Appendix 0.4

Balance of Plant Preliminary Failure Mode and Effects Analysis



Empire Solar Major Use Permit PDS2022-MUP-22-010 Balance of Plant Preliminary IEC 60812 Failure Mode and Effects Analysis

20250320-SLS-AW0764-BOP-FMEA-R1

Issued: 23 July 2025

<u>AHJ Revision Note:</u> This Balance of Plant (BOP) Preliminary IEC 60812 Failure Mode and Effects Analysis (FMEA) is provided as a "Land Use Permit" approval analysis to support the initial permitting of the Starlight Solar Energy Storage Project in San Diego County California. This BOP Preliminary FMEA was created using the best available OEM information and addresses the majority of the liquid cooled GridSolv Quantum design failure modes that could result in fire, shock, explosion, or injury to personnel.

The information presented in this Preliminary FMEA is provided only as a technical basis for a fire risk assessment for the development of the required Major Use Permit Hazard Mitigation Analysis. This BOP FMEA shall be updated upon determination of the actual energy storage technology for the Starlight Solar Project. This Preliminary FMEA is intended to be considered as "information only" and shall not be used for final Building Permit Approval.

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Table of Contents

Revision History	∠
Purpose and Objectives	5
Engineering Methodology	е
FMEA Overview	е
FMEA Process Summary	е
Definition of the Project Scope	8
Analysis Enabling Assumptions	11
Hazard Identification	12
Criticality Ranking (FMECA)	12
Failure Mode Identification	13
Single Failure Criteria	15
Hidden Detectable Failures	15
Common Cause Failures	16
Unavailability of Redundancy (due to maintenance or other cause)	16
Failure of Active and Passive Components	16
External Events as Failure Modes	17
FMEAs of Controls, Instrumentation and Safety Systems	17
Severity Classifications (Sv.)	17
Occurrence Classifications (OC.)	18
Detection Classifications (Dt.)	20
Causes	21
Risk Priority Number	21
Results and Discussion	21
References:	22
Attachment A: Starlight Solar BOP IEC 60812 Failure Mode and Effects Analysis	24





Revision History

Revision	Date	Description
0	12 May 2025	Released to Client for Dissemination
1	23 July 2025	Redefinition of the intent of the document as preliminary at the client. Title page and appropriate verbiage changed as directed by client.



Purpose and Objectives

This Balance of Plant (BOP) Preliminary IEC 60812 Failure Modes and Effects Analysis (FMEA) was conducted to evaluate the external hazards and risks associated with a theoretical UL9540 compliant energy storage system (BESS) for the Empire II LLC Starlight Project. The Empire II LLC Starlight Project is an eight-parcel project located in San Diego County, southeast of Manzanita CA in proximity of 32.66016162785173, -116.28052568720432

The intent of performing this BOP FMEA is to identify and quantify the potential failure mechanisms that, if left unmitigated, could result in fire, shock, explosion, or personal injury hazards associated with the Empire II LLC (Empire) Empire battery energy storage Project that utilizes a typical Lithium-Iron-Phosphate (LFP) chemistry. This BOP FMEA is intended to be agnostic of the proposed BESS OEM.

A standards-based FMEA is typically and recursively developed throughout the design development process where key design decisions are implemented using a combination of Engineering and Administrative Controls and to establish the technical basis for fire risk management decisions. FMEAs are a key element for the formation of a Layers of Protection Analysis where risk informed decisions can be made leading to Independent Protection Layers (IPLs) that may consist of the combination of Engineering and Administrative Control mitigation measures.

Whenever a system failure could result in undesirable consequences such loss of availability, reliability, system degradation, fire, etc., best practices advise carrying out a quantitative or qualitative risk analysis, such as a Failure Mode and Effects Analysis (FMEA), as an integral part of the design and operational development process. Hiller standards-based FMEA process, when incorporated into the design development of Battery Energy Storage Systems industry expertise can be a powerful decision aid in identifying possible failures which could potentially improve the overall safety of consumer products.

This BOP FMEA focused on the external threats to the Empire Battery Energy Storage System (BESS) Project with the objective of evaluating the theoretical failure mechanisms, modes and evaluating the potential impact that could result in a fire, shock, or personal injury. This BOP FMEA follows the guidelines outlined in IEC 60812, *Failure Modes And Effects Analysis (FMEA And FMECA)* [1] to establish the standards-based technical basis of the interdependent system performance upon which risk informed design decisions are made.

This FMEA also integrates the industry lessons learned, supporting databases and publications including:

- Electric Part Reliability Data (EPRD) -2014 [2]
- Non-electric Part Reliability Data (NPRD) 2016 [3]
- Failure Mode/Mechanism Distributions (FMD) 2016 [4]
- Center for Chemical Process Safety, Guidelines for Process Equipment Reliability Data (PERD), with Data Tables [5]
- OREDA, Offshore Reliability Data Handbook [6]
- Reliability Data for Safety Instrumented Systems PDS Data Handbook [7],
- Reliability Prediction Method for Safety Instrumented Systems PDS Method Handbook 2013 Edition [8]
- MIL-HDBK-217F, Military Handbook Reliability Prediction of Electronic Equipment [9]

- IEC/TR 62380 Reliability data handbook Universal model for reliability prediction of electronics components, PCBs and equipment [10]
- IEEE Standard 493-1997: *IEEE Recommendation Practice for the Design of Reliable Industrial and Commercial Power Systems* [11]
- CARDEROCKDIV NSWC-10: Handbook of Reliability Prediction Procedures for Mechanical Equipment -Mechanical equipment - military applications [12]
- Safety Equipment Reliability Handbook, Volume 1 Sensors [13]
- Safety Equipment Reliability Handbook, Volume 2 Logic Solvers and Interface Modules [14]
- Safety Equipment Reliability Handbook, Volume 3 Final Elements [15]
- IEEE Std. 500-1984: *IEEE Guide to the Collection and Presentation of Electrical, Electronic, Sensing Component, and Mechanical Equipment Reliability Data for Nuclear Power Generating Stations* [16]
- Failure mode and effect analysis: FMEA from theory to execution [17]
- The Basics of FMEA [18]
- Guidelines for failure mode and effects analysis for automotive, aerospace and general manufacturing industries [19]
- The Power of Deduction-Failure Modes and Effects Analysis for Design [20]

Engineering Methodology

FMEA Overview

A FMEA is a design and engineering tool which analyzes potential failure modes within a system to determine the impact of those failures. It was first developed by the US Department of Defense for use in Systems Engineering Design practices. The FMEA technique has since been adopted by commercial industries in an attempt to minimize failures and reduce safety, and environmental and economic impacts that could result from these failures. FMEAs have more recently become a preferred risk analysis tool in the energy storage market sector and is recommended as a Safety Analysis tool of the Energy Storage Management System (ESMS) in UL 9540 and the Installation Standard for Stationary Energy Storage Systems, and NFPA 855 [21, 22]. It is required for certain systems by the internationally recognized safety standards, Societies, select regulatory bodies, and industry groups to improve the safety of a design or operation, to increase its reliability and to minimize undesired events. As an integral part of the Risk Management Program, FMEAs are also an essential element of the design process to identify the risk and the associated hazards where purposeful engineering and administrative controls are applied to minimize the likelihood of occurrence. The methodology presented in this FMEA follows the suggested use of IEC 60812:2018 [1] as referenced in NPFA 855 [22] and UL 9540 [23].

This BOP FMEA was developed using Isograph Reliability Workbench v. 15.0.1.0 with data from the Electronic Parts Reliability Data, EPRD-2016, Nuclear Parts Reliability Data, NPRD-2016, and Failure Mode/Mechanisms Distribution, FMD-2016 as well as the other referenced recognized process safety industry databases to provide technically defendable reliability data. If component information was not contained in these databases, comparable reliability data was based on recent energy storage market sector data and engineering judgement.

FMEA Process Summary

The FMEA is generated through a desktop analytical process intended to identify system design and safety system configuration opportunities for improvement in all expected operational modes of the particular

system. This BOP FMEA utilized the numerous Empire Project engineering documents that delineate the asconstructed installation.

Once it has been determined that an FMEA will be performed and the scope of the study is agreed upon, an appropriate FMEA team of subject matter experts from Hiller and the Empire team to carry out the analysis using the Delphi Method [24] to identify the potential system level failures when the failure modes/mechanisms were not documented in the referenced Reliability Engineering databases. This process relied primarily on the experienced FMEA practitioner knowledgeable in the typical Battery Energy Storage System(s) normative requirements and was supplemented by specific design details not readily presented in the engineering design media.

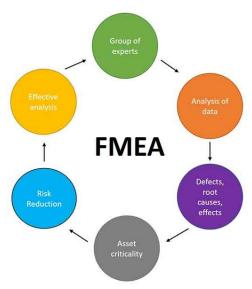


Figure 1: Classical FMEA Approach

The Empire System boundaries are defined as the BESS Container and the interdependent and supporting structures, systems and components (SSCs) from the BESS Yard to the connections to the assumed existing 34.5kV Switchgear. The Hiller/Empire team interfaced with the applicable stakeholders to exchange data, including collection of system schematics, operational procedures and manuals and system configurations as needed. The team primarily relied upon:

- Published failure modes (FM),
- Failure rate distributions and probabilities (Occ)
- Cascading impacts effects throughout the interdependent system leading to fire, shock or injury to personnel (Severity – Sv),
- Failure Causes (FC)
- Anticipated detection methods, alarms, and annunciations (Dt)
- Recommended compensatory corrective actions (RA).



Recommendations were provided for design considerations throughout the FMEA development process, and these recommendations may be ranked according to the severity of the potential effect to mitigate the consequence or probability of fire related events. The general process flow elements of the IEC 60812 FMEA process are presented in Figure 2.

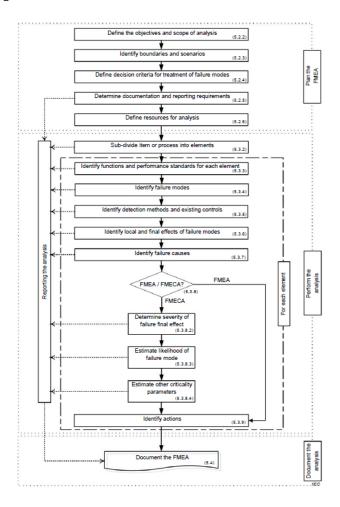


Figure 2: IEC 60812 FMEA Process Flow Chart

Definition of the Project Scope

Typically, system block diagrams and many other system-modeling techniques are used to understand system hierarchies. The system model used for this FMEA is based on the Empire Battery ESS Project. This FMEA is based on the engineering documentation provided and was decomposed into the following subsystems presented in Figure 3.



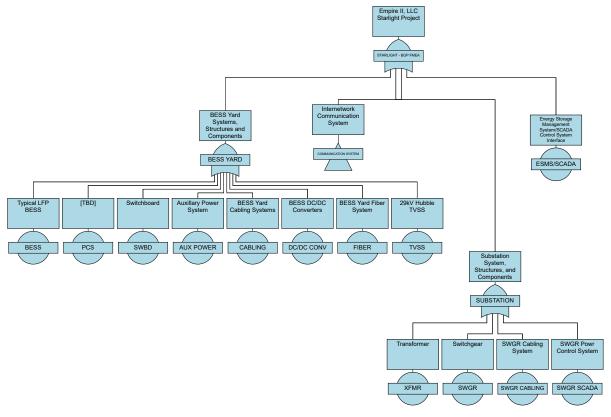


Figure 3: Summary FMEA Elements

The Empire BESS Project is based on the safe installation of individual BESS OEM structures Battery Energy Storage Systems as show in Figure 4. A view of a typical BESS OEM is presented in Figure 5.



