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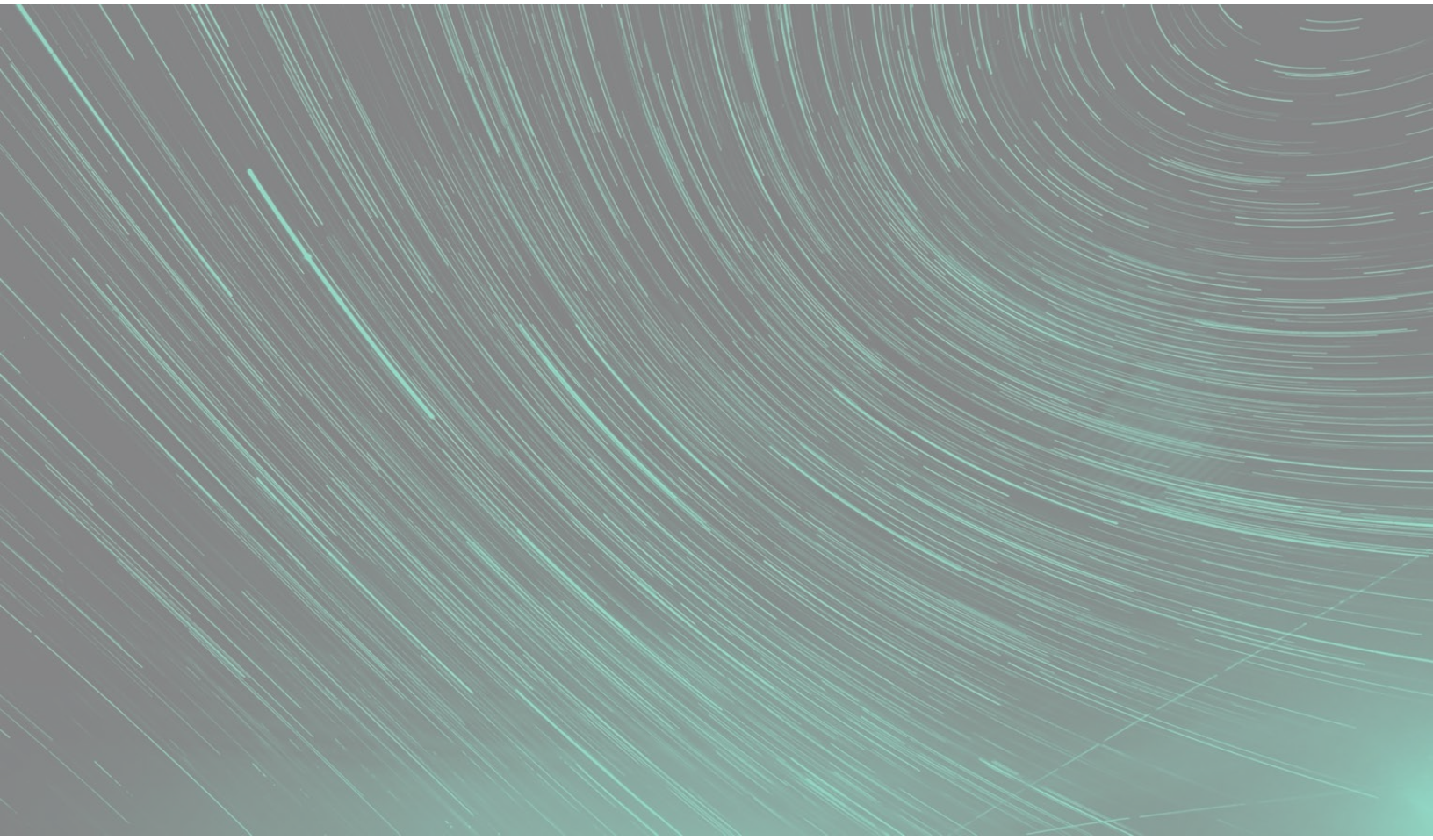

October 2021

LITHIUM-ION BATTERY EMERGENCY RESPONSE GUIDE

FOR POWIN PRODUCTS INCLUDING STACKS, SMART ENCLOSURES AND CENTIPEDE

CONFIDENTIAL

Powin

Powin has pioneered a cost-effective, safe and scalable battery energy storage system (BESS) that is purpose-built for the demands of utility scale, commercial and industrial, and microgrid applications. Our BESS also features a modular architecture and streamlined installation process. Behind our industry-leading products is an unrivaled team of experts from across the energy industry, almost three decades of supply chain management expertise and extensive battery management software development proficiency.

Disclaimer

The specifications and descriptions contained in this document are verified to be as accurate as possible at the time of publication. However, because Powin's products and their performance are constantly evolving, Powin reserves the right to make product or documentation modifications at any time, with or without notice.

The images provided in this document are for demonstration purposes only. Details may vary by product version and geography.

This document does not create contractual obligations for Powin or its affiliates, except to the extent expressly agreed in a contract.

To communicate any inaccuracies or omissions in this document, please send an email to: *documentation@powin.com*.

Powin

20550 Southwest 115th Avenue
Tualatin, OR 97062

powin.com

IN CASE OF AN EMERGENCY:
Contact the Remote Operations Center immediately at:

Phone: **1-(855)-888-3659** (24/7 coverage)
Email: service@powin.com (24/7 coverage)

For any questions regarding the safe use and maintenance of this product, please contact Customer Support at:

Phone: **1 (503) 598-6659**
Email: contact@powin.com

For any questions regarding the safe transport of this product, please contact Powin at:

Phone: **1 (503) 673-3246**

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1.0 Purpose

This Emergency Response Guide (ERG) is a resource for Authorities Having Jurisdiction (AHJs) and emergency responders in regards to Powin BESS products.

2.0 Scope

This ERG applies to Powin's latest generation of Stacks, Smart Enclosures, and Centipede, including Stack225, Stack230P/E, Stack360P/E and Stack 750E.

3.0 Company and Emergency Contact Information

POWIN	Headquarters	20550 Southwest 115th Avenue Tualatin, OR 97062	
	Customer Support	Phone: **1 (503) 598-6659** Email: contact@powin.com	Do **NOT** use for emergencies.
EMERGENCY CONTACTS	Remote Operations Center (ROC)	In case of an emergency, contact the ROC immediately at: Phone: **1 (855)-888-3659** (24/7 coverage) Email: service@powin.com (24/7 coverage)	
	First Responders	Phone: **911**	
	Hazmat Responders	For a hazardous materials (or dangerous goods) incident, such as a spill, leak, fire, exposure, or accident, call ChemTel and Powin's Transportation and Safety at: ChemTel: **1 (888) 255-3924** (24/7 coverage) Powin Transportation and Safety: **1 (503) 673-3246** (24/7 coverage)	

4.0 Product Information

Powin BESS products contain prismatic, lithium-ion phosphate/graphite (LFP) battery cells. The LFP cells DO NOT contain lithium metal. LFP cells are generally considered the safest lithium-ion chemistry available today.

