel consist of a sulfuric acid electrolyte. The electrolyte solution does not combust easily but does pose a health risk when exposed to personnel. See the safety data sheet (SDS) contained in Attachment for further details.

Location: The Lead Acid Electrolyte is contained within the SolBank's UPS and fire panel which is in the electrical cabinet.

6.3 Fire & Explosion Hazards

6.3.1 Electrical Fire

As a result of short circuit, failed OCPD (over-current protection device), or other electrical component failure, electrical fires are possible within the SolBank.

6.3.2 Thermal Runaway and Battery Fire

Due to excessive heat build-up from external sources (i.e. electrical fire), or internal cell failure, it is possible that one, or many of the SolBank's LFP cells may be pushed into a state of thermal runaway. Once this occur, the design of the LFP cell and battery pack is designed to reduce the propagation of thermal runaway to adjacent cells, a process called "cascading thermal runaway."

6.3.3 Explosion of Battery Off Gas

When Li-ion batteries go into thermal runaway, toxic and combustible gases are released in a process called off-gassing. During cascading thermal runaway events, when many cells are consumed, sufficient gas can build up within a confined space to create conditions sufficient for explosion.

7 Emergency Response

7.1 Emergency System Shutdown

In the event of an emergency on site, the SolBank can be shut down locally, or remotely. A system shutdown will result in electrical isolation of the battery strings and cessation of battery charging or discharging. A system shutdown will not de-energize the battery bank, nor will it guarantee that a fault or thermal runaway event has been stopped. Do not open the SolBank until deemed safe to do so by an individual qualified to direct such decision.
Procedures for shutdown of the site and isolation from the grid should be dictated within the ERP.

7.1.1 Local Emergency Shutdown

If safe to approach the SolBank (See the symptom described in 7.2.1), as agreed upon by all stakeholders and per the project Emergency Response Plan, SOPs, Emergency Incident Commander, or other qualified on-site personnel, the F-stop button located on either end of the SolBank can be pushed. See Figure 7 for the location of the F-stop buttons. This should only be done if remote shutdown is not possible.
When the F-stop is pushed, the SolBank BMSs will disconnect all battery strings from the main system bus, thereby stopping all charging and discharging. Simultaneously, the plant PCS will shut down if properly configured to do so.

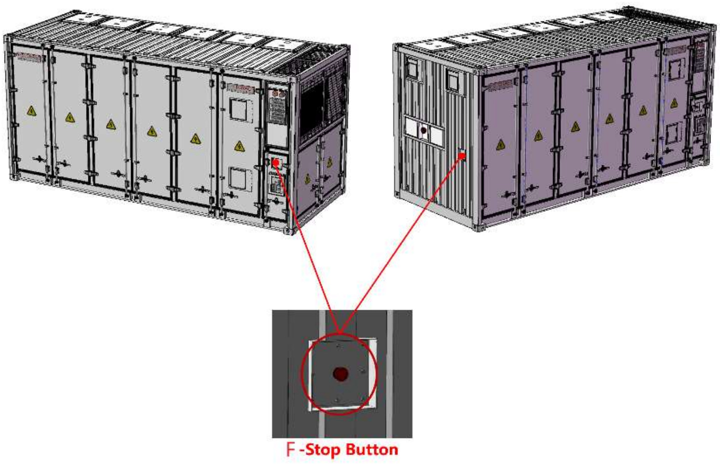

Figure 7: Location of F-stop, fire sensing, and alarms.

Pressing the F-stop while charging and discharging places considerable stress on the system. Only use the F-Stop to stop the system during an emergency. Before restarting the system, the F-stop must be pulled out to its original position.

If indications of a fire within the SolBank exists, such as smoke emanating from the SolBank, or activation of the fire alarm strobe, it is recommended to immediately evacuate the area and maintain a safe perimeter. System shut down should be attempted remotely as described in Section 7.1.2. Do not open the SolBank access doors.

7.1.2 Remote System Shutdown

During normal operation, the SolBank will be under the control of a site Energy Management System (EMS). The EMS in turn will communicate with, and be controlled by, an offsite fleet controller, SCADA operations center, or other third-party dispatch and monitoring entity. SolBank alarms will be forwarded to such remote operations, and in turn, remote operations personnel can shut down the SolBank if determined to be necessary.
On-site personnel witnessing an emergency should not however assume automated alarms have

reached the EMS or that they have been passed onto remote operations. Such personnel are advised to first call 911, and then contact remote operations directly in addition to other key stakeholders identified in the ERP.

7.2 Fire Alarm Response

7.2.1 Initial Indications of fire

If any of the below is observed, personnel should immediately evacuate the area, contact 911, and notify all stakeholders as defined within the ERP. **Do not open the SolBank access doors under any circumstance.**

- Acrid burning or sweet smell
- Excessively hot access door handles or outer surfaces
- Unusual sounds indicating electrical arcing, cell venting (popping), or combusting materials Triggered audible or visual fire alarm
- Smoke emanating from the SolBank

7.2.2 Establish Secure Perimeter and Monitor

In the event of a fire, or indication of a fire within the SolBank, e-STORAGE recommends that first responders establish a secure perimeter, monitor, and approach only when determined safe to do so by an incident commander or other qualified authority. **No direct suppression tactics are advised by e-STORAGE.**

7.2.2.1 Establish a Perimeter

The circumference of such perimeter should be calculated as part of a project specific ERP. Variables analyzed should include, wind direction, proximity to other buildings and sensitive areas (schools, etc), and the potential blast radius should a cascading thermal runaway result in accumulation and ignition of explosive gases.