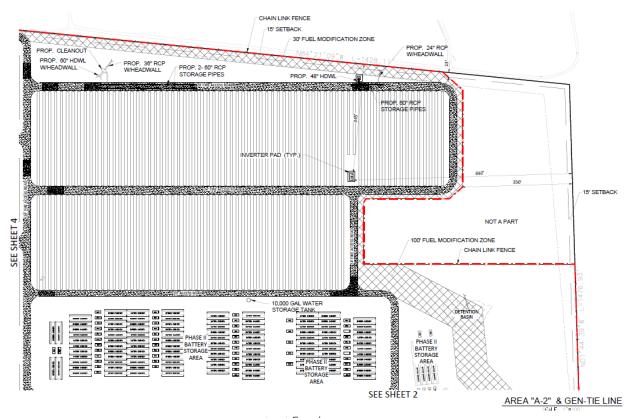


Figure 4: (typ.) Empire Site Layout

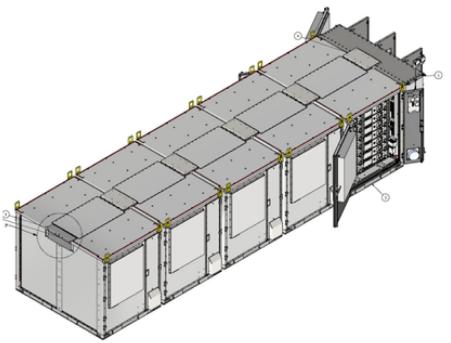


Figure 5: (ass, typ.) BESS OEM 2 LFP System

Analysis Enabling Assumptions

The following enabling assumptions were used to facilitate this Failure Mode and Effects Analysis (FMEA) to characterize the typical failure scenario:

Assumptions made in the development of this FMEA include:

- This BoP IEC 60812 FMEA is based on a theoretical energy storage system.
- In the absence of specific component failure data, it is assumed the reliability data contained within the *Electronic Parts Reliability Data*, EPRD-2016; *Nuclear Parts Reliability Data*, NPRD-2016; and *Failure Mode/Mechanisms Distribution*, FMD-2016 provide technically defendable reliability data. When specific component data is not listed within EPRD, NPRD, or FMD, approximates are used based on class of equipment.
- No distinction is made for each item's maturity of design or its associated failure rates; each item was modeled based on its intended function.
- The system analyzed included the identified interdependent subsystems of the Empire Project.
- In the absence of the interfacing inverter design details, the inverter is assumed to be UL1741 compliant, and no additional analysis of failure modes are assessed as part of this FMEA.
- The FMEA followed the model defined by the Design FMEA section of IEC 60812:2018
- The FMEA emphasized analysis at the functional level, based on the defined component functions.
- The failure modes were generally defined as the negative of the function resulting in contributors leading to fire, electrical shock, or injury to personnel or the environment.



- Limited procedures were provided that indicate typical responses to emergent conditions. Therefore, typical Administrative Controls were assumed and included in the proposed Layers of Protection. Validation of assumed Administrative Controls will be required as part of NFPA 855 documentation and is not part of this project deliverable.
- Requisite NFPA 855, Article 4.1.4, *Hazard Mitigation Analysis*, is not included within this project deliverable.
- The BESS OEM BESS design is not inclusive of Safety-Related components or systems. Therefore, unmitigated failures of interdependent systems are assumed to cause cascading failure.
- This analysis assumes the combinations of known or published latent/hidden failure/additional failure combinations that lead to an undesired event.

Hazard Identification

This FMEA does not attempt to identify every possible fault of every component in the system but focuses on those events that will result in fire, electrical shock, or injury to personnel. This FMEA relies upon the best available structure, system, or component information and leverages failure consequences of related quantitative analysis and/or national consensus standards for hazard identification. The attached FMEA is structured to depict system level functional failure modes and effects and evaluates documented mean-time-to-failure (MTTF) of the integrated systems and published failure modes and mechanisms that can lead to identified hazards. Many of the evaluated hazards are based on those presented in the National Fire Protection Association (NFPA) Standard 855 Standard for the Installation of Stationary Energy Storage Systems [22].

The potential risks range from loss of a given subsystem to the potential cascading impact of interdependent system performance. Interdependent system failures are evaluated to determine the impacts can result in system or subsystem loss. For example, understanding there are no Safety Integrity Level (SIL) certified equipment within the Empire Project, given a theoretical failure within the HVAC system, its failure is evaluated to determine if the Energy Storage Management System (ESMS) could be adversely impacted or damaged. The unavailability of the ESMS is then evaluated to determine the impact to increased probability of a fire, result in a shock, or injury to personnel.

Criticality Ranking (FMECA)

Failure Modes, Effects, and Criticality Analysis (FMECA) is an extension of the Hiller FMEA process which includes an additional criticality assessment for the Empire Project. The criticality ranking explicitly and transparently brings to prominence the most critical issues and is extremely helpful for deciding if additional corrective actions need to be implemented. In the development, follow-up and implementation process of corrective actions, the criticality ranking helps to evaluate that the effort, time and resources are commensurate with the criticality of the item.

Criticality rankings based on risk use a combination of the consequence (severity) of the failure and the anticipated likelihood of the consequence occurring. The analysis will highlight failure modes with high probability of occurrence and severity of consequences, allowing corrective actions to be implemented where they will produce the greatest impact. Ideally, frequency estimates will be based on historically quantifiable databases, but in many cases data of this type is unavailable or poorly documented. If the event of the information



unavailability industry experience is relied upon.

It is worth noting that some standards draw a distinction between a qualitative and quantitative criticality assessment. The quantitative assessment as described by the MIL STD 1629 [25] is quite involved and will not be discussed here as it not a requirement of this analysis. When necessary, qualitative assessment principles and judgement of criticality used expert judgment to place the event in criticality or risk matrix or a criticality benchmark.

The most common method used in this FMEA for qualitative evaluating the criticality is the use of ranking systems which scale severity of consequence vs. likelihood. The matrix shown in Figure 6 example has four levels of consequence and four levels of likelihood. More levels can be defined as needed, but anything less than four levels may not provide enough granularity to make appropriate risk-based decisions. This FMEA is a quantitative analysis that leverages recognized industry process safety management reliability databases supplemented by qualitative assessment when necessary.

Given the overall lack of reliability data for many evaluated systems and components, performing an assessment on a semi-qualitative level based on experience and knowledge of the system under study is sometimes the only means by which to achieve a meaningful criticality assessment. However, this BOP FMEA leveraged published reliability data for comparable systems and components and utilized engineering judgement when necessary. A high severity and high likelihood event is not acceptable, and where appropriate risk control measures to reduce either the likelihood of occurrence or severity may was applied to establish technically defensible bases for risk.

Failure Mode Identification

A common approach for FMEA is to analyze failures related to a particular function of the equipment not being performed or being performed incorrectly. For example, while not directly applicable to the Empire project, assuming a system needs to pump x gpm from point A to point B. Typical functional failures for such a system would include failure of pumping capability, pumping at a rate below requirements, pumping at a rate exceeding requirements and pumping backwards. The causes or failure mechanisms for these functional failures would include motor failure; loss of power; degraded pump or motor, under voltage to motor; over voltage to motor; leaky non-return valve on discharge of pump.

This FMEA utilizes the failure modes/mechanisms identified in FMD-2016, OREDA, exida, and other identified recognized industry publications to characterize credible failure modes [4, 6, 12-15].

The intent of the use of FMD-2016, IEEE Std. 493-1997 and the other databases is to present failure distributions on parts and assemblies to be used in support of reliability analyses for the Empire Project. Failure Data and Distributions presented in the attached FMEA can be used to apportioned cut-sets (a cut set is the unique combinations of component failures that can cause system failure) of an item's failure rate into modal elements by multiplying the failure rate by the percentage attributable to specific failure modes. The intent of these distributions is to provide a baseline set of probabilities to be used in understanding the potential risks of a given hazard.



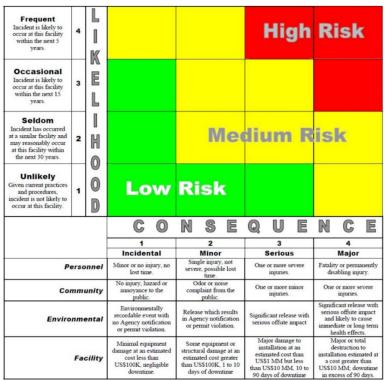


Figure 6: Example of a Qualitative Risk Matrix

The majority of information used in this document is derived from previously published industry and market sector reports of energy storage systems. Where and when necessary, engineering judgement is applied based on energy storage market sector experience. Historical published Maintenance data was the next most predominant performance source followed by failure analysis reports. It is noted that there are inherent gaps in the published failure databases where specific manufacture device information may not be available. To address this issue, applicable failure distributions were derived based on several data sources and will be integrated to yield a single failure normal distribution. Initial data analysis and summarization efforts included the use of various weighting schemes to rank the data in accordance with a combination of both the quality and quantity of data. While this methodology has merit, in some circumstances and where appropriate some individual data sources were weighted equally.

The Failure Mode/Mechanism fields presented in the databases and publications used are "categorized failure modes or mechanisms". For the purposes of this analysis, a failure mode is defined as the "observable consequence of failure where the failure mechanism is defined as the physical process which causes the failure" [4]. Failure modes and normal probability distributions are categorized by industry expertise and empirical data from which the detailed failure description is derived. Industry expertise and empirical data is relied upon for the efficacy of all reviewed failure modes and mechanisms for a given part type or a structured list that is representative of all data sources. Relevant and recent industry data will be used when applicable.

The Empire BOP FMEA considered the following typical functional failures and impacts:

• Catastrophic Failure – leading to fire, electrical shock, and injury of personnel.



- Empire II LLC, Confidential -
- Premature or spurious operation leads to degraded or catastrophic failure.
- Failure to operate when required as an unmitigated operating scenario as no SIL equipment is included in the design.
- Intermittent operation where interdependent system reliability/availability may be overcome by environmental conditions due to fire or system degradation.
- Failure to stop/initiate operating when required.
- Loss of interdependent communication and control input/output or failure during operation.
- Degraded output or degraded operational capability or functionality.

Single Failure Criteria

While NFPA 855 does not require consecutive failures, this FMEA was performed assuming single failures and their effects (i.e., two simultaneous independent failures are not considered) are the initiating events that could lead to over applicable 500 failure scenarios. Assessments of this type are usually limited to SSC failures that would result in unwanted consequences. A "single act" is generally taken to mean the operation of a single button, switch, lever, etc. There are two distinct instances when more than one failure was considered in this FMEA:

- When one of the failures can be latent, undetected or hidden.
- When two or more systems or components can fail due to a single specific event or cause (common cause failures).

Hidden Detectable Failures

An exception to the single failure criteria is for the case of latent, or hidden, failures where their presence is not readily detectable. In such cases, single failures in combination with an initial hidden failure and their combined consequences were included in this analysis. Since the initial hidden



Figure 7: Hidden Detectable Failure

failure is typically unknown until the second failure occurs, the two failures are considered together as a single event. Equipment that performs a back-up function and is in a non-operational or standby state may fall into this category if the functionality of the stand-by equipment cannot be verified until it is activated. Likewise, most safeguards and barriers are prone to hidden failures. They are not needed for operation but without proper monitoring to detect their failure, could result in a common cause/mode failure. It is generally understood that it is only discovered when there is a demand for the safeguard due to another failure of an interdependent system or subsystem.

It is important to note that not every hidden failure was not specifically assessed in the evaluation of the Empire Project BOP FMEA. The level to which hidden failures are assessed depends on the ramifications known and where detectability and probability of occurrence and are based on either industry experience or published data. Unknown failure mechanisms of known systems are not considered as part of this FMEA. Unknown failure mechanisms of the documented system could result in an unanalyzed state resulting in catastrophic loss of the



ESS, electrical shock, or injury to personnel.

The BESS OEM BESS design is not inclusive of Safety-Related components or systems. Therefore, unmitigated failures of interdependent systems are assumed to cause cascading failure. No other SIL equipment was identified are used in this analysis.

This analysis assumes the combinations of known or published latent/hidden failure/additional failure combinations that lead to an undesired event, but loss of either component on its own will not.

Common Cause Failures

A common cause failures occur when where multiple failures occur due to a shared cause or cause (e.g., multiple components failing due to high temperature): a design deficiency, a manufacturing defect, operation and maintenance errors, an environmental issue, an operator-induced event, or an unintended cascading effect from any other operation, failure within the system, or a change in environmental conditions. For the purposes of this FMEA development, it is critical to identify aspects of the system design where a single event could cause the loss of more than one component leading to the system failing to perform its intended function.

In conducting this FMEA, consideration was given to external factors such as temperature, humidity and vibration which can lead to common cause failures in interdependent systems. An example of common cause failure might be a common power supply breaker operation that supplies electricity for redundant or interdependent functions.

Common connections between systems create paths by which a fault in one system may affect another independent system.

No design basis accidents are considered in this analysis.

Unavailability of Redundancy (due to maintenance or other cause)

The Empire BOP Project does not include redundant systems.

Failure of Active and Passive Components

Many of the evaluated components associated with the Empire BOP FMEA utilize passive components protective components. This FMEA utilizes the active and passive failure mechanisms outlined in FMD-2016 and are applied when necessary.

Passive static components are, in general, considered to be of high reliability, whereas active components have lower reliability. However, unless otherwise indicated, the failure data classification applied to passive components may, based on EPRD, NPRD, OREDA, or exida data, may have a significant probability of failure within certain systems and associated failures modes. In these cases, consideration for typical administrative controls is applied within this BOP FMEA to supplement associated engineering control for an integrated, layered

protection scheme. The applied Layers of Protection Analysis is based on IEC 61511, ANSI/ISA 84.01-1996, for risk mitigation [26, 27].

The concept of passive and active equipment can be explained as follows:

- Active or rotating components in mechanical systems refer to machinery that moves and rotates during operation (e.g., pumps, compressors, generators, thrusters, remote controlled valves, etc.). For electrical/electronic systems, active equipment refers to those that require being powered in some way to make them work (e.g., integrated circuits, PLCs, switchboards, etc.).
- Passive or static components in mechanical systems refer to those having parts that normally do not move (e.g., pipes, tanks, vessels, shell-and-tube heat exchanger, manual valves, etc.). For electrical/electronic systems, passive components are those that do not require energy to make them work (e.g., electrical cables, resistors, capacitors, etc.).

External Events as Failure Modes

This BOP FMEA does not evaluate the external events leading to equipment failure as no design basis accident scenarios have been identified.

FMEAs of Controls, Instrumentation and Safety Systems

The Empire Project does not have any identified Instrumented Safety Systems, and associated performance and failure effects are assumed to result from their failure. Safety Controls and levels are not evaluated as part of this FMEA.

Therefore, those systems designed for mitigation of fire, electrical shock, or injury of personnel are identified and applied as commercial grade assemblies.

Severity Classifications (Sv.)

The severity is a measure of the seriousness of the effect of the failure mode. The Severity classifications applied for the Empire ESS Project are assumed safety confidence metric and are assigned to provide a qualitative measure of the worst possible consequences resulting from failure. Typically, scales are assigned to predetermined loss criteria.

Table 1 presents the severity classification that was used in the analysis of this BOP Project.



Table 1: Starlight Solar Severity Classification

Rating	Severity	Customer Description
10	Catastrophic Weighting:100	Very hazardous effect. Effect occurs suddenly without warning to user and may pose a safety concern. Non-compliance with regulatory requirements and injury is likely.
9	HAZARDOUS EFFECT WITH WARNING Weighting:90	Potentially hazardous effect with safety concerns. Able to halt system operation without mishap, i.e., gradual failure. Compliance with significant regulatory requirements is in jeopardy.
8	SERIOUS EFFECT Weighting:80	System, subsystem, major component is inoperable but safe, or a system is inoperable but safe.
7	MAJOR EFFECT Weighting:70	System performance is severely degraded but has some operational capability and remains safe. A subsystem may be inoperable but in a degraded condition impacting BOP mission objectives.
6	SIGNIFICANT EFFECT Weighting:60	Noticeable system degraded performance is observed but operable and safe, or a non-vital subsystem is inoperable. A subsystem may be in a degraded condition impacting BOP mission objectives causing interdependent system instability.
5	MODERATE EFFECT Weighting:50	Moderate degradation of BOP performance; non-vital fault often requires repair.
4	MINOR EFFECT Weighting:40	Minor degradation of product performance that generally does not require repair.
3	SLIGHT EFFECT Weighting:30	Slight degradation of product performance. Non-vital fault noticed by median performance with inconsequential annunciation of system performance parameters not satisfied.
2	VERY SLIGHT EFFECT Weighting:10	Very slight degradation of BOP interdependent system performance. Easily corrected during convenient scheduled maintenance activities.
1	No Effect Weighting:0	No discernible effect.

Occurrence Classifications (OC.)

Occurrence is often expressed as a qualitative or quantitative probability of failure mode occurrence. Typically, metrics are assigned to predetermined probability criteria. Occurrence classifications reflect the probability that a failure mode will occur during the planned life expectancy of the system. These qualitative probabilities can be described in terms of potential occurrences per unit time, events, population, items, or activity.



Table 2: Starlight Solar Occurrence Classification Ranking

Rating	Occurrence	History	Failure Rate
1.	Remote	Significant, proven prevention controls. Implemented design previously and has proven predictability. Failure rate of 1 in a million operational hours	>1E ⁻⁶
2.	Very Low	Significant, proven prevention controls. Failure rate of 1 in a one hundred thousand to million operational hours	1E ⁻⁵ to 1E ⁻⁶
3.	Low	Good and effective prevention controls. Existing Technology with new application. Knowledge of many factors, effects and noises. Failure rate of 1 in ten thousand operational hours	0.0001
4.	Moderate: 1 in 2000	Strong prevention controls. Existing Technology with new application. Knowledge of many factors, effects and impacts. Failure rate of 1 in 2000 operational hours	0.005
5.	Moderate: 1 in 400	Significant, proven prevention controls. Implemented design previously and has proven predictability. Failure rate of 1 in 400 operational hours	0.0025
6.	Moderate: 1 in 80	Some proven prevention controls. Failure rate of 1 in 80 operational hours	0.0125
7.	High: 1 in 20	limited prevention controls. Failure rate of 1 in 20 operational hours	0.05
8.	High: 1 in 8	Ineffective prevention controls. Failure rate of 1 in 8 operational hours	0.125
9.	Very High: 1 in 3	Ineffective prevention controls. Failure rate of 1 in 3 operational hours	.025



10.	Very High: 1 in 2	No prevention controls. Failure rate of 1 in 2 operational hours	0.5
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Detection Classifications (Dt.)

Detection is a qualitative measure of the probability of observing the failure mode or indications of imminent failure before advancing to the next operation, activity, or delivering a product to a customer. Typically, scales are assigned to predetermined detection probability criteria.

Detection classifications reflect an assessment of the ability of existing process controls to detect a potential failure mode or cause before the failure effect can be realized. Detection Classification criteria used for the Starlight Solar Project are presented in Table 3.

Table 3: Starlight Solar Detection Classification Ranking Criteria

Rating	Detection	Criteria
1	Almost Certain	Highest effectiveness of method; detection nearly certain in all known cases (proven design standard, best practice with near-total elimination of failure, etc.) where highly instrumented systems will annunciate when performance thresholds are achieved. Detection Probability: 1
2	Very High	Effectiveness is very high but requires discretion i.e., test history of similar parts using proven test methods or validated simulation, computation, or modeling Detection Probability: 0.5
3	High	High level of effectiveness, such as previously verified calculation or simulation based on similar designs; degradation testing prior to design release Detection Probability: 0.25
4	Moderately High	Effective detection based on data-driven extrapolation and/or technical judgment from testing to failure or computation, simulation, or analysis with some correlation to expected operating conditions Detection Probability: 0.125
5	Moderate	Moderate detection from testing or computation, i.e., test results from moderately similar designs or order-of-magnitude computations; pass/fail testing prior to design release Detection Probability: 0.05
6	Low	Detection methods reveal failure modes less than half the time; degradation testing in controlled conditions Detection Probability: 0.0125
7	Very Low	Available methods reveal failure modes only under optimal conditions; testing to failure after design release Detection Probability: 0.0025



8	Remote	Available methods require extensive judgment or extrapolation and are known to have limited capability; pass/fail testing after design release Detection Probability: 0.005
9	Very Remote	Speculative, unproved, or unreliable methods of detection; virtual analysis is not correlated with expected operating conditions Detection Probability: 0.0001
10	Absolute Uncertainty	No known effective technique or method available, or no analysis planned Detection Probability: 0

Causes

Causes indicate a reason for why or how a failure mode can occur. However, all causes do not contribute equally to a potential failure mode. Only "root causes" are likely to contribute to the majority of the failure mode. These root causes were emphasized in cause determination. The cause of failure is attributed to physical or electrical processes, design defects, quality defects, part misapplication, or other processes which are the basic reason for failure, or which initiate the physical process by which deterioration proceeds to failure.

Common cause failures (CCFs) are those failures when there is more than one component, item, or system due to the same cause or initiating event. CCF can involve the initiating event and one or more safeguards, or the interaction of several safeguards.

Risk Priority Number

Automotive FMEAs often use Risk Priority Number (RPN) values to assess criticality. Higher RPN values are an indication of more critical items. The product of the severity, occurrence, and detection values determines the RPN. The equation for RPN is: RPN = Severity × Occurrence × Detection.

Results and Discussion

The detailed BOP FMEA results for the Empire Project are contained in Attachments A of this report.

The detailed FMEA demonstrates the credited potential failure mode, potential effect, cause, measures for prevention, and detection that is presented FMD-2016, IEEE Std. 493 or understood from industry databases for each system, subsystem or major system component. Using the values determined for severity, occurrence, and detection a risk priority number (RPN) was calculated for each failure mode.

Failure modes with a RPN greater than 100 should be evaluated and actions were taken in order to reduce the RPN to a value below 100. The RPN value of 100 is an industry accepted threshold that is used to promote further discussions to determine if additional cost-effective measures can be implemented to reduce the probability of the risk. Likewise, it is recommended mitigation strategies be considered by the design team to lessen the likelihood of an event occurring.



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Attachment A: Starlight Solar BOP IEC 60812 Failure Mode and Effects Analysis



Prepared by: Robert Steele, PhD.

FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 1 of 135

Design Responsibility: Empire II, LLC and BESS OEM

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Documents

12302 Exposition Blvd | Los Angeles, CA 90068 Design Basis: Assumed Typical LFP BESS Project Project Manager: Mr.James Whalen

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1	1.1	Starlight Solar Project BESS Yard	Reduced Capacity	Moderate Effect - Moderate degradation of product performance;	10	FC-78 System degradation results in reduced power delivery to the grid	5	EC-01 Auto Shutdown: Ability of system to actively shut itself down or disconnect itself	4	200	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC Starlight Solar EOPs and SOP update	Refer to Empire II, LLC Procedures Index	5	4	3	60
	1.2		Eventual BESS Unavailability	Moderate Effect - Moderate degradation of product performance;	10	FC-75 Degradation/Age related failure: Failures realized as part of programming lifecycle	5	EC-01 Auto Shutdown: Ability of system to actively shut itself down or disconnect itself	3	150	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC Starlight Solar EOPs and SOP update	Refer to Empire II, LLC Procedures Index	5	4	2	40
	1.3		No Immediate Measurable Impact	Moderate Effect - Moderate degradation of product performance;	8	FC-76 Random Failure: Failures that they do not appear to have any pattern or regularity.	4	EC-01 Auto Shutdown: Ability of system to actively shut itself down or disconnect itself	10	320	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC Starlight Solar EOPs and SOP update	Refer to Empire II, LLC Procedures Index. Requires validation substantiatin g RPN reduction	4	3	8	96
	1.4		Industrial Safety (Fire, Personnel) Issue	Catastrophic - Very hazardous effect. Effect occurs suddenly without warning to user and may pose an industrial safety concern.	10	FC-04 Haz Internal Temp: High temperature in the room from normal operations	5	AC-01: EOP - System operator plan to handle all emergency events. Refer to Empire II, LLC Procedures Index	7	350	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC Starlight Solar EOPs and SOP update	Refer to Empire II, LLC Procedures Index. Requires validation substantiatin g RPN reduction	5	4	4	80
	1.5		ESMS/BMS Control Failure	Hazardous Effects with Indication	9	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	8	AC-01: EOP - System operator plan to handle all emergency events	2	144	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC Starlight Solar EOPs and SOP update	Refer to Empire II, LLC Procedures Index. Requires validation substantiatin g RPN reduction	5	6	3	90



Prepared by: Robert Steele, PhD.

FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 2 of 135

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Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Project Manager: Mr.James Whalen

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Oc	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1	1.6	Starlight Solar Project BESS Yard	Electrical fault resulting in unavailability	Serious Effects - Product is inoperable but safe, or a system is inoperable but safe.	8	FM-01: Electrical Failure	5	EC-22 Site Elec Prot: Protection for electrical systems such that a failure of the PCS or associated circuit does not result in adverse effects on the site balance of system electrical gear	3	120	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC Starlight Solar EOPs and SOP update	Refer to Empire II, LLC Procedures Index	4	4	2	32
	1.7		Failure to Operate	Moderate Effect - Moderate degradation of product performance;	5	FC-05 HVAC Failure: Mechanical or electrical failure of the HVAC system that will result in high temperatures throughout system	7	EC-08 Redundant HVAC: Design, sizing, and hardware physical redundancy of the HVAC system such that failure of one or multiple units does not result in adverse conditions within the container or system	5	175	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC Starlight Solar EOPs and SOP update	Refer to Empire II, LLC Procedures Index	3	6	4	72
	1.8		Partial/Total loss of capacity	Minor Effect - Minor degradation of product performance that generally does not require repair.	4	EC-03 ESS HVAC: Heating, ventilation and air conditioning for the overall container designed to maintain overall system temperature and humidity levels.	7	EC-25 Container Monitoring: Monitoring within the container which may detect adverse Container Thermal/Operati ng Environment Conditions	5	140	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC Starlight Solar EOPs and SOP update	Refer to Empire II, LLC Procedures Index	2	6	4	48
	1.9		Inadvertent System S/D	Moderate Effect - Moderate degradation of product performance;	5	FM-36 Elec Risks, Electrical Design Failure: Overall bad design that allows ground loops, floating, voltages, etc which would force errors.	7	AC-01: EOP - System operator plan to handle all emergency events. AC-11 Human Factors/RAGAG EP: In addition to analysis required by product standards, good engineering practice should require design review such that design mistakes and weaknesses	7	245	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC Starlight Solar EOPs and SOP update	Refer to Empire II, LLC Procedures Index	3	6	5	90



Empire II, LLC Starlight Solar Project BOP Level FMEA Empire II, LLC

Page 3 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Design Responsibility: Empire II, LLC and BESS OEM

											Documents						
Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1	1.10	Starlight Solar Project BESS Yard	Potential System Overvoltage Transients	Serious Effects - Product is inoperable but safe, or a system is inoperable but safe.	8	FM-76 Random Failure: Failures that they do not appear to have any pattern or regularity. FM-77 Systematic Failure: Failures that they are related deterministically to a certain cause or causes	4	"AC-01: EOP - System operator plan to handle all emergency events. AC-11 Human Factors/RAGAG EP: In addition to analysis required by product standards, good engineering practice should require design review such that design mistakes and weaknesses"	4	128	AC-01: EOP - System operator plan to handle all emergency events.	Empire II LLC EOPs and SOP update	Refer to Starlight Solar Procedures Index	5	4	4	80
	1.11		Degraded Performance	Moderate Effect - Moderate degradation of product performance;	7	FM-76 Random Failure: Failures that they do not appear to have any pattern or regularity. FM-77 Systematic Failure: Failures that they are related deterministically to a certain cause or causes	3	"AC-01: EOP - System operator plan to handle all emergency events. AC-11 Human Factors/RAGAG EP: In addition to analysis required by product standards, good engineering practice should require design review such that design mistakes and weaknesses"	4	84	AC-01: EOP - System operator plan to handle all emergency events.	Empire II LLC EOPs and SOP update	Refer to Starlight Solar Procedures Index	5	3	3	45



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Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 4 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Design Basis: Assumed Typical LFP BESS Project

FMEA Date (Orig.): 23 July 2025	Project Manager: Mr.James Whalen	Design E Docume
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(typ.) OEM BESS Structure	System Level Short Circuit Current Contribution	Major Effect - Product performance is severely degraded but has some operational capability and remains safe. Serious Effects - Product is inoperable but safe, or a system is inoperable but safe.	8	FC-39 Human Factors - Design Errors and Omissions	4	EC-17 Elec Pass Prot: Current interrupt devices, fuses or other passive surge arresting elements which may open the	6	192	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC Starlight Solar EOPs and SOP update	Refer to Empire II, LLC Procedures	4	3	5	60
						circuit in the case of failure and general resilience of design to withstand adverse electrical conditions.					Index				
	Rapid Cell Discharge	Eventual BESS Unavailability Significant Effect - Product performance is degraded but operable and safe, or a non-vital part is inoperable. Serious Effects - Product is inoperable but safe, or a system is inoperable but safe.	8	FC-17 Cell Therm Runaway: A single cell has entered thermal runaway resulting in flames and combustion or production of flammable or explosive gases	4	EC-19 Adequate Sense/Cntrl: Aggregate of the ability of the BMS to detect cell imbalance and to properly return system to balance if possible.	6	192	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC Starlight Solar EOPs and SOP update	Refer to Empire II, LLC Procedures Index	4	3	5	60
	Cascading Fire and BESS Loss	Hazardous Effects with Indication Industrial Safety (Fire, Personnel) Issue Catastrophic - Very hazardous effect. Effect occurs suddenly without warning to user and may pose an industrial safety concern.	10	FC-47 Elec Risks, FACP Failure to detect and actuate Thermal Management Coolant	7	AC-02: EOP - Fire department response including active firefighting suppression	7	490	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC Starlight Solar EOPs and SOP update	Refer to Empire II, LLC Procedures Index. Requires validation substantiatin g RPN reduction	4	6	4	96
	System Overtemperature Trip	Serious Effects - Product is inoperable but safe, or a system is inoperable but safe.	8	FC-05 HVAC Failure: Mechanical or electrical failure of the HVAC system that will result in high temperatures throughout system	6	EC-01 Auto Shutdown: Ability of system to actively shut itself down or disconnect itself	4	192	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC Starlight Solar EOPs and SOP update	Refer to Empire II, LLC Procedures Index	4	5	3	60
	Excessive Thermal Cycling	Moderate Effect - Moderate degradation of product performance; Significant Effect - Product performance is degraded but operable and safe, or a non-vital part is inoperable.	6	FC-05 HVAC Failure: Mechanical or electrical failure of the HVAC system that will result in high temperatures throughout system	6	EC-01 Auto Shutdown: Ability of system to actively shut itself down or disconnect itself	4	144	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC Starlight Solar EOPs and SOP update	Refer to Empire II, LLC Procedures Index	3	5	3	45
		Overtemperature Trip Excessive Thermal	System Overtemperature Trip Serious Effects - Product is inoperable but safe, or a system is inoperable but safe. Excessive Thermal Cycling Moderate Effect - Moderate degradation of product performance; Significant Effect - Product performance is degraded but operable and safe, or a non-vital	System Overtemperature Trip Serious Effects - Product is inoperable but safe, or a system is inoperable but safe. 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Serious Effects - Product is inoperable but safe, or a system is inoperable and safe, or a non-vital operable and safe, or a non-vital of the HVAC system that will result in plight emperatures of the HVAC system that will result in plight emperatures of the HVAC system that will result in plight emperatures of the HVAC system that will result in plight emperatures of the HVAC system that will result in plight emperatures of the HVAC system that will result in plight emperatures of the HVAC system that will result in plight emperatures of the HVAC system that will result in plight emperatures of the HVAC system that will result in plight emperatures of the HVAC system that will result in plight emperatures of the HVAC system that will result in plight emperatures of the HVAC system that will result in plight emperatures of the HVAC system that will result in plight emperatures of the HVAC system that will result in plight emperatures of the HVAC system that will result in plight emperatures of the HVAC system that will result in plight emperatures of the HVAC system that will result in plight emperatures of the HVAC system that will result in plight emperatures of the HVAC system that will result in plight emperatures of the HVAC system to actively shut itself down or disconnect itself shift experiment that will result in plight emperatures of the HVAC system to actively shut itself down or disconnect itself shift experiment that will result in plight emperatures of the HVAC system to actively shut itself down or disconnect itself shift



Prepared by: Robert Steele, PhD.

FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 5 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM
Design Basis: Assumed Typical LFP BESS Project

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Documents

Project Manager: Mr.James Whalen

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.1	1.1.6	(typ.) OEM BESS Structure	Thermal Abuse	Significant Effect - Product performance is degraded but operable and safe, or a non-vital part is inoperable. Hazardous Effects with Indication	9	FC-03 Module Failure: Hazardous Temperature Condition - Module. High temperature in the module during normal operation without failure/thermal runaway	6	EC-21 BMS Cntrl: Includes monitoring and shutdown/isolati on capabilities of the affected BMS/module or system if necessary.	5	270	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC Starlight Solar EOPs and SOP update	Refer to Empire II, LLC Procedures Index. Requires validation substantiatin g RPN reduction	5	5	3	75
	1.1.7		Degraded Operation	Reduced Capacity Inadvertent System S/D Eventual BESS Unavailability	6	FM-34 Elec Risks, Inadequate Balancing/Balancin g Failure: This includes cells that become imbalanced within a module, modules out of balance with other modules in a string or strings/racks out of balance with the rest of the system.	6	EC-01 Auto Shutdown: Ability of system to actively shut itself down or disconnect itself EC-21 BMS CTRL: Includes monitoring and shutdown/isolati on capabilities of the affected BMS/module or system if necessary.	4	144	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC Starlight Solar EOPs and SOP update	Refer to Empire II, LLC Procedures Index, PLACEHOL DER Refer to Empire II, LLC Emergency Operating Procedure No.	3	5	3	45
	1.1.8		Loss of BESS OEM Liquid Thermal Management	Inadvertent System S/D Eventual BESS Unavailability Industrial Safety (Fire, Personnel) Issue	10	FM-54 Cascading failure of interdependent/inter facing system into connected systems	7	EC-01 Auto Shutdown: Ability of system to actively shut itself down or disconnect itself EC-21 BMS CTRL: Includes monitoring and shutdown/isolati on capabilities of the affected BMS/module or system if necessary.	4	280	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC Starlight Solar EOPs and SOP update	Refer to Empire II, LLC Procedures Index, PLACEHOL DER Refer to Empire II, LLC Emergency Operating Procedure No. DER	5	6	3	90
	1.1.9		BMS Malfunction	Inadvertent System S/D ESMS/BMS Control Failure Partial/Total loss of capacity	9	FM-45 Loss of BMS due to Software Induced Problem/Failure	7	EC-21 BMS CTRL: Includes monitoring and shutdown/isolati on capabilities of the affected BMS/module or system if necessary.	5	315	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC Starlight Solar EOPs and SOP update	Refer to Empire II, LLC Procedures Index, PLACEHOL DER	5	6	3	90



Empire II, LLC

Page 6 of 135

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen Design Responsibility: Empire II, LLC and BESS OEM
Design Basis: Assumed Typical LFP BESS Project

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Documents

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
													Refer to Empire II, LLC Emergency Operating Procedure No. PLACEHOL DER				
1.1	1.1.10	1.10 (typ.) OEM BESS Structure	ESMS Malfunction	ESMS/BMS Control Failure Eventual BESS Unavailability Inadvertent System S/D Partial/Total loss of capacity	9	FM-12 ESMS Failure: Failure of the controller at the rack or system level which results in adverse condition to the system	6	EC-31 ESMS/BMS CTRL: Ability of the BMS and balancing system to adequately balance the circuit including sizing of the balancing resistors or transistors	5	270	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC Starlight Solar EOPs and SOP update	Refer to Empire II, LLC Procedures Index, PLACEHOL DER Refer to Empire II, LLC Emergency Operating Procedure No. PLACEHOL DER	5	5	3	75
	1.1.11		Communications Systems Failure	Inadvertent System S/D ESMS/BMS Control Failure Partial/Total loss of capacity	9	FM-15 Comms Failure: Failure of the system to properly report an adverse condition to local or remote monitoring. Failure of the system to report failures within itself and to act on those failures, resulting in adverse condition	5	EC-27 Inv/PCS CTRL: Includes monitoring, shutdown/isolati on capabilities. and transient protections	5	225	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC Starlight Solar EOPs and SOP update	Refer to Empire II, LLC Procedures Index, PLACEHOL DER Refer to Empire II, LLC Emergency Operating Procedure No. PLACEHOL DER	5	4	4	80
	1.1.12		Fire/Deflagration	Industrial Safety (Fire, Personnel) Issue Partial/Total loss of capacity	10	FM-02 Cell Failure: Hazardous Temperature Condition - Cell. High temperature at the cell level during normal operations w/o thermal runaway	6	EC-04 Temp Monitoring/Alarm s: Thermal monitoring within the container including BMS, fire alarm thermal monitoring and any BoS temperature monitoring	6	360	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC Starlight Solar EOPs and SOP update	Refer to Empire II, LLC Procedures Index, PLACEHOL DER	5	5	5	125



Empire II, LLC

Page 7 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Design Responsibility: Empire II, LLC and BESS OEM

Documents																	
Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
													Refer to Empire II, LLC Emergency Operating Procedure No. PLACEHOL DER				
1.1	1.1.13	(typ.) OEM BESS Structure	Mechanical Impact/Damage	Partial/Total loss of capacity Eventual BESS Unavailability Failure to Operate	5	FM-37 Misc Human Factors: Human induced failures due to negligence		AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	3	45	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC Starlight Solar EOPs and SOP update	Refer to Empire II, LLC Procedures Index, PLACEHOL DER Refer to Empire II, LLC Emergency Operating Procedure No. PLACEHOL DER	3	2	2	12



Empire II. LLC

Page 8 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

Design Basis: Assumed Typical LFP BESS Project Project Manager: Mr.James Whalen Documents **Potential** Current Potential failure Recommended cause(s) / Responsibility | Actions ID Item function Effects descriptions Sv Oc Dt **RPN** Sv Oc Dt **RPN Parent** Design mode failure Action(s) and Date Taken Controls mechanisms 60 2 1.1.1 1.1.1.1 UPS Output fails to BESS trip if UPS Reduced Capacity FC-31 Elec Risks, EC-21 BMS AC-01: EOP - System Empire II, LLC Refer to 18 zero/ Unhealthy output falls to zero or Moderate Effect - Moderate Hazardous Voltage Cntrl: Includes operator plan to handle Starlight Solar Empire II. EOPs and SOP non-zero below threshold. degradation of product Condition: This monitoring and all emergency events. LLĊ Strings lost if output could include high shutdown/isolati Procedures performance: update on capabilities of falls unhealthy (line voltages, high Index Non-zero) voltages from the the affected PCS. floating BMS/module or ground issues, or system if other high voltage necessary issues at the cell, module or rack level 1.1.1.2 BESS trip if UPS EC-01 Auto 60 AC-01: EOP - System 2 Reduced Capacity FC-64 Operating Empire II, LLC Refer to output falls to zero or Moderate Effect - Moderate Outside of Shutdown: operator plan to handle Starlight Solar Empire II, Specification: A below threshold. degradation of product Ability of system all emergency events. EOPs and SOP LLĊ Strings lost if output performance; failure resulting to actively shut update Procedures falls unhealthy (from the fact that itself down or Index Non-zero) the failed system disconnect itself was operating outside of specifications (e.g., high voltage surge caused by lightning, electromagnetic/radi o frequency interference (EMI/RFI) induced fault 1.1.1.3 BESS trip if UPS Reduced Capacity Significant Effect - Product FC-64 Operating EC-01 Auto AC-01: EOP - System Empire II. LLC Refer to output falls to zero or Outside of Shutdown: operator plan to handle Starlight Solar Empire II, below threshold. performance is degraded but Specification: A Ability of system all emergency events. EOPs and SOP operable and safe, or a non-vital to actively shut Procedures Strings lost if output failure resulting update falls unhealthy (part is inoperable. from the fact that itself down or Index Non-zero) the failed system disconnect itself was operating outside of specifications (e.g., high voltage surge caused by lightning, electromagnetic/radi o frequency interference (EMI/RFI) induced fault



Prepared by: Robert Steele, PhD.

FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 9 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Design Basis: Assumed Typical LFP BESS Project Documents

Project Manager: Mr.James Whalen

Potential Current Potential failure cause(s) / Recommended Responsibility | Actions Effects descriptions Oc Design **Parent** ID Item function Sv Dt **RPN** Sv Oc Dt **RPN** mode failure Action(s) and Date Taken Controls mechanisms 1.1.1 1.1.1.4 Reduced Capacity Significant Effect - Product 90 2 24 UPS Output fails to BESS trip if UPS FC-64 Operating EC-01 Auto AC-01: EOP - System Empire II, LLC Refer to zero/ Unhealthy output falls to zero or Outside of Shutdown: operator plan to handle Starlight Solar Empire II, Specification: A Ability of system EOPs and SOP LLĊ non-zero below threshold. performance is degraded but all emergency events. failure resulting update Strings lost if output operable and safe, or a non-vital to actively shut Procedures falls unhealthy (part is inoperable. itself down or from the fact that Index Non-zero) the failed system disconnect itself was operating outside of specifications (e.g., high voltage surge caused by lightning, electromagnetic/radi o frequency interference (EMI/RFI) induced fault



Prepared by: Robert Steele, PhD.

FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 10 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM
Design Basis: Assumed Typical LFP BESS Project

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Project Manager: Mr.James Whalen

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.1.2	1.1.2.1	Excessive Environmental Exposure	Increased battery temperature, reduced life and capacity , HVAC overload	Eventual BESS Unavailability Significant Effect - Product performance is degraded but operable and safe, or a non-vital part is inoperable.	6	FC-37 Misc Human Factors: Human induced failures due to negligence	5	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	5	150	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC Starlight Solar EOPs and SOP update	Refer to Empire II, LLC Procedures Index	3	4	4	48
	1.1.2.2		Increased battery temperature, reduced life and capacity , HVAC overload	Eventual BESS Unavailability Significant Effect - Product performance is degraded but operable and safe, or a non-vital part is inoperable.	6	FC-37 Misc Human Factors: Human induced failures due to negligence	5	EC-25 Container Monitoring: Monitoring within the container which may detect adverse Container Thermal/Operati ng Environment Conditions	5	150	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC Starlight Solar EOPs and SOP update	Refer to Empire II, LLC Procedures Index	3	4	4	48



Project Manager: Mr.James Whalen

Empire II, LLC

Page 11 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Design Basis: Assumed Typical LFP BESS Project Documents

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.1.3	1.1.3.1	Fail to contain the fire due to burning battery into single battery compartment	Delayed Thermal Management Coolant	Cascading Fire and BESS Loss Catastrophic - Very hazardous effect. Effect occurs suddenly without warning to user and may pose an industrial safety concern.	10	FC-10 Sensor Failure: A sensor inside the system fails, resulting in incorrect reporting of system properties	5	EC-12 Thermal Management Coolant: BESS OEM Liquid Cooling Thermal Management Direct Injection	5	250	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC Starlight Solar EOPs and SOP update	Refer to Empire II, LLC Procedures Index	5	4	4	80
	1.1.3.2		Incorrect Thermal Management Coolant	Cascading Fire and BESS Loss Catastrophic - Very hazardous effect. Effect occurs suddenly without warning to user and may pose an industrial safety concern.	10	FC-39 Human Factors - Design Errors and Omissions	7	AC-11 Human Factors/RAGAG: In addition to analysis required by product standards, good engineering practice should require design review such that design mistakes and weaknesses are identified and corrected in a timely and efficient manner	8	560	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC Starlight Solar EOPs and SOP update	Refer to Empire II, LLC Procedures Index. Requires validation substantiatin g RPN reduction	5	5	3	75
	1.1.3.3		Insufficient Thermal Management Coolant	Cascading Fire and BESS Loss Catastrophic - Very hazardous effect. Effect occurs suddenly without warning to user and may pose an industrial safety concern.	10	FC-39 Human Factors - Design Errors and Omissions	6	AC-11 Human Factors/RAGAG: In addition to analysis required by product standards, good engineering practice should require design review such that design mistakes and weaknesses are identified and corrected in a timely and efficient manner	7	420	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC Starlight Solar EOPs and SOP update	Refer to Empire II, LLC Procedures Index. Requires validation substantiatin g RPN reduction	5	5	3	75



Empire II, LLC

Page 12 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Design Responsibility: Empire II, LLC and BESS OEM

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.1.4	1.1.4.1	Protection Against System Overcurrent/Shock	Protection Against External Fault	System Level Short Circuit Current Contribution Rapid Cell Discharge Significant Effect - Product performance is degraded but operable and safe, or a non-vital part is inoperable.	8	FC-31 Elec Risks, Hazardous Voltage Condition: This could include high line voltages, high voltages from the PCS, floating ground issues, or other high voltage issues at the cell, module or rack level	4	EC-22 Site Elec Prot: Protection for electrical systems such that a failure of the PCS or associated circuit does not result in adverse effects on the site balance of system electrical gear	6	192	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC Starlight Solar EOPs and SOP update	Refer to Empire II, LLC Procedures Index	4	3	5	60



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 13 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Project Manager: Mr.James Whalen

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.1.5	1.1.5.1	Inadequate cooling	Reduced Battery Life , Increased Temp, Excessive current	Reduced Capacity Significant Effect - Product performance is degraded but operable and safe, or a non-vital part is inoperable.	6	FC-19 Int Defect/Failure/Fault: A cell has failed as a result of an internal defect or dendrite formation, creating a short circuit, open circuit, or other electrical condition or off-gas but not entering thermal runaway	4	EC-05 Module Therm Mgmnt: Thermal management at the model scale including effectiveness of system HVAC at this level, passive materials, fans and liquid cooling	3	72	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC Starlight Solar EOPs and SOP update	Refer to Empire II, LLC Procedures Index	3	3	2	18
	1.1.5.2		Reduced Battery Life , Increased Temp.loose electrical connection	Reduced Capacity Moderate Effect - Moderate degradation of product performance;	5	FC-08 Elect Hotspot: Loose connections in the system may increase resistance and cause hotspots. Hotspots may form in other ways for unknown reasons.	4	AC-05: Human Factors: Overall quality of the cell such that internal defects are minimized and cells maintain rigidity and shape during operations.	3	60	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC Starlight Solar EOPs and SOP update	Refer to Empire II, LLC Procedures Index	3	3	2	18
	1.1.5.3		Reduced Battery Life , Increased Temp. HVAC controller failure	Reduced Capacity Significant Effect - Product performance is degraded but operable and safe, or a non-vital part is inoperable.	6	FC-05 HVAC Failure: Mechanical or electrical failure of the HVAC system that will result in high temperatures throughout system	3	EC-08 Redundant HVAC: Design, sizing, and hardware physical redundancy of the HVAC system such that failure of one or multiple units does not result in adverse conditions within the container or system	2	36	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC Starlight Solar EOPs and SOP update	Refer to Empire II, LLC Procedures Index	3	2	2	12
	1.1.5.4		Reduced Battery Life , Increased Temp. IO sensor failure	Reduced Capacity Significant Effect - Product performance is degraded but operable and safe, or a non-vital part is inoperable.	6	FC-10 Sensor Failure: A sensor inside the system fails, resulting in incorrect reporting of system properties	4	EC-19 Adequate Sense/Cntrl: Aggregate of the ability of the BMS to detect cell imbalance and to properly return system to balance if possible.	3	72	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC Starlight Solar EOPs and SOP update	Refer to Empire II, LLC Procedures Index	3	3	2	18



Empire II, LLC

Page 14 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Design Responsibility: Empire II, LLC and BESS OEM

											Documents						
Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.1.5	1.1.5.5	Inadequate cooling	Reduced Battery Life, Increased Temp. Over voltage/ overcharging	Reduced Capacity Significant Effect - Product performance is degraded but operable and safe, or a non-vital part is inoperable.	6	FC-11 BMS Failure: Cell/module level monitoring and control fails, resulting in inability to shutdown, report adverse conditions, properly monitor, balance or protect the system resulting in adverse condition	3	EC-30 Vol/SoC Monitoring: This may apply at the cell, module, and rack level. While voltage monitoring may be useful more advanced methods such as coulomb counting may be used as well.	3	54	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC Startight Solar EOPs and SOP update	Refer to Empire II, LLC Procedures Index	3	2	2	12
	1.1.5.6		Reduced Battery Life , Increased Temp. HVAC failure	Reduced Capacity Moderate Effect - Moderate degradation of product performance;	7	FC-05 HVAC Failure: Mechanical or electrical failure of the HVAC system that will result in high temperatures throughout system	3	EC-08 Redundant HVAC: Design, sizing, and hardware physical redundancy of the HVAC system such that failure of one or multiple units does not result in adverse conditions within the container or system	2	42	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC Starlight Solar EOPs and SOP update	Refer to Empire II, LLC Procedures Index	4	2	2	16



Empire II, LLC Starlight Solar Project BOP Level FMEA Empire II, LLC

Page 15 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Design Responsibility: Empire II, LLC and BESS OEM

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.1.6	1.1.6.1	Loose electrical connection in one battery	Reduced Battery Life , May lead to Temperature hotspot,Structural Vibrations	Reduced Capacity Minor Effect - Minor degradation of product performance that generally does not require repair.	7	FC-23 Ext/Envr Risk, Mechanical Shock/Drop - The system, rack or module is subject to mechanical shock or drop, mechanical jarring or damaging the system	4	EC-23 ESS Cont Struct: Resiliency of the system and container of the system to withstand impacts or strikes	5	140	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	Empire II, LLC Engineering	Refer to Empire II, LLC Procedures Index	4	3	4	48
	1.1.6.2		Reduced Battery Life , May lead to Temperature hotspot, Corrosion at junction	Reduced Capacity Significant Effect - Product performance is degraded but operable and safe, or a non-vital part is inoperable.	8	Internal Failure - Electrical (Corrosion)	4	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	5	160	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	Empire II, LLC Engineering	Refer to Empire II, LLC Procedures Index	4	3	4	48
	1.1.6.3		Reduced Battery Life , May lead to Temperature hotspot, Poor workmanship;	Reduced Capacity Moderate Effect - Moderate degradation of product performance;	7	FC-37 Misc Human Factors: Human induced failures due to negligence	3	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	5	105	RA-01: Performance of Scheduled System Maintenance,	Empire II, LLC Engineering/O&M Provider	Refer to Empire II, LLC Procedures Index	4	2	4	32
	1.1.6.4		Reduced Battery Life , May lead to Temperature hotspot, Short Circuit Introduction	Significant Effect - Product performance is degraded but operable and safe, or a non-vital part is inoperable.	8	FC-08 Elect Hotspot: Loose connections in the system may increase resistance and cause hotspots. Hotspots may form in other ways for unknown reasons.	3	EC-20 Act Cell Prot: Active cell protections which may mitigate thermal runaway such as module fans, liquid cooling systems, module scale Thermal Management Coolant systems, or other mitigation measures	5	120	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/O&M Provider	Refer to Empire II, LLC Procedures Index	4	2	4	32



Empire II, LLC

Page 16 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.1.7	1.1.7.1	Uneven rate of cell degradation — Different cells at different timing	BMS Failure to control Module, Loss of Communication	Major Effect - Product performance is severely degraded but has some operational capability and remains safe.	7	FC-15 Comms Failure: Failure of the system to properly report an adverse condition to local or remote monitoring. Failure of the system to report failures within itself and to act on those failures, resulting in adverse condition		EC-31 ESMS/BMS Cntrl: Ability of the BMS and balancing system to adequately balance the circuit including sizing of the balancing resistors or transistors	8	168	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC Starlight Solar EOPs and SOP update	Refer to Empire II, LLC Procedures Index	4	2	7	56



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 17 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Oc	Dt	RPN
1.1.8	1.1.8.1	Battery catches fire	Electrical Abuse, Too many deep cycle charge/discharge	Hazardous Effects with Indication	9	FC-02 Cell Failure: Hazardous Temperature Condition - Cell. High temperature at the cell level during normal operations Wo thermal runaway	6	EC-29 Sys Elec Abuse Tolerance: Refers to ability of the overall system collectively to withstand adverse electrical abuse such as overcharge or dead shorts without failure	8	432	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Refer to Empire II, LLC Procedures Index	5	5	3	75
	1.1.8.2		Thermal Abuse, LTA Environmental Control	Hazardous Effects with Indication	9	FC-04 Haz Internal Temp: High temperature in the room from normal operations	3	EC-04 Temp Monitoring/Alarm s: Thermal monitoring within the container including BMS, fire alarm thermal monitoring and any BoS temperature monitoring	4	108	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Refer to Empire II, LLC Procedures Index	5	2	3	30



Empire II, LLC Starlight Solar Project BOP Level FMEA Empire II, LLC

Page 18 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Design Responsibility: Empire II, LLC and BESS OEM

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.1.9	1.1.9.1	Individual Cell Failure/Expansion	Compression forces on adjacent cells, Individual Cell Failure/Internal Pressure Development	Major Effect - Product performance is severely degraded but has some operational capability and remains safe.	7	FC-21 Cell Pressure Increase: A cell has begun to build internal pressure as a result of gas generation. The cell has not yet failed or vented this gas.	3	EC-35 Cell Passive Protection: High pressure release of gasses (venting)	7	147	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Refer to Empire II, LLC Procedures Index	4	2	6	48



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 19 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.1.10	1.1.10.1	External Forces Damage	Manufacturing and Assembly, Unintentional Module Housing Damage	Moderate Effect - Moderate degradation of product performance;	7	FC-22 Ext/Envr Risk, Impact - Something has struck, sharply or as blunt force, the battery system, causing mechanical damage or deformation	3	EC-24 Module Resiliency: Resiliency of the individual modules to withstand impacts, shocks or other mechanical abuse	4	84	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	Empire II, LLC Engineering/RRC/B ESS OEM Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	4	2	3	24
	1.1.10.2		Introduction of Debris, Manufacturing QA Oversight	Moderate Effect - Moderate degradation of product performance;	7	FC-40 Human Factors, MFG Quality Control: MFG induced failures due to quality control	5	EC-24 Module Resiliency: Resiliency of the individual modules to withstand impacts, shocks or other mechanical abuse	3	105	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	4	4	2	32
	1.1.10.3		Introduction of Debris, Module Cooling System Entrainment	Moderate Effect - Moderate degradation of product performance;	7	FC-29 Ext/Envr Risk, Dust/Dirt/Particulate Accumulation: LTA Maintenance	3	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	3	63	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	4	2	2	16
	1.1.10.4		Rack Field Assembly, Drop, Impact	Minor Effect - Minor degradation of product performance that generally does not require repair.	4	FC-22 Ext/Envr Risk, Impact - Something has struck, sharply or as blunt force, the battery system, causing mechanical damage or deformation	3	EC-24 Module Resiliency: Resiliency of the individual modules to withstand impacts, shocks or other mechanical abuse	3	36	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Refer to Empire II, LLC Procedures Index	2	2	2	8



Empire II, LLC

Page 20 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Design Responsibility: Empire II, LLC and BESS OEM

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.1.10	1.1.10.5	External Forces Damage	Manufacturing and Assembly, Internal Creepage and Clearance during transport and assembly	Minor Effect - Minor degradation of product performance that generally does not require repair.	6	FC-28 Ext/Envr Risk, Shipping and Construction: An issue occurs with the system during shipping or construction that results in an adverse condition that may or may not be detected or protected via active controls. Results in Cell Failure	3	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	6	108	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Refer to Empire II, LLC Procedures Index	3	2	5	30



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 21 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.1.11	1.1.11.1	Thermal Abuse	BMS Failure to control Module, Excessive Discharge	Excessive Thermal Cycling Major Effect - Product performance is severely degraded but has some operational capability and remains safe.	7	FC-32 Elec Risks, Hazardous Current Condition: This includes high current issues from the PCS or interconnection	4	EC-17 Elec Pass Prot: Current interrupt devices, fuses or other passive surge arresting elements which may open the circuit in the case of faillure and general resilience of design to withstand adverse electrical conditions.	5	140	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Refer to Empire II, LLC Procedures Index	4	3	4	48
	1.1.11.2		BMS Failure to control Module, Excessive Overcharge	Excessive Thermal Cycling Major Effect - Product performance is severely degraded but has some operational capability and remains safe.	7	FC-44 Module Failure: Loss of BMS Control	4	EC-31 ESMS/BMS Cntrl: Ability of the BMS and balancing system to adequately balance the circuit including sizing of the balancing resistors or transistors	5	140	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Refer to Empire II, LLC Procedures Index	4	3	4	48



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 22 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Project Manager: Mr.James Whalen

											Documents						
Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.1.12	1.1.12.1	Electrical Abuse	BMS Failure to control Module, Excessive Discharge	Major Effect - Product performance is severely degraded but has some operational capability and remains safe.	8	FC-32 Elec Risks, Hazardous Current Condition: This includes high current issues from the PCS or interconnection	4	EC-17 Elec Pass Prot: Current interrupt devices, fuses or other passive surge arresting elements which may open the circuit in the case of failure and general resilience of design to withstand adverse electrical conditions.	5	160	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Refer to Empire II, LLC Procedures Index	4	3	4	48
	1.1.12.2		BMS Failure to control Module, Excessive Overcharge	Major Effect - Product performance is severely degraded but has some operational capability and remains safe.	8	FC-44 Module Failure: Loss of BMS Control	4	EC-31 ESMS/BMS Cntrl: Ability of the BMS and balancing system to adequately balance the circuit including sizing of the balancing resistors or transistors	5	160	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Refer to Empire II, LLC Procedures Index	4	3	4	48



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 23 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Project Manager: Mr.James Whalen

Documents

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.1.13	1.1.13.1	Reduced Battery Life	Reduction in Battery Performance	Reduced Capacity Moderate Effect - Moderate degradation of product performance;	7	FC-20 Lifecycle Failure: A cell or cells have reached end of life, resulting in an adverse electrical condition which could exacerbate imbalance or other adverse electrical conditions	3	EC-21 BMS Cntri: Includes monitoring and shutdown/isolati on capabilities of the affected BMS/module or system if necessary.	6	126	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM Empire II, LLC Engineering	Refer to Empire II, LLC Procedures Index	4	2	5	40
	1.1.13.2		Reduction in Battery Performance	Reduced Capacity Serious Effects - Product is inoperable but safe, or a system is inoperable but safe.	8	FC-11 BMS Failure: Cell/module level monitoring and control fails, resulting in inability to shutdown, report adverse conditions, properly monitor, balance or protect the system resulting in adverse condition	4	EC-31 ESMS/BMS Cntrl: Ability of the BMS and balancing system to adequately balance the circuit including sizing of the balancing resistors or transistors	5	160	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Refer to Empire II, LLC Procedures Index	4	3	4	48
	1.1.13.3		Reduction in Battery Performance	Reduced Capacity Major Effect - Product performance is severely degraded but has some operational capability and remains safe.	7	FC-32 Elec Risks, Hazardous Current Condition: This includes high current issues from the PCS or interconnection	5	EC-31 ESMS/BMS Cntrl: Ability of the BMS and balancing system to adequately balance the circuit including sizing of the balancing resistors or transistors	5	175	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Refer to Empire II, LLC Procedures Index	4	4	4	64
	1.1.13.4		Reduction in Battery Performance	Reduced Capacity Significant Effect - Product performance is degraded but operable and safe, or a non-vital part is inoperable.	7	FC-10 Sensor Failure: A sensor inside the system fails, resulting in incorrect reporting of system properties	5	EC-20 Act Cell Prot: Active cell protections which may mitigate thermal runaway such as module fans, liquid cooling systems, module scale Thermal Management Coolant systems, or other mitigation measures	5	175	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Refer to Empire II, LLC Procedures Index	4	4	4	64



Empire II, LLC Starlight Solar Project BOP Level FMEA Empire II. LLC

Page 24 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Design Responsibility: Empire II, LLC and BESS OEM

Documents

Potential Current Potential failure Recommended cause(s) / Responsibility | Actions ID Item function Effects descriptions Sv Oc Dt **RPN** Sv Oc Dt **RPN Parent** Design mode Action(s) and Date Taken failure Controls mechanisms 2 32 1.1.13 1.1.13.5 Reduced Battery Reduction in Battery Reduced Capacity FC-39 Human AC-11 Human 105 RA-01: Performance of BESS OEM/Empire Refer to Performance Moderate Effect - Moderate Factors - Design Factors/RAGAG: Scheduled System II, LLC Engineering Empire II. LLĊ degradation of product Errors and In addition to Maintenance analysis required RA-24: Empire II. Procedures performance: Omissions, wrong LLC/Commissioning and set point from unit by product Index controller standards, good testing to demonstrates engineering interdependent system practice should performance of the BESS OEM ESS require design review such that design mistakes and weaknesses are identified and corrected in a timely and efficient manner BESS OEM/Empire 1.1.13.6 Reduction in Battery Reduced Capacity FC-02 Cell Failure: EC-19 Adequate 140 RA-01: Performance of Refer to Performance Major Effect - Product Hazardous Sense/Cntrl: Scheduled System II, LLC Engineering Empire II, Aggregate of the Maintenance performance is severely Temperature LLĊ Condition - Cell. ability of the RA-24: Empire II, Procedures degraded but has some operational capability and High temperature at BMS to detect LLC/Commissioning and Index the cell level during cell imbalance testing to demonstrates remains safe. normal operations and to properly interdependent system return system to performance of the w/o thermal BESS OEM ESS runaway, battery balance if imbalance, variation possible. and different rate of deterioration FC-20 Lifecycle 1.1.13.7 Overall capacity Reduced Capacity AC-08 Human 224 RA-01: Performance of BESS OEM/Empire Refer to 6 reduction, end of life Serious Effects - Product is Failure: A cell or Factors Maint: Scheduled System II, LLC Engineering Empire II, inoperable but safe, or a system cells have reached Proper Maintenance LLĊ is inoperable but safe. end of life, resulting RA-24: Empire II, Procedures preventive in an adverse maintenance to LLC/Commissioning and Index testing to demonstrates electrical condition minimize the which could impact of interdependent system performance of the exacerbate adverse. long imbalance or other BESS OEM ESS term or slow adverse electrical acting conditions environmental effects resulting in degradation



Empire II, LLC

Page 25 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Documents

Prepared by: Robert Steele, PhD.

FMEA Date (Orig.): 23 July 2025

Project Manager: Mr.James Whalen

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.1.14	1.1.14.1	Cell degradation	Reduced Cell Level Performance, Number of charge/discharge cycles	Reduced Capacity Moderate Effect - Moderate degradation of product performance;	7	Internal Component Failure - Electrical Abuse	5	EC-19 Adequate Sense/Cntrl: Aggregate of the ability of the BMS to detect cell imbalance and to properly return system to balance if possible.	5	175	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Refer to Empire II, LLC Procedures Index	4	4	4	64
	1.1.14.2		Reduced Cell Level Performance, Overcharge/Discharge	Reduced Capacity Major Effect - Product performance is severely degraded but has some operational capability and remains safe.	7	EC-29 Sys Elec Abuse Tolerance: Refers to ability of the overall system collectively to withstand adverse electrical abuse such as overcharge or dead shorts without failure	5	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence	5	175	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Refer to Empire II, LLC Procedures Index	4	4	4	64
	1.1.14.3		Reduced Cell Level Performance, Number of charge/discharge cycles	Major Effect - Product performance is severely degraded but has some operational capability and remains safe. Moderate Effect - Moderate degradation of product performance;	7	EC-29 Sys Elec Abuse Tolerance: Refers to ability of the overall system collectively to withstand adverse electrical abuse such as overcharge or dead shorts without failure	5	EC-24 Module Resiliency: Resiliency of the individual modules to withstand impacts, shocks or other mechanical abuse	5	175	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Refer to Empire II, LLC Procedures Index	4	4	4	64
	1.1.14.4		Low Cell Charging, BMS Failure	Moderate Effect - Moderate degradation of product performance; Significant Effect - Product performance is degraded but operable and safe, or a non-vital part is inoperable. Major Effect - Product performance is severely degraded but has some operational capability and remains safe.	7	FC-11 BMS Failure: Cell/module level monitoring and control fails, resulting in inability to shutdown, report adverse conditions, properly monitor, balance or protect the system resulting in adverse condition	3	EC-29 Sys Elec Abuse Tolerance: Refers to ability of the overall system collectively to withstand adverse electrical abuse such as overcharge or dead shorts without failure	8	168	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Refer to Empire II, LLC Procedures Index	4	2	7	56



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 26 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.1.15	1.1.15.1	(typ.) OEM BESS DC Disconnect	Defective Component (IEEE Std. 493)	Electrical fault resulting in unavailability Reduced Capacity ESMS/BMS Control Failure	7	FM-46 Subcomponent/Sub system Failure: Lifecycle failure of components impacting availability/capabilit y to execute intended design function	5	EC-01 Auto Shutdown: Ability of system to actively shut itself down or disconnect itself EC-29 Sys Elec Abuse Tolerance: Refers to ability of the overall system collectively to withstand adverse electrical abuse	3	105	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	4	4	2	32
	1.1.15.2		Improper Application (IEEE Std. 493)	Industrial Safety (Fire, Personnel) Issue Reduced Capacity Electrical fault resulting in unavailability	10	FM-39 Human Factors - Design Errors and Omissions	4	AC-09 Human Factors/SME: Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for managing situations	3	120	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	5	3	2	30
	1.1.15.3		Improper Handling (IEEE Std. 493)	No Immediate Measurable Impact Eventual BESS Unavailability	7	FC-23 Ext/Envr Risk, Mechanical Shock/Drop - The system or component is subject to mechanical shock or drop, mechanical jarring or damaging the system FC-27 Ext/Envr Risk, Human Factors: An adverse condition caused by the result of human interaction	4	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	3	84	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	4	3	2	24



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 27 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Project Manager: Mr.James Whalen

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Oc	Dt	RPN
1.1.15	1.1.15.4	(typ.) OEM BESS DC Disconnect	Improper Installation (IEEE Std. 493)	Reduced Capacity Electrical fault resulting in unavailability Eventual BESS Unavailability	8	FC-66 Installation Error: A failure due to an error or errors during installation (e.g., ignoring to install the hardware in the required configuration)	5	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling	3	120	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	4	4	2	32
	1.1.15.5		Less than adequate maintenance (IEEE Std. 493)	Reduced Capacity Eventual BESS Unavailability Electrical fault resulting in unavailability	8	FM-91 Less than adequate resulting in system unavailability, erratic performance, degraded performance	5	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	3	120	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	4	4	2	32
	1.1.15.6		Improper Operating Procedure(s) (IEEE Std. 493)	Reduced Capacity Eventual BESS Unavailability Electrical fault resulting in unavailability	8	FM-92 Improper Operating procedure implementation of guidance resulting in equipment failure, mis-operation, system degradation	5	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management. AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions	3	120	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	4	4	2	32



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 28 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Design Basis: Assumed Typical LFP BESS Project Project Manager: Mr.James Whalen

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.1.15	1.1.15.7	(typ.) OEM BESS DC Disconnect	Spurious Actuation (FMD, IEEE Std. 493)	Electrical fault resulting in unavailability	8	FM-76 Random Failure: Failures that they do not appear to have any pattern or regularity.	5	EC-22 Site Elec Prot: Protection for electrical systems such that a failure of the PCS or associated circuit does not result in adverse effects on the site balance of system electrical gear	3	120	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	4	4	2	32
	1.1.15.8		Thermocycling (FMD, IEEE Std. 493)	Reduced Capacity Electrical fault resulting in unavailability	8	FM-29 Ext/Envr Risk, Dust/Dirt/Particulate Accumulation: LTA Maintenance	4	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence	3	96	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	4	3	2	24
	1.1.15.9		Mechanical Damage due to Foreign Objects (FMD, IEEE Std. 493)	Eventual BESS Unavailability Electrical fault resulting in unavailability	6	FM-29 Ext/Envr Risk, Dust/Dirt/Particulate Accumulation: LTA Maintenance	4	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence	3	72	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	3	3	2	18
	1.1.15.10		Shorting by tools or metal objects (FMD, IEEE Std. 493)	Electrical fault resulting in unavailability Reduced Capacity	5	FM-93 Foreign object introduction results in system failure, de-energization, short circuit, arc flash events	3	EC-22 Site Elec Prot: Protection for electrical systems such that a failure of the PCS or associated circuit does not result in adverse effects on the site balance of system electrical gear	3	45	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	3	2	2	12



Empire II, LLC

Page 29 of 135

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.1.15.1	1.1.15.1.1	Protective Device (GE Prolec)	Opens without command (FMD)	Spurious Actuation (FMD, IEEE Std. 493) Electrical fault resulting in unavailability	8	FM-72 Intermittent failure: Failures that appear and disappear seemingly at random	5	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence EC-30 Vol/SoC Monitoring: This may apply at the cell, module, and rack level.	4	160	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Refer to Empire II, LLC Procedures Index	4	4	3	48
	1.1.15.1.2		Does not Trip/Open on command (FMD)	Spurious Actuation (FMD, IEEE Std. 493) Reduced Capacity ESMS/BMS Control Failure	7	FM-72 Intermittent failure: Failures that appear and disappear seemingly at random FM-89 Fail to respond to input	4	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence	2	56	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	4	3	3	36
	1.1.15.1.3		Degraded Operation (FMD)	Improper Operating Procedure(s) (IEEE Std. 493) Less than adequate maintenance (IEEE Std. 493)	8	FM-92 Improper Operating procedure implementation of guidance resulting in equipment failure, mis-operation, system degradation	5	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	3	120	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	4	4	2	32



Empire II, LLC

Page 30 of 135

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Oc	Dt	RPN
1.1.15.1	1.1.15.1.4	Protective Device (GE Prolec)	Subcomponent Failure - cracked/fractured (FMD)	Spurious Actuation (FMD, IEEE Std. 493) Defective Component (IEEE Std. 493)	9	FM-87 Internal Component Failure - Equipment Lifecycle Failure FM-77 Systematic Failure: Failures that they are related deterministically to a certain cause or causes	3	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence	3	81	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	5	2	2	20
	1.1.15.1.5		Mechanical Failure(s) (FMD)	Spurious Actuation (FMD, IEEE Std. 493) Defective Component (IEEE Std. 493)	9	FM-76 Random Failure: Failures that they do not appear to have any pattern or regularity.	3	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence	3	81	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	5	2	2	20
	1.1.15.1.6		Unknown/Indeterminat e Failures (FMD)	Spurious Actuation (FMD, IEEE Std. 493) Defective Component (IEEE Std. 493)	9	FM-72 Intermittent failure: Failures that appear and disappear seemingly at random	3	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence EC-30 Vol/SoC Monitoring: This may apply at the cell, module, and rack level. Whil	2	54	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in BESS OEM/Empire II, LLC's O&M Manuals Refer to Empire II, LLC Engineering Procedure Index	5	2	2	20



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 31 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Project Manager: Mr.James Whalen

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.2	1.2.1	Site Inverter (PCS)	Failure to Operate	Failure to Operate Reduced Capacity	5	FM-09 INV/PCS Failure: Inverter or power electronics fail in a way that poses risk to the batteries. Could include a lock up in the "On" position which drives overcharge.	4	EC-22 Site Elec Prot: Protection for electrical systems such that a failure of the PCS or associated circuit does not result in adverse effects AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	5	100	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	3	3	4	36
	1.2.2		Erratic Operation (FMD)	Eventual BESS Unavailability Partial/Total loss of capacity	5	FM-31 Elec Risks, Hazardous Voltage Condition: This could include high line voltages, high voltages from the PCS, floating ground issues, or other high voltage issues at the cell, module or rack level	3	EC-22 Site Elec Prot: Protection for electrical systems such that a failure of the PCS or associated circuit does not result in adverse effects AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	6	90	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	3	2	5	30
	1.2.3		Frequency out of tolerance (FMD)	Eventual BESS Unavailability Partial/Total loss of capacity	5	FM-46 Subcomponent/Sub system Failure: Lifecycle failure of components impacting availability/capabilit y to execute intended design function	3	EC-22 Site Elec Prot: Protection for electrical systems such that a failure of the PCS or associated circuit does not result in adverse effects AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	7	105	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	3	2	6	36



Empire II, LLC

Page 32 of 135

Design Responsibility: Empire II, LLC and BESS OEM

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

	Date (Orig.).	23 July 2025				,					Documents						
Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Oc	Dt	RPN
1.2	1.2.4	Site Inverter (PCS)	Improper Output (FMD)	Partial/Total loss of capacity Inadvertent System S/D	5	FM-46 Subcomponent/Sub system Failure: Lifecycle failure of components impacting availability/capabilit y to execute intended design function	3	EC-22 Site Elec Prot: Protection for electrical systems such that a failure of the PCS or associated circuit does not result in adverse effects AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	7	105	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	3	2	6	36
	1.2.5		Overtemperature S/D (FMD)	Partial/Total loss of capacity Eventual BESS Unavailability	5	FM-51 Overall System Degradation due to system/subsystem failure/degradation	3	EC-22 Site Elec Prot: Protection for electrical systems such that a failure of the PCS or associated circuit does not result in adverse effects AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	3	45	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	3	2	2	12



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 33 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.3	1.3.1	BESS Auxiliary Power System	Defective Component (IEEE Std. 493)	Electrical fault resulting in unavailability Reduced Capacity ESMS/BMS Control Failure	8	FM-46 Subcomponent/Sub system Failure: Lifecycle failure of components impacting availability/capabilit y to execute intended design function	4	EC-01 Auto Shutdown: Ability of system to actively shut itself down or disconnect itself EC-29 Sys Elec Abuse Tolerance: Refers to ability of the overall system collectively to withstand adverse electrical abuse	3	96	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	4	3	2	24
	1.3.2		Improper Application (IEEE Std. 493)	Industrial Safety (Fire, Personnel) Issue Reduced Capacity Electrical fault resulting in unavailability	8	FM-39 Human Factors - Design Errors and Omissions	5	AC-09 Human Factors/SME: Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for managing situations	3	120	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	4	4	2	32
	1.3.3		Improper Handling (IEEE Std. 493)	No Immediate Measurable Impact Eventual BESS Unavailability	5	FC-23 Ext/Envr Risk, Mechanical Shock/Drop - The system or component is subject to mechanical shock or drop, mechanical jarring or damaging the system FC-27 Ext/Envr Risk, Human Factors: An adverse condition caused by the result of human interaction	4	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	3	60	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	3	3	2	18



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 34 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Project Manager: Mr.James Whalen

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.3	1.3.4	BESS Auxiliary Power System	Improper Installation (IEEE Std. 493)	Reduced Capacity Electrical fault resulting in unavailability Eventual BESS Unavailability	8	FC-66 Installation Error: A failure due to an error or errors during installation (e.g., ignoring to install the hardware in the required configuration)	4	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling	3	96	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	4	3	2	24
	1.3.5		Less than adequate maintenance (IEEE Std. 493)	Reduced Capacity Eventual BESS Unavailability Electrical fault resulting in unavailability	8	FM-91 Less than adequate resulting in system unavailability, erratic performance, degraded performance	5	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	3	120	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	4	4	2	32
	1.3.6		Improper Operating Procedure(s) (IEEE Std. 493)	Reduced Capacity Eventual BESS Unavailability Electrical fault resulting in unavailability	8	FM-92 Improper Operating procedure implementation of guidance resulting in equipment failure, mis-operation, system degradation	5	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management. AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions	3	120	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	4	4	2	32



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 35 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project

Documents

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.3	1.3.7	BESS Auxiliary Power System	Spurious Actuation (FMD, IEEE Std. 493)	Electrical fault resulting in unavailability	8	FM-76 Random Failure: Failures that they do not appear to have any pattern or regularity.	5	EC-22 Site Elec Prot: Protection for electrical systems such that a failure of the PCS or associated circuit does not result in adverse effects on the site balance of system electrical gear	3	120	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	4	4	2	32
	1.3.8		Thermocycling (FMD, IEEE Std. 493)	Reduced Capacity Electrical fault resulting in unavailability	9	FM-29 Ext/Envr Risk, Dust/Dirt/Particulate Accumulation: LTA Maintenance	6	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence	4	216	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	5	5	3	75
	1.3.9		Mechanical Damage due to Foreign Objects (FMD, IEEE Std. 493)	Eventual BESS Unavailability Electrical fault resulting in unavailability	8	FM-29 Ext/Envr Risk, Dust/Dirt/Particulate Accumulation: LTA Maintenance	4	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence	5	160	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	4	3	4	48
	1.3.10		Shorting by tools or metal objects (FMD, IEEE Std. 493)	Electrical fault resulting in unavailability Reduced Capacity	8	FM-93 Foreign object introduction results in system failure, de-energization, short circuit, arc flash events	4	EC-22 Site Elec Prot: Protection for electrical systems such that a failure of the PCS or associated circuit does not result in adverse effects on the site balance of system electrical gear	5	160	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering II, LLC Engineering Procedure Index	4	3	4	48



Empire II, LLC

Page 36 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM
Design Basis: Assumed Typical LFP BESS Project

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Documents

Prepared by: Robert Steele, PhD.

FMEA Date (Orig.): 23 July 2025

Project Manager: Mr.James Whalen

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.3	1.3.11	BESS Auxiliary Power System	Failure to Operate	Failure to Operate Partial/Total loss of capacity	5	FC-05 HVAC Failure: Mechanical or electrical failure of the HVAC system that will result in high temperatures throughout system	8	EC-08 Redundant HVAC: Design, sizing, and hardware physical redundancy of the HVAC system such that failure of one or multiple units does not result in adverse conditions within the container or system	3	120	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	5	7	2	70
	1.3.12		Partial/Total loss of capacity	Partial/Total loss of capacity Eventual BESS Unavailability	5	EC-03 ESS HVAC: Heating, ventilation and air conditioning for the overall container designed to maintain overall system temperature and humidity levels.	8	EC-25 Container Monitoring: Monitoring within the container which may detect adverse Container Thermal/Operati ng Environment Conditions	3	120	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	3	7	2	42
	1.3.13		Inadvertent System S/D	Inadvertent System S/D ESMS/BMS Control Failure	9	FM-36 Elec Risks, Electrical Design Failure: Overall bad design that allows ground loops, floating, voltages, etc which would force errors.	6	AC-01: EOP - System operator plan to handle all emergency events. AC-11 Human Factors/RAGAG EP: In addition to analysis required by product standards, good engineering practice should require design review such that design mistakes and weaknesses	4	216	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	3	5	3	45



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 37 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.3	1.3.14	BESS Auxiliary Power System	Reduced Capacity	Reduced Capacity Eventual BESS Unavailability	5	FM-36 Elec Risks, Electrical Design Failure: Overall bad design that allows ground loops, floating, voltages, etc which would force errors.	6	AC-01: EOP - System operator plan to handle all emergency events. AC-11 Human Factors/RAGAG EP: In addition to analysis required by product standards, good engineering practice should require design review such that design mistakes and weaknesses	3	90	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	3	5	2	30
	1.3.15		Eventual ESS Unavailability	Eventual BESS Unavailability Reduced Capacity	5	FM-36 Elec Risks, Electrical Design Failure: Overall bad design that allows ground loops, floating, voltages, etc which would force errors.	6	AC-01: EOP - System operator plan to handle all emergency events. AC-11 Human Factors/RAGAG EP: In addition to analysis required by product standards, good engineering practice should require design review such that design mistakes and weaknesses	3	90	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	3	5	2	30
	1.3.16		Electrical Fault resulting in unavailability	Degraded Performance Eventual BESS Unavailability	5	FM-36 Elec Risks, Electrical Design Failure: Overall bad design that allows ground loops, floating, voltages, etc which would force errors.	6	AC-01: EOP - System operator plan to handle all emergency events. AC-11 Human Factors/RAGAG EP: In addition to analysis required by product standards, good engineering practice should require design review such that design mistakes and weaknesses	3	90	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	3	5	2	30



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 38 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM

Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

		20 daily 2020									Documents						
Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.3.1	1.3.1.1	Protective Device (TBD)	Opens without command (FMD)	Spurious Actuation (FMD, IEEE Std. 493) Failure to Operate Electrical fault resulting in unavailability	9	FM-72 Intermittent failure: Failures that appear and disappear seemingly at random	5	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence EC-30 Vol/SoC Monitoring: This may apply at the cell, module, and rack level. Whil	4	180	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Refer to Empire II, LLC Procedures Index	5	4	3	60
	1.3.1.2		Does not Trip/Open on command (FMD)	Spurious Actuation (FMD, IEEE Std. 493) Failure to Operate Reduced Capacity ESMS/BMS Control Failure	9	FM-72 Intermittent failure: Failures that appear and disappear seemingly at random FM-89 Fail to respond to input	4	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence	2	72	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	5	3	3	45
	1.3.1.3		Degraded Operation (FMD)	Improper Operating Procedure(s) (IEEE Std. 493) Less than adequate maintenance (IEEE Std. 493)	8	FM-92 Improper Operating procedure implementation of guidance resulting in equipment failure, mis-operation, system degradation	5	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	3	120	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	4	4	2	32



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 39 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM
Design Basis: Assumed Typical LFP BESS Project

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Project Manager: Mr.James Whalen

Documents

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.3.1	1.3.1.4	Protective Device (TBD)	Subcomponent Failure - cracked/fractured (FMD)	Spurious Actuation (FMD, IEEE Std. 493) Defective Component (IEEE Std. 493) Failure to Operate Erratic Operation (FMD)	9	FM-87 Internal Component Failure - Equipment Lifecycle Failure FM-77 Systematic Failure: Failures that they are related deterministically to a certain cause or causes	5	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence	3	135	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	5	4	2	40
	1.3.1.5		Mechanical Failure(s) (FMD)	Spurious Actuation (FMD, IEEE Std. 493) Defective Component (IEEE Std. 493) Failure to Operate	9	FM-76 Random Failure: Failures that they do not appear to have any pattern or regularity.	5	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence	3	135	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	5	4	2	40
	1.3.1.6		Unknown/Indeterminat e Failures (FMD)	Spurious Actuation (FMD, IEEE Std. 493) Defective Component (IEEE Std. 493) Failure to Operate Erratic Operation (FMD)	9	FM-72 Intermittent failure: Failures that appear and disappear seemingly at random	5	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence EC-30 Vol/SoC Monitoring: This may apply at the cell, module, and rack level. Whil	2	90	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Refer to Empire II, LLC Procedures Index	5	4	2	40



Empire II, LLC

Page 40 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Design Responsibility: Empire II, LLC and BESS OEM

Documents

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.3.2	1.3.2.1	Aux Switchgear	Thermocycling (FMD, IEEE Std. 493)	Partial/Total loss of capacity Inadvertent System S/D Failure to Operate	7	FM-29 Ext/Envr Risk, Dust/Dirt/Particulate Accumulation: LTA Maintenance	5	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence	3	105	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	4	4	2	32
	1.3.2.2		Mechanical/Structural Failure (FMD, IEEE Std. 493)	Partial/Total loss of capacity Inadvertent System S/D Failure to Operate	5	FM-52 Internal Component Failure - Mechanical	3	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	3	45	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	3	2	2	12
	1.3.2.3		Mechanical Damage due to Foreign Objects (FMD, IEEE Std. 493)	Partial/Total loss of capacity Inadvertent System S/D Failure to Operate	9	FM-29 Ext/Envr Risk, Dust/Dirt/Particulate Accumulation: LTA Maintenance	4	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence	3	108	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	5	3	2	30
	1.3.2.4		Shorting by tools or metal objects (FMD, IEEE Std. 493)	Partial/Total loss of capacity Inadvertent System S/D	6	FM-93 Foreign object introduction results in system failure, de-energization, short circuit, arc flash events	4	EC-22 Site Elec Prot: Protection for electrical systems such that a failure of the PCS or associated circuit does not result in adverse effects on the site balance of system electrical gear	3	72	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	3	3	2	18



Empire II, LLC

Project Manager: Mr.James Whalen

12302 Exposition Blvd | Los Angeles, CA 90068

Page 41 of 135

Design Responsibility: Empire II, LLC and BESS OEM

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Design Basis: Assumed Typical LFP BESS Project Documents

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

						Potential		Current			Documents						
Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	cause(s) / failure mechanisms	Ос	Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.3.2	1.3.2.5	Aux Switchgear	Shorting due to animals (FMD, IEEE Std. 493)	Partial/Total loss of capacity Inadvertent System S/D	6	FM-93 Foreign object introduction results in system failure, de-energization, short circuit, arc flash events	3	EC-22 Site Elec Prot: Protection for electrical systems such that a failure of the PCS or associated circuit does not result in adverse effects on the site balance of system electrical gear	3	54	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	3	2	2	12
	1.3.2.6		Defective Component (IEEE Std. 493)	Partial/Total loss of capacity Failure to Operate Defective Component (IEEE Std. 493)	9	FM-46 Subcomponent/Sub system Failure: Lifecycle failure of components impacting availability/capabilit y to execute intended design function	5	EC-01 Auto Shutdown: Ability of system to actively shut itself down or disconnect itself EC-29 Sys Elec Abuse Tolerance: Refers to ability of the overall system collectively to withstand adverse electrical abuse	3	135	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	5	4	2	40
	1.3.2.7		Less than adequate maintenance (IEEE Std. 493)	Inadvertent System S/D Failure to Operate Partial/Total loss of capacity	9	FM-91 Less than adequate resulting in system unavailability, erratic performance, degraded performance	5	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	3	135	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	5	4	2	40
	1.3.2.8		Improper Operating Procedure(s) (IEEE Std. 493)	Inadvertent System S/D Partial/Total loss of capacity	9	FM-92 Improper Operating procedure implementation of guidance resulting in equipment failure, mis-operation, system degradation	5	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	3	135	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	5	4	2	40



Empire II, LLC

Page 42 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Design Responsibility: Empire II, LLC and BESS OEM

											Documents						
Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
								AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions									
1.3.2	1.3.2.9	Aux Switchgear	Spurious Actuation (FMD, IEEE Std. 493)	Inadvertent System S/D Partial/Total loss of capacity	9	FM-76 Random Failure: Failures that they do not appear to have any pattern or regularity.	4	EC-22 Site Elec Prot: Protection for electrical systems such that a failure of the PCS or associated circuit does not result in adverse effects on the site balance of system electrical gear	2	72	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	5	3	2	30
	1.3.2.10		Degraded Performance	Failure to Operate Eventual ESS Unavailability	1	FM-77 Systematic Failure: Failures that they are related deterministically to a certain cause or causes	6	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	5	30	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC Engineering EOPs. Refer to Empire II, LLC Engineering Procedure Index	RA-01: Performance of Scheduled System Maintenance	5	4	3	60



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 43 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.3.2.1	1.3.2.1.1	Aux Control System	Improper Application (IEEE Std. 493)	Partial/Total loss of capacity Inadvertent System S/D	9	FM-39 Human Factors - Design Errors and Omissions	3	AC-09 Human Factors/SME: Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for managing situations	3	81	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	5	2	2	20
	1.3.2.1.2		Improper Installation (IEEE Std. 493)	Failure to Operate Inadvertent System S/D Partial/Total loss of capacity	9	FC-66 Installation Error: A failure due to an error or errors during installation (e.g., ignoring to install the hardware in the required configuration)	3	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling	3	81	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	5	2	2	20
	1.3.2.1.3		Less than adequate maintenance (IEEE Std. 493)	Less than adequate maintenance (IEEE Std. 493) Degraded Performance	6	FM-91 Less than adequate resulting in system unavailability, erratic performance, degraded performance	3	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	3	54	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	3	2	2	12
	1.3.2.1.4		Improper Operating Procedure(s) (IEEE Std. 493)	Degraded Performance	6	FM-92 Improper Operating procedure implementation of guidance resulting in equipment failure, mis-operation, system degradation	3	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	3	54	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	3	2	2	12



Empire II, LLC

Page 44 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Design Responsibility: Empire II, LLC and BESS OEM

											Documents						
Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
								AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions									
1.3.2.1	1.3.2.1.5	Aux Control System	Spurious Actuation (FMD, IEEE Std. 493)	Degraded Performance	7	FM-76 Random Failure: Failures that they do not appear to have any pattern or regularity.	3	EC-22 Site Elec Prot: Protection for electrical systems such that a failure of the PCS or associated circuit does not result in adverse effects on the site balance of system electrical gear	3	63	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	3	2	2	12
	1.3.2.1.6		Mechanical