The LFP cells used in Powin BESS products are approximately 2.82 x 6.85 x 8.16 inches (in) or 71.57 x 173.9 x 207.3 millimeters (mm). Electrical ratings of the LFP cells are 3.2 volts (nominal) and 280-amp hour (Ah).

Individual LFP cells are connected to form Stacks. Stacks are then connected in parallel inside Smart Enclosures or Centipede Segments to provide larger energy capacities.

A summary of the approximate specifications of the Stacks, Smart Enclosures, and Centipede Segments are listed below. In addition, more details for each product can be found in their respective data sheets and product manuals.

Table 1. Powin Product Specifications

PRODUCT	SOC (SHIPPED)	MAX SYSTEM DC VOLTAGE	WEIGHT	DIMENSIONS
STACK225	30%	954.2 V	4,997 lbs. (2,266 kg)	52" W x 38.1" D x 76.8" H (1,320 mm x 968 mm x 1950 mm)
STACK230P/E		937 V	5,000 lbs. (2,273 kg)	4'4" W x 3'2" D x 6'5" H (1,321 mm x 965 mm x 1,956 mm)
STACK360P/E		1,470 V	7,500 lbs. (3,409 kg)	6'2" W x 3'2" D x 6'5" H (1,880 mm x 965 mm x 1,956 mm)
40-FOOT SMART ENCLOSURE		937 V	90,500 lbs. (41,050 kg)	40' L x 8' W x 9'6" H (12.19 m x 2.44 m x 2.90 m)
53-FOOT SMART ENCLOSURE		937[1] V 1,470[2] V	126,415[1] lbs. (57,461 kg) 136,315[2] lbs. (61,691 kg)	53' L x 8' W x 9'6" H (12.19 m x 2.44 m x 2.90 m)
STACK 750E CENTIPEDE		1,210 V - 1,491 V	20,000 lbs. (9,091 kg)	8'1" W x 5'2" D x 10'8" H (2,443 mm x 1,572 mm x 3,282 mm)

1. When populated with Stack230P/E
2. When populated with Stack360P/E

5.0 SDS Information

Powin BESS products contain sealed, lithium-ion battery cells that are composed of lithium iron phosphate (LiFePO4). In addition, the Smart Enclosures use an R134A: 1,1,1,2-Tetrafluoroethane refrigerant in the HVAC units installed outside of the enclosures and the same refrigerant is used in the HVAC units located in the top cap of a Centipede Segment. Safety Data Sheets (SDS) for the lithium-ion cells and refrigerant are available upon request.

6.0 Hazard Precautions

6.1 General Precautions

Powin BESS products contain LFP battery cells that are connected to form large-format batteries. A battery is a source of energy and can be dangerous if mishandled. Under normal use conditions, the LFP battery cell electrode materials and electrolyte are not exposed. However, risk of exposure to those materials or the battery energy source may occur in cases of abuse such as mechanical, thermal, electrical, or environmental. Injury to property or person (including loss of life) is possible, if these products are mishandled. Do not short circuit, puncture, incinerate, crush, immerse, force discharge, or expose the BESS products to temperatures above the listed operating temperature range of the product.

6.2 High-Voltage Electrical Hazard

WARNING: DANGER – Hazardous Voltage and Arc Flash Hazard

Never cut into a Powin BESS product, including a Stack, Smart Enclosure, or Centipede Segment. Damaging internal components by cutting into a BESS Product could produce an arc flash reaction or thermal runaway condition.

LFP batteries are **ALWAYS LIVE** and present an electrical hazard even when disconnected, powered off, or in a discharged condition. Consider them LIVE and dangerous unless formal Lockout/Tagout has been achieved and verified by qualified personnel.

AVERTISSEMENT : DANGER - Tension dangereuse et risques d'arc électrique

Ne coupez jamais dans un produit Powin BESS, y compris un segment Stack, Smart Enclosure, ou Centipede. L'endommagement des composants internes en coupant dans un produit BESS pourrait produire une réaction d'arc électrique ou un emballement thermique.

Les batteries LFP sont TOUJOURS SOUS TENSION et présentent un risque électrique même lorsqu'elles sont déconnectées, éteintes ou déchargées. Considérez-les sous tension et dangereux à moins que le verrouillage / étiquetage formel n'ait été réalisé et vérifié par un personnel qualifié.

Under normal use conditions, handling the Powin BESS products does not pose an electrical hazard. Numerous safeguards, including Stack-level fusing and automatic disconnects, prevent electrical faults from propagating and minimize arc flash potential. These safeguards, among others, have been designed into the products to help ensure that the high voltage battery is kept safe and secure during anticipated abuse conditions. However, Powin's BESS products contain LFP batteries that are **ALWAYS LIVE** and present an electrical hazard even when disconnected and powered off or in a discharged condition. **Voltages of up to** 1.5 kV (DC) (AC) can be achieved within the products. These may pose a significant high voltage and electrocution risk if the outer enclosure of the Stack / Smart Enclosure / Centipede has been damaged or compromised or the safety circuits within BESS products

have been damaged or compromised. 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. If a Powin BESS Product has been visibly damaged or its outer enclosure has been compromised, practice appropriate high-voltage preventative measures until the danger has been assessed (and dissipated if necessary).

For proper installation / removal instructions please contact Powin's ROC team.

6.3 Mechanical Hazards

Mechanical damage to a Powin BESS product can result in a several hazardous conditions including, but not limited to:

- Coolant leak
- Refrigerant leak
- LFP cell electrolyte leak
- LFP cell thermal runaway (the rapid heating of individual cells due to exothermic reaction of constituent materials) with or without propagation of self-heating and thermal runaway reactions to neighboring cells.
- Cell venting
- Fire

To prevent mechanical damage to Powin BESS products, they should be handled, used, and stored (in their original packaging when not in use or prior to being installed) in accordance with their installation guide at all times.

Reference the Fire & Off-Gas Emergency Procedure (PE-Fire-Gas-2) for additional information.

6.4 Elevated Temperatures

Powin BESS products are designed to withstand operating ambient temperatures up to 113°F (45°C) and up to 85% humidity with no condensation.

Powin BESS products exposed to temperatures beyond what is listed above can degrade the battery, resulting in reduced battery service life or, possibly, failure or damage to the LFP cells themselves and should be avoided. This can lead to cells going into thermal runaway and possibly a fire or other thermal event. In addition, exposing the BESS products to heating equipment, localized heat sources, flames or sparks could result in cell thermal runaway reactions and should also be avoided.

6.5 Refrigerant Leak

WARNING: DANGER – Poison/Corrosive Hazard

Avoid contact with any leaked refrigerant

AVERTISSEMENT : DANGER - Risque de poison/corrosion

Évitez tout contact avec tout réfrigérant qui fuit.

HVACs mounted on the ends (outside) of the Smart Enclosure or inside the top cap of a Centipede Segment contain refrigerant. Leaks of the refrigerant are unlikely to enter the Smart Enclosure or Centipede Segment. However, avoid contact with the refrigerant should a leak occur.

6.6 Electrolyte Leak

WARNING: Corrosion Hazard, Fire Hazard, and Vented Gas Hazard

Avoid contact with any leaked electrolyte.

If an electrolyte leak is suspected, evacuate the area immediately and ventilate the space.

AVERTISSEMENT : DANGER - Risque de corrosion, risque d'incendie et risque de gaz évacué

Évitez tout contact avec un électrolyte qui fuit.

Si une fuite d'électrolyte est suspectée, évacuez immédiatement la zone et aérez l'espace.

The electrolyte within LFP cells includes a volatile hydrocarbon-based liquid and a dissolved lithium salt (which is a source of the lithium ions). The electrolyte in LFP cells incorporated into Powin BESS products is largely absorbed in the electrodes within the individual cells. In practical terms, there is no liquid electrolyte that is freely flowing within an LFP cell that can easily leak out into the environment if the cell is damaged.

In addition, each cell includes a rigid aluminum exterior providing an added degree of protection against external impacts. Because of this, it is very difficult to mechanically damage an LFP cell resulting in a leak of electrolyte material, and the likelihood of an electrolyte spill from a Powin BESS product is very small.

However, it can occur under extreme abuse conditions, such as a severe crush. Modules of LFP cells are isolated from each other by steel barriers within the BESS products, which act as structural members of the racking system and de facto thermal barriers between modules. These modules are stacked on the steel racking and are enclosed by an IP-21/56 steel enclosure. Each IP-21/56 steel enclosure has the capacity to contain the liquid from a large number of LFP cells should there be a leak involving multiple cells.

For the electrolyte liquid to come into contact with a user of a Powin BESS product, the cell, steel barriers/racking, and steel external enclosure would have to be significantly damaged, crushed or mechanically struck. Given the architecture and design of the LFP cell and the design and construction of the BESS products around those cells, Powin BESS products do not pose a significant liquid electrolyte release hazard.

Should there ever be a liquid electrolyte leak, the material typically evaporates quickly, leaving a white salt residue behind rather than collecting or pooling up on a surface. The liquid electrolyte is colorless and its vapors are usually identified as having a sweet odor that is obvious to the person nearby. If an odor is detected or if a liquid is observed that is suspected to be electrolyte, evacuate the area, and activate the system's Emergency Ventilation Mode to ventilate the area as the electrolyte vapors are flammable.

In addition to being flammable, the liquid electrolyte can be corrosive, irritating to the eyes and skin, and could cause chemical burns to the skin. As such, avoid contact with the liquid until a positive identification can be made and sufficient personal protective equipment (PPE) can be obtained (eye, skin, and respiratory protection).

Identification of the electrolyte can typically be obtained by using chemical classifier strips on the liquid electrolyte. LFP cell electrolyte will contain petroleum/organic solvent and fluoride compounds. If it is determined that the liquid is electrolyte, protective clothing covering up exposed skin, an air-purifying respirator with organic vapor/acid gas cartridges, safety goggles or a full-face respirator, and safety gloves (Butyl rubber or laminated film) should be worn before cleaning up the liquid. To clean up the liquid, use a dry absorbent material.

At this time, an acceptable exposure concentration of lithium-ion electrolyte has not been identified by the American Council of Governmental Industrial Hygienists (ACGIH). Care should always be taken when coming in contact with the liquid electrolyte.

6.7 Vented Gases

WARNING: DANGER – Poisonous Atmosphere/Vented Gas Hazard, Corrosion Hazard, and Fire Hazard

Avoid contact with vented gasses.

A Powin BESS product that is suspected of venting should only be approached by trained First Responders equipped with appropriate personal protective equipment (PPE), as discussed in Firefighter PPE.

AVERTISSEMENT : DANGER - Atmosphère toxique/danger de gaz évacué, risque de corrosion et risque d'incendie

Évitez tout contact avec des gaz ventilés.

Un produit Powin BESS suspecté d'être ventilé ne doit être approché que par des premiers intervenants formés et équipés d'un équipement de protection individuelle (EPI) approprié, comme indiqué dans EPI des pompiers.

Unlike other battery types, under normal usage conditions, venting of electrolyte should not occur in an LFP cell. However, if they are subjected to abusive conditions or external heating, an LFP cell can vent its electrolyte and electrolyte decomposition products as vapors. Each LFP cell includes a safety vent to provide a controlled release of internal pressure during abnormal conditions and a rigid aluminum exterior provides an added degree of protection against external impacts.

Venting gases is a common early indicator of a thermal runaway reaction of an LFP cell. Thermal runaway is the condition when an electro-chemical cell increases its temperature through self-heating in an uncontrollable fashion and progresses when the cell's heat generation is at a higher rate than it can dissipate, potentially leading to off-gassing, fire, or explosion.

Irritation of the eyes, skin, and throat may occur if you come in contact with vented gases. In addition, vented gases can cause thermal burns as, upon exiting from an LFP cell, vent gas temperatures can exceed 1,100°F (600°C). Avoid contact with vented gases at all times.

The vented gases are also flammable and may ignite on contact with a competent ignition source such as an open flame, spark, or a hot surface. Vented electrolyte may also ignite on contact with other LFP cells that are undergoing a thermal runaway reaction.

If gases or smoke are observed escaping from a Powin BESS product, evacuate the area as the gases or smoke are likely flammable and could ignite unexpectedly. Immediately notify the Emergency Response Coordinator (ERC), the Powin Remote Operations Center (ROC) and/or the local Fire Department. A Powin BESS product that is suspected of venting should only be approached by trained First Responders equipped with appropriate personal protective equipment (PPE), as discussed in Firefighter PPE.

The LFP cell vent gas composition will depend upon a number of factors, including the cell state of charge and the cause of cell venting. However, testing has demonstrated that LFP cells release the following compounds when undergoing thermal runaway:

- Hydrogen (H_2)
- Carbon Monoxide (CO)
- Carbon Dioxide (CO_2)
- Methane (CH_4)
- Ethene (C_2H_4)
- Ethane (C_2H_6)
- Propene (C_3H_6)
- Propane (C_3H_8)

The compounds listed above are a mixture of CO, CO_2 and H_2 and a combination of hydrocarbons. This mixture is flammable; however, no additional toxic compounds (such as HCN, HCL, HF, etc.) that are typically found in the products of combustion of modern fires are released by the cell during venting. If the vented gas event leads to a fire that involves materials outside of the LFP cell (such as plastics within the module, wire insulation, etc.), products of combustion that are typically found in a common plastics fire could be produced. As such, contact with any products of combustion from a fire or a vented gas without the appropriate PPE should be avoided at all times.

7.0 First Aid

The following are common first aid measures employed when exposed to potential Powin BESS hazards:

- **Electrical Hazards:** Electrical shock / electrocution is possible if a person is exposed to battery components / cells, either during routine maintenance activities or because the BESS product has been compromised or damaged in some manner. Seek immediate medical assistance if an electrical shock, electrocution, or other electrical event has occurred or is suspected to have occurred.
- **Electrolyte Leak:** The LFP cells are sealed prismatic batteries and electrolyte leaks should not occur in normal use; however, if contact occurs with liquid electrolyte it can be corrosive, cause eye/skin irritation, and/or chemical burns.
  - If contact occurs to exposed skin, flush immediately with water for 15 minutes and wash the affected area with soap and water.
  - If a chemical burn occurs or if irritation persists, seek immediate medical assistance.
  - If eye contact occurs, flush with significant amounts of water for 15 minutes without rubbing, occasionally lifting the upper and lower eyelids, and seek immediate medical assistance.

- If liquid electrolyte is ingested, drink at least two glasses of milk or water, induce vomiting (unless the patient is unconscious), and seek immediate medical assistance.

- **Electrolyte Vapor:** The LFP cells are sealed prismatic batteries and electrolyte vapor leaks should not occur in normal use; however, should there ever be an electrolyte liquid leak, the material typically evaporates quickly into a vapor.
  - If inhalation of electrolyte vapors occurs, evacuate the area, assisting anyone that needs help, and move to an area with fresh air.
  - If a person is not breathing or having trouble breathing, give artificial respiration, use oxygen if available, and seek immediate medical assistance.
- **Vent Gas:** The LFP cells are sealed prismatic batteries and venting of gases should not occur in normal use; however, should contact with vented gases occur, evacuate the area, assisting anyone that needs help, and move to an area with fresh air.
  - If a person is not breathing or having trouble breathing, give artificial respiration and seek immediate medical assistance.

8.0 Firefighting

WARNING: DANGER – Poisonous Atmosphere/Vented Gas Hazard, Corrosion Hazard, and Fire Hazard

Responding to a fire or other hazardous event involving a Powin Bess product should only be performed by trained professionals.

Always contact Powin's Remote Operations Center for guidance when responding to an event and follow Powin's fire & off-gas emergency procedures. (PE-Fire-Gas-0)

AVERTISSEMENT : DANGER - Atmosphère toxique/danger de gaz évacué, risque de corrosion et risque d'incendie

L'intervention en cas d'incendie ou de tout autre événement dangereux impliquant un produit Powin BESS ne doit être effectuée que par des professionnels qualifiés.

Contactez toujours le centre d'opérations à distance de Powin pour obtenir des conseils lorsque vous répondez à un événement et suivez les procédures d'urgence en cas d'incendie et de dégagement de gaz de Powin. (PE-Fire-Gas-0).

Powin uses only Lithium Iron Phosphate (LFP) batteries, which are generally considered the safest lithium-ion chemistry available today. Testing to UL test methods has demonstrated that a single cell thermal runaway does not propagate to neighboring cells. In addition, modules are also isolated from each other by steel barriers which act as structural members and de facto thermal barriers. All internal and UL testing to date demonstrates these thermal barriers effectively stop thermal runaway from propagating from module to module. Therefore, a fully involved fire involving a Powin BESS product would likely require a significant external event that affects multiple cells/safety systems simultaneously. Examples of such significant external events could include a fire unrelated to the cells or a severe mechanical impact. Even then, inside each Smart Enclosure and Centipede Segment there are redundant flammable gas, smoke, and heat detectors that automatically activate a number of safety systems to quickly respond to the thermal event, in addition to providing remote notifications of the incident.

In the unlikely event of a large fire or other thermal event in a Powin BESS product, the following actions should be performed:

1. If the alarm system has not already signaled the local Fire Department, immediately call the local Fire Department (911).
2. Call the Emergency Response Coordinator (ERC) listed in the Emergency Response Plan (ERP), and call Powin's Remote Operations Center (ROC) at **1 (855) 888-3659**.
3. Establish a safety perimeter of 100 feet (30.5 meters) around all sides of the BESS product and do not allow personnel other than firefighters to enter the safety perimeter.
4. Provide copies of the information for First Responders from the top of this document. Provide the HMI (Human Machine Interface) to First Responders so that they can monitor the information/data regarding the condition of the BESS product as well as any adjacent products. The ERC and/or the ROC can provide details to the Fire Responders and assist in its use.

8.1 General Firefighting

WARNING: DANGER – Poisonous Atmosphere, Corrosion Hazard, Fire Hazard and Vented Gas Hazard

When responding to a fire event with Powin BESS product, do not approach the Smart Enclosure or Centipede Segment directly in front of any doors and do not attempt to open any doors.

Use care when applying water directly to the outside of a **Smart** Enclosure or Centipede Segment that is burning on the inside. Ensure that the electrolysis of water is not occurring which could contribute to the flammable gas mixture and fire.

Do not enter the **Smart** Enclosure or open the access doors to a Centipede Segment without testing for flammable gas and ensuring there are no sources of heat or hot spots that remain in the enclosure or segment.

AVERTISSEMENT : DANGER - Atmosphère toxique, risque de corrosion et risque d'incendie

Lorsque vous répondez à un incendie avec le produit Powin BESS, ne vous approchez pas du boîtier intelligent ou du segment Centipede directement devant les portes et n'essayez pas d'ouvrir les portes.

Soyez prudent lorsque vous appliquez de l'eau directement à l'extérieur d'un boîtier intelligent ou d'un segment Centipede qui brûle à l'intérieur. Assurez-vous que l'électrolyse de l'eau ne se produit pas, ce qui pourrait contribuer au mélange de gaz inflammable et à l'incendie.

N'entrez pas dans l'enceinte intelligente et n'ouvrez pas les portes d'accès à un segment Centipede sans tester la présence de gaz inflammable et vous assurer qu'il n'y a pas de sources de chaleur ou de points chauds dans l'enceinte ou le segment.

Powin's recommendation is to fight a Powin BESS product fire defensively. **When responding to a fire event with a Powin BESS product, do not approach the Smart Enclosure or Centipede Segment directly in front of any doors and do not attempt to open any doors.** Coordinate all operations with the ERC and Powin's ROC utilizing the HMI to determine the condition of the Powin BESS product and any adjacent products.

Water has been found to be the best suppression agent to use on exposed lithium-ion batteries when the batteries can be directly accessed with water. Water cools the batteries, thus slowing down the thermal runaway reactions.

Other suppression agents, such as dry chemicals or gaseous agents (CO_2, N2, Halon, clean agents, etc.) may temporarily suppress the fire associated with the batteries; however, they do not cool the lithium-ion batteries. Without cooling the batteries, thermal runaway reactions will continue, thus extending the duration of the event, but not stopping it.

Please note, lithium-ion batteries do not contain lithium metal. As such, metal fire suppressants are not an appropriate suppression agent and should not be used as they are unlikely to be effective.

CAUTION: Risk of Re-ignition

Powin does not recommend manual venting or reactivation of the emergency ventilation system after a fire event. The introduction of outside air can lead to re-ignition of a fire or lead to explosive conditions.

ATTENTION : Risque de ré allumage

Powin ne recommande pas la ventilation manuelle ou la réactivation du système de ventilation d'urgence après un incendie. L'introduction d'air extérieur peut entraîner la ré allumage d'un incendie ou conduire à des conditions explosives.

Caution should also be exercised if water is applied directly to the outside of a **Smart** Enclosure or Centipede Segment that is burning on the inside. Electrolysis of water, which is the splitting of water into hydrogen and oxygen, may occur and could contribute to the flammable gas mixture and fire.

Care should be taken to ensure this is not occurring if water is directly applied to the **Smart** Enclosure or Centipede Segment.

If a fire develops inside the **Smart** Enclosure or Centipede Segment, Powin recommends applying water to adjacent exposures, as necessary, in a defensive manner, rather than aggressively attacking the fire in the burning unit. The fire inside the **Smart** Enclosure or Centipede Segment is protected by several layers of steel and therefore, water does not have direct access to the batteries. As such, this will not stop the thermal runaway event and may only delay the eventual combustion of the entire Powin BESS product. Utilizing a fog pattern to knock down a fire plume/smoke or to reduce the thermal output of the fire on nearby exposures, combustibles, **Smart** Enclosures, or Centipede Segments can also be an effective defensive tactic.

A battery fire may continue for several hours or days, and it may take even longer for the battery packs to cool after it has been fully consumed by a thermal runaway event. A lithium-ion battery fire that has been seemingly extinguished can flare up again if all cells have not been consumed. Therefore, Powin recommends you allow the BESS product to fully consume itself and then cool the burned system by flooding it with water. **Smart** Enclosures and Centipede Segments come equipped with a Fire Department connection. This is a flooding type connection that simply allows for the Smart Enclosure or Centipede Segment to be filled by a fire hose from the outside. This connection can be utilized to flood the entire Smart Enclosure or Centipede Segment after the BESS product has been fully consumed to aid in cooling the battery packs without First Responders needing to enter the enclosure or open the access door to a Centipede Segment. Depending on the size of the Smart Enclosure and the water supply, this can take up to 30 minutes and a Centipede Segment can typically be filled in 10-15 minutes.

After all fire and smoke has visibly subsided, a thermal imaging camera can be used to actively measure the temperature of the unit from outside the **Smart** Enclosure or Centipede Segment. For a Smart Enclosure, if conditions seem clear for entry, measurements of flammable gas should be done using the gas sample port first, prior to anyone entering the enclosure. If the gas sample port is not available, the Fire Department connection can be used for this purpose. If conditions inside the enclosure are clear for entry after taking gas measurements, thermal images, and no signs of smoke/off-gassing are observed, First Responders can enter the enclosure under the agreement of all parties involved (ERC, Powin's ROC, First Responders, and site operator).

For a Centipede Segment, if conditions seem clear for opening the access door, measurements of flammable gas should be done around the exterior of the cabinet first, then inside the cabinet through the open vents of the top cap, prior to anyone opening the access doors. If conditions inside the segment are clear for entry after taking gas measurements, thermal images, and no signs of smoke/off-gassing are observed, First Responders can enter the enclosure under the agreement of all parties involved (ERC, Powin's ROC, First Responders, and site operator).

Once inside a Smart Enclosure or after opening an access door to a Centipede Segment, a thermal camera or imager can then be used to detect any localized hotspots. If there are any abnormalities detected at any point, evacuate the area to a safe distance and wait until the conditions improve to safe levels before proceeding.

	**CAUTION: Risk of Re-ignition**
	Do NOT perform manual venting or reactivation of the emergency ventilation system after a fire event. The introduction of outside air can lead to re-ignition of a fire or lead to explosive conditions.
	**ATTENTION : Risque de ré allumage**
	N'effectuez PAS de ventilation manuelle ou de réactivation du système de ventilation d'urgence après un incendie. L'introduction d'air extérieur peut entraîner la ré allumage d'un incendie ou conduire à des conditions explosives.

Powin does not recommend manual venting or reactivation of the emergency ventilation system after a fire event. The introduction of outside air can lead to re-ignition of a fire or lead to explosive conditions.

8.2 Defensive Firefighting Tactics

Powin's recommendation is to fight a Powin BESS product fire defensively. The Fire Department and other First Responders should maintain a safe distance from the **Smart** Enclosure or Centipede Segment at all times wearing the appropriate PPE.

First Responders should allow the battery to burn itself out while limiting any fire spread to nearby exposures, combustibles, Smart Enclosures or Centipede Segments. First Responders can use a fog pattern to protect adjacent exposures or to knock down a fire plume/smoke in situations where the smoke is a nuisance or hazard to nearby structures.

One-and-three-quarter inch (1 ¾") hose lines have been shown to be effective in controlling the fire plume/smoke and cooling nearby exposures. As mentioned above, applying water directly on the burning **Smart** Enclosure or Centipede Segment will not provide significant improvement to the fire and will only delay the eventual consumption of the entire BESS product.

A battery fire may continue for several hours, or days, and it may take even longer for the battery packs to cool after they have been fully consumed by a thermal runaway event. A lithium-ion battery fire that has been seemingly extinguished can flare up again if all the cells have not been consumed.

	**CAUTION: Risk of Re-ignition**
	A lithium-ion battery fire that has been seemingly extinguished can flare up again if all the cells have not been consumed. Caution should be exercised not to assume the fire is out as the fire event unfolds. The fire may flare up again once additional cells inside the **Smart E**nclosure or Centipede Segment go into thermal runaway.
	**ATTENTION : Risque de ré allumage**
	Un incendie de batterie au lithium-ion qui a été apparemment éteint peut se réveiller si toutes les cellules n'ont pas été consommées. Il faut faire preuve de prudence pour ne pas supposer que le feu est éteint au fur et à mesure que l'incendie se déroule. L'incendie peut reprendre une fois que des cellules supplémentaires à l'intérieur du boîtier intelligent ou du segment Centipede entrent en emballement thermique.

8.3 Firefighter PPE

Firefighters should wear their typical firefighting gear anytime they are responding to a Powin BESS product fire. This includes wearing a self-contained breathing apparatus (SCBA) and firefighter turnout gear.

As mentioned above, LFP cells or battery modules may vent or release hazardous organic vapors if exposed to excessive heat, fire, mechanical damage, or abnormal electrical conditions. These vapors are flammable and may include other volatile organic compounds (VOCs), such as:

- hydrogen gas
- carbon dioxide
- carbon monoxide
- hydrocarbons
- soot and particulates containing oxides of iron
- aluminum, lithium
- copper
- phosphorus

In addition, if a fire involves materials outside of the LFP cell (such as plastics within the module , wire insulation, etc.), products of combustion that are typically found in a common plastics fire could be produced. As such, contact with any products of combustion from a fire or a vented gas without the appropriate PPE should be avoided at all times.

9.0 Shutting Down the System

WARNING: DANGER – Hazardous Voltage

Shutting down or disconnecting a Powin BESS product does not de-energize the batteries. The batteries will remain charged and are an electrical hazard.

AVERTISSEMENT : DANGER - Tension dangereuse

L'arrêt ou la déconnexion d'un produit Powin BESS ne met pas les batteries hors tension. Les batteries resteront chargées et présentent un risque électrique.

In the event of a fire or other thermal event that has led to the activation of the Emergency Ventilation System, fire suppression system, or fire alarm system, the BESS should automatically go into an Emergency Stop (E-Stop) that shuts down the system by disconnecting all DC power to the BESS product.

If that does not occur, coordinate with the ERC, Powin's ROC, First Responders, and the site operator to determine if the system can be de-energized at a circuit breaker upstream of the system. However, only perform this activity with trained personnel that are utilizing the appropriate PPE.

10.0 Storage

Battery modules come preassembled in all Powin BESS products and are shipped separately from the Smart Enclosures (if one is used) or come already installed inside a Centipede Segment. If they are not immediately installed, the BESS products should be stored in the approved packaging that they arrived in as they await installation. Refer to the Powin BESS Product Installation Procedure document for more guidance and information.

Contact Powin's Customer Service team if storage of a Powin BESS product is required for longer than three months and/or is not temporary. In general, for temporary storage of a Powin BESS product prior to installation, the following precautions should be exercised:

- Do not store them in a manner that allows the terminals to short circuit (i.e., do not allow the formation of an electrically-conductive path).
- Do not store Powin BESS products near heating equipment or other equipment that can create flames or sparks.
- Do not store them in a manner that exposes them to extreme environmental conditions, such as elevated temperatures, high humidity, or moisture (either precipitation or condensation). Exposure to extreme environmental conditions during storage can result in reduced battery service life or, possibly, failure or damage to the LFP cells. Powin BESS products operate at ambient temperatures between 14°F and 113°F (-10°C and 45°C) at a humidity of <85% and protected from moisture and should be stored within these ambient conditions at all times.
- Powin BESS products should be stored at 30-50% state of charge (SOC). Powin BESS products should not be stored for extended periods either at a full SOC or completely discharged since both conditions adversely impact battery life.
- Powin BESS products should not be stored untended for longer than three months since battery service life likely will be adversely impacted.
- The storage area should be protected from standing water, flowing water, and flooding.

If long-term storage is required of a Powin BESS product, please contact Powin's Customer Support team for assistance and refer to Service Bulletin: SB-001, Maintaining the State-of-Health for Long-Term Storage of Powin Energy Storage System Products.

Also note, long term storage areas of lithium-ion batteries and products must be compliant with the applicable fire code requirements relating to the storage of lithium-ion batteries.

11.0 Maintenance

	**CAUTION: Risk of Equipment Damage** Improper maintenance, service, or repairs on a Powin BESS product could void the product's warranty and/or lead to a failure of the product.
	**ATTENTION : Risque d'endommagement de l'équipement** Un entretien, un service ou des réparations incorrects sur un produit Powin BESS peuvent annuler la garantie du produit et / ou entraîner une défaillance du produit.

All maintenance, service, and repairs (including proactive and corrective maintenance) of Powin BESS products over the lifetime of the product must be performed by Powin approved field service technicians. Service personnel that are not approved nor authorized by Powin should not perform maintenance, servicing, or repairs on the BESS products as this could result in an unsafe condition and/or unexpected electrical/thermal event.

Refer to the Energy Control Plan (ECP) for detailed instructions on how to properly maintain, service, or repair your specific BESS product. The ECP covers topics, including, but not limited to, tools and equipment, PPE requirements, and lockout/tagout.

12.0 Damaged BESS Products

WARNING: DANGER – Hazardous Voltage, Arc Flash, and Fire Hazard

Handle the damaged module with extreme caution. It is possible that a damaged battery may sustain further damage during transportation, resulting in a fire or other thermal event.

NEVER store damaged Powin BESS products adjacent to undamaged products. Damaged cells can ignite and create thermal runaway and/or arc flash conditions potentially damaging adjacent cells and/or injuring personnel.

NEVER transport a damaged Powin BESS product without specific direction and instruction from the ERC or ROC.

AVERTISSEMENT : DANGER - Tension dangereuse, arc électrique et risque d'incendie

Manipulez le module endommagé avec une extrême prudence. Il est possible qu'une batterie endommagée subisse d'autres dommages pendant le transport, entraînant un incendie ou un autre événement thermique.

NE JAMAIS entreposer les produits Powin BESS endommagés à côté de produits non endommagés. Les cellules endommagées peuvent s'enflammer et créer des conditions d'emballement thermique et / ou d'arc électrique susceptibles d'endommager les cellules adjacentes et / ou de blesser le personnel.

NE JAMAIS transporter un produit Powin BESS endommagé sans instructions et instructions spécifiques du coordonnateur des interventions d'urgence ou du centre d'opérations à distance.

If the event of damage to a Powin BESS product, contact the EMC and Powin's ROC immediately if they have not already been notified. If the product has been mechanically damaged in an obvious manner (i.e., the battery enclosure has been dented, cut, or compromised in some other manner), it is possible that cells inside the battery enclosure have been damaged. This could lead to thermal runaway of the damaged LFP cells and possibly spread thermal runaway to neighboring cells.

Before handling or transporting a damaged Powin BESS product, wait at least 24 hours or longer, as instructed by the EMC and Powin's ROC. Off-gassing or smoke may be an indication that a thermal reaction is in progress inside the battery enclosure. If evidence of heat, fire, explosion, or off-gas is not observed for 24 hours, the Powin BESS product may be disconnected and moved to a designated location for safe storage.

A safe storage location for a damaged lithium-ion battery is a location separated from combustibles, buildings, lots lines, etc. by at least 50 feet. In addition, the storage area should be accessible only by trained professionals who are authorized to evaluate the damaged product. An example of a safe, designated storage space would be a fenced in an open yard.

Once safely moved to its designated storage location, a damaged Powin BESS product should be monitored during storage for evidence of off-gassing, smoke, heat, flames, or any other signs of

abnormal activity. If full-time monitoring of the product is not possible the EMC and Powin's ROC can provide additional options to safeguard the BESS product during temporary storage prior to transport.

Specific instructions for evaluating, disconnecting, and preparing a damaged Powin BESS product for transport can be obtained by the EMC and Powin's ROC. Please contact Powin before performing any activities associated with transporting a damaged BESS product.

13.0 Disposal

Powin offers an optional BESS Battery Recycle Program where Powin can contract to take back full systems or partial systems (e.g., Stacks) at system End-of-Life (EOL). Contact Powin's Customer Service Team at **1 (503) 598-6659** and refer to Service Bulletin: SB-003, Recycling Powin Battery Energy Storage System Products for more guidance on how to properly dispose of all Powin BESS products.

Never dispose of a damaged (either mechanically damaged or after a fire or other thermal event) Powin BESS product without first contacting Powin, as outlined above in Section 12.0.

Powin BESS products should be disposed of or recycled in accordance with all local, state, and federal regulations. However, regulations can vary by jurisdiction so care should be taken in ensuring all applicable regulations are met in the area where the installation resides. Powin recommends participation in their optional BESS Battery Recycle Program; however, if you choose not to, Powin recommends consulting with local, state, and/or federal authorities on the appropriate methods for disposal and recycling to ensure all regulations and procedures are followed.

Powin BESS products do not contain heavy metals such as lead, cadmium, or mercury and are RoHS Compliant. As such, throughout the United States, rechargeable, LFP batteries are classified as Universal Waste Batteries. Many jurisdictions (such as California) have detailed regulations regarding how to dispose of Universal Waste Batteries. For instance, batteries in California must be taken to a Universal Waste handler or authorized recycling facility.

14.0 Transportation

Lithium-ion batteries are regulated in the United States by the Code of Federal Regulations, Title 49 Transportation, Section 173.185 as well as other national and international organizations, such as:

- 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).

These regulations contain very specific packaging, labeling, marking, and documentation requirements. These requirements typically require:

- the UN Number (3481)
- the shipping name of the item (Lithium-Ion Batteries)
- the hazard classification (Class 9 Miscellaneous)
- the packing group (N/A)

In addition, individuals involved in the preparation of dangerous goods for transport are required to be trained on how to properly package, label, mark, and prepare shipping documents per these regulations.

15.0 Warning, Caution, and Important Notice Descriptions

The following **WARNING**, **CAUTION**, and **IMPORTANT** notices are used throughout Powin documentation to identify situations of presenting personal hazard, equipment damage, or provide information that is important to be aware of BEFORE performing the tasks identified in this document. These notices are critical to the safe installation and operation of this equipment.

READ these notices carefully. Understand the level of severity that each of them provides and ensure that all personnel who are involved in the activities described in any Powin document are fully aware of the potential hazards and properly trained in the mitigation or avoidance of such hazards.

WARNING: DANGER - Risk of Death or Serious Personal Injury

This **WARNING** notice indicates a risk of death or serious injury in the event that the product is installed, used, or handled incorrectly or without proper safety procedures.

Failure to heed the information in these warnings could result in severe, if not fatal, personal injury.

Hazardous Voltage hazards indicate that the there is a danger of electric shock present. Use extreme caution to avoid electrocution.

Drop or Crush hazards indicate a danger of being crushed by heavy equipment. Use appropriate lift-safety techniques or seismic securing requirements to ensure that the equipment cannot fall onto any person working around the equipment.

Arc Flash hazards indicate a danger of high-energy (explosive) electrical discharge between two electrically-conductive materials. Avoid opening electrical enclosures unless electrical components are de-energized or specialized personal protective equipment is worn.

Fire Hazard indicates that conditions could product fire or thermal run away.

Toxic Substance Hazard indicates tl;ploklhat substances (water, vapor, smoke etc.) could contain toxic and poisonous particulates that could be harmful to human life.

Corrosion Hazard indicates that substances (Battery electrolyte or HVAC refrigerant) may be present that could cause equipment damage and/or failure or cause acid-type burns and damage to human flesh.

Vented Gas Hazard indicates that off-gassing may have occurred creating an atmosphere hazardous to human life and potentially explosive if not ventilated properly.


Tension dangereuse


Risques d'écrasement


Risques d'arc électrique


Risque d'incendie


Risque de substance toxique


Risque de corrosion


Risque de gaz évacué

AVERTISSEMENT : DANGER - Risque de mort ou de blessures graves

Cet *AVERTISSEMENT* indique un risque de mort ou de blessures graves dans le cas où le produit est installé, utilisé ou manipulé de manière incorrecte ou sans procédures de sécurité appropriées.

Le non-respect des informations contenues dans ces avertissements peut entraîner des blessures graves, voire mortelles.

***Des risques de tension dangereux* indiquent qu'il existe un risque de choc électrique.** Soyez extrêmement prudent pour éviter l'électrocution.

Les risques de chute ou d'écrasement indiquent un risque d'être écrasé par un équipement lourd. Utiliser des techniques de sécurité de levage appropriées ou des exigences de sécurisation sismique pour s'assurer que l'équipement ne peut pas tomber sur une personne travaillant autour de l'équipement.

Les dangers d'arc électrique indiquent un danger de décharge électrique à haute énergie (explosive) entre deux matériaux électriquement conducteurs. Évitez d'ouvrir les boîtiers électriques, sauf si les composants électriques sont hors tension ou si un équipement de protection individuelle spécialisé est porté.

Le risque d'incendie indique que les conditions pourraient provoquer un incendie ou un emballement thermique.

Le risque de substance toxique indique que les substances (liquide, vapeur, fumée, etc.) peuvent contenir des particules toxiques qui pourraient être nocives pour la vie humaine.

Le risque de corrosion indique que des substances (électrolyte de batterie ou réfrigérant HVAC) peuvent être présentes et provoquer des dommages et / ou une panne de l'équipement ou des brûlures de type acide et des dommages à la chair humaine.

Le risque de gaz ventilé indique qu'un dégagement de gaz peut s'être produit, créant une atmosphère dangereuse pour la vie humaine et potentiellement explosive si elle n'est pas correctement ventilée.

CAUTION: Risk of Non-Fatal Personal Injury or Damage to Equipment

This **CAUTION** notice indicates a risk of injury or damage to property in the event that the product is used or handled incorrectly or without proper safety procedures.

ATTENTION: Risque de blessures corporelles non mortelles ou de dommages à l'équipement

Cet avis *d'ATTENTION* indique un risque de blessures ou de dommages matériels en cas d'utilisation ou de manipulation incorrecte du produit ou sans procédures de sécurité appropriées.

	IMPORTANT: This **IMPORTANT** notice will contain information that is important to the proper installation, operation, or maintenance of this equipment. This information does not indicate a hazardous or dangerous condition.
	IMPORTANT: Cet avis *IMPORTANT* indique un risque de blessure ou de dommage matériel en cas d'utilisation ou de manipulation incorrecte du produit ou sans procédures de sécurité appropriées.

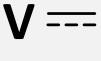
16.0 Definitions

The following terms and acronyms are used in this document.

AC	Alternating Current
AC Battery	The AC Battery is the DC battery system plus the equipment and software used to convert the stored DC power to AC power for grid utilization.
API	Application Programming Interface
Array	A group of Stacks connected in parallel is an array. The number of Stacks and their location within an array is dictated by the owner's energy capacity requirement and space limitations.
BESS	Battery Energy Storage System. This is a general term for an energy storage system that utilizes batteries as its power-storage medium. Other energy storage systems include gravity (water storage) and centrifugal energy. A Powin BESS is considered to be the AC Battery + the StackOS.
Block	A block is a BESS having its own grid point of insertion. A block may be comprised of one or more arrays.
BMS	Battery Management System
BP	Battery Pack
BPC	Battery Pack Controller
CAN	Control Area Network. A robust bus that facilitates communication.
CFMEA	Concept Failure Mode Effect Analysis
Constant-Power (CP) Energy	This is the energy delivered during a complete bulk discharge without a low-power top-off charge.
CPU	Central Processing Unit
DC	Direct Current
EMS	Energy Management System
ESS	Energy Software System
HVAC	Heating, ventilation, and cooling

ISO	International Standards Organization
LFP	Lithium Iron Phosphate
LOTO	Lockout/Tagout
NFPA	National Fire Protection Agency
Notifications	Notifications are time-stamped messages that indicate a condition has been set or cleared. They are generated in multiple levels of the system. Notifications are communicated by the user interface, aggregated by the EMS, and sent to the Powin cloud. For more information, see the StackOS Product manual.
OS	Operating System
PCS	Power Control System
PPE	Personal Protective Equipment
PTC	Push-To-Configure – a part of the Installation Process
RAM	Random Access Memory
SCADA	Supervisory Control and Data Acquisition
SOC	State-of-Charge
StackOS	The name of the operating system of the Powin BESS
StackOS+	This is Powin's Energy Management System Software and it includes the data warehouse and analytics features, remote operations, monitoring and dispatch as well as the Powin Energy Optimization features.
UI	User Interface
UL	Underwriters Laboratories

These symbols may be found on the product to identify the source of energy input (AC or DC) and the required ground connections per UL, NEC/CEC requirements.

	Alternating Current (AC)
	Direct Current (DC)
	Volts AC (Vac)
	Volts DC (Vdc)
	Ground

	Lockout Required Before Servicing

17.0 References

17.1 Powin Product References

The following documents are relevant to this product manual and are an integral to the proper installation, maintenance, and use of this product. Be sure to read them carefully to ensure the safety of anyone working with this product.

- Stack* Product Manual
- Stack* Installation Procedure
- StackOS Product Manual
- Environmental, Health & Safe Guide
- Powin Energy Control Plan (POM-002)
- PE-FIRE-GAS-2 Fire and Off-Gas Emergency Procedure
- SB-001 Maintaining the State-of-Health for Long-Term Storage of Powin Energy Storage System Products
- SB-002 Maintenance Schedule
- SB-003 Powin BESS Recycling Program
- SB-004 AC and DC Fuse Replacement in the Stack225 and Stack230

*Stack= Stack Product Module for the current installation.

17.2 Regulatory References

- NFPA 70 National Electric Code (NEC), Current Edition
- CSA C22.1 Canadian Electric Code (CEC), Current Edition
- UL 1973 Standard for Safety Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications
- IEEE Std 946-2004 Annex C Batteries, Available Short-Circuit Current-Sample Calculations.
- UL 9540A Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems

18.0 Revision History

NAME	DATE	REASON FOR CHANGES	VERSION
G. Moffet	2021.10.29	Initial Publication	C01
K. Considine	2021.10.29	Management Approval for Publication & Release	C01
V. Sukumar	2021.04.06	Technical Review	B01
A. Blum	2021.04.01	Initial Draft	A01

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Notes:

POWIN