7.2.2.2 Monitor

In the absence of a justified reason to enter the site (i.e. entrapment of personnel), it is advised that emergency first responders not take direct action to suppress the fire. A communication link should be established with the remote system operator to obtain data regarding system status if available. Battery/cell status, temperature, and voltage trends should be observed to quantify scope of event and conditions within the affected and adjacent SolBanks. IR cameras can also be used to evaluate hot spots and decreasing/increasing temperatures. Note, a battery fire may continue for 24 hours or longer and can re-ignite later due to a number of reasons.

If deemed appropriate and safe to do so by the incident commander, water can be applied to the SolBank and adjacent structures to prevent fire spread. Such processes should be clearly indicated in the ERP and incorporated into fire department and customer SOPs.

7.2.2.3 Direct Suppression

It is outside the scope of this manual to advise on means and methods for direct suppression of Li-ion fires. Again, e-STORAGE does not advise direct firefighting tactics. e-STORAGE does however offer the following general information for consideration should it be necessary to take a direct suppression approach:

- Foam and other chemical agents will not be effective. Foam suppressants may trap heat and increase rate of propagation.
- Ventilation of internal areas of the SolBank is essential to ensuring the absence of accumulated explosive gases. Firefighters are advised to not open access doors until it can be confirmed that combustible gas have been reduced to a safe value, the exhaust valve has been opened and the

exhaust fans have reduced the concentration to below flammable limits. All stakeholders should agree to this action.

- Approaching the SolBank from the sides without access doors may minimize injury in the event of explosion.
- Testing on similar batteries has shown that under some conditions, fogging patterns from fire hoses may be effective at managing off-gas clouds from the batteries, especially in conditions where the offgas is lazy, hugging the ground, or not dispersing well on it’s own.
- A large amount of water is used to cool the fire point. At the same time, a large amount of water is used to cool and isolate the surrounding of the fire point.

8 Other System Precautions

8.1 Storage Precautions

Should the SolBank or Li-ion battery pack require storage for extended periods of time, the following is advised:
1. Storage temperature shall be between -20°C and 45°C. Elevated temperatures can result in increased capacity degradation and/or fire danger. Contact e-STORAGE if short duration storage is anticipated to exceed the above limits for reasons outside the installer/owner's control.
2. Batteries should be stored at a humidity <85% and protected from moisture, condensation, and flooding.
3. Batteries should be stored between 25%-60% SOC to prevent accelerated capacity degradation.
4. Battery system, and sub-assemblies should be stored in approved packaging.
5. Storage facility should be compliant with the appropriate local fire code requirements.
6. Acceptable storage density of battery packs and storage height of battery packs shall be defined by the local authority having jurisdiction (AHJ). Requirements and limits will be based upon a number of factors including the structural and fire protection characteristics of the storage area and recommendations for fire protection promulgated by the National Fire Protection Association (NFPA).

8.2 Installation, Operation, and Maintenance Precautions

Numerous safety hazards exist during the installation, operation, and maintenance of the SolBank. Please refer to the relevant manuals identified in Section 1.3 for further details.

8.3 Handling, Storage, and Transportation of Damaged Goods

If a battery pack has been damaged (battery enclosure has been dented or broken), it is possible that heating is occurring that may eventually lead to a fire. Damaged cells/batteries can result in the release of combustible vapors, and propagation of thermal runaway reactions to neighboring packs.

The damaged battery pack must be isolated with a space of 5 meters free of inflammable and explosive materials.Please contact e-STORAGE Service team.

A damaged battery pack should be monitored during storage for evidence of smoke, flame, leakage of electrolyte or signs of heat. If full-time monitoring of the damaged product is not possible (for example during extended storage), the damaged product should be moved to a safe storage location.

A safe storage location for a damaged battery pack will be free of combustible materials, accessible only by trained professionals. Do not store a damaged battery pack adjacent to undamaged products.

8.4 Disposal Procedures

Batteries at the end of their service life should be disposed of or recycled in accordance with local, state, and federal regulations. Note that regulations regarding disposal of batteries vary by jurisdiction. In the United States, batteries are classified as "Universal Waste", and in addition, many individual states have specific regulations regarding disposal of battery packs. For example, in California, all batteries must be taken to a Universal Waste handler or authorized recycling facility.

e-STORAGE Lithium-ion Batteries contain recyclable materials. e-STORAGE lithium-ion batteries do not contain heavy metals such as lead, cadmium, or mercury. e-STORAGE strongly encourages recycling. Please consult with local, state and/or federal authorities on the appropriate methods for disposal and recycling.

8.5 Transportation Information

Lithium-ion batteries are regulated as Class 9 Miscellaneous dangerous goods (also known as "hazardous materials") pursuant to the International Civil Aviation Organization (ICAO) Technical Instructions for the Safe Transport of Dangerous Goods by Air, International Air Transport Association (IATA) Dangerous Goods Regulations, the International Maritime Dangerous Goods (IMDG) Code, European Agreements concerning the International Carriage of Dangerous Goods by Rail (RID) and Road (ADR), and applicable national regulations such as the USA's hazardous materials regulations. These regulations contain very specific packaging, labeling, marking, and documentation requirements. The regulations also require that individuals involved in the preparation of dangerous goods for transport be trained on how to properly package, label, mark and prepare shipping documents.

Table 6: Transportation of SolBank

UN Number	3536
Proper Shipping Name	Lithium-ion Batteries
Hazard Classification	Class 9 Miscellaneous
Packing Group	N/A

Attachment: Safety Data Sheets (SDSs)

Please refer to applicable Safety Data Sheets (SDSs) as part of the UN38.3 reports per specific product model used for each project or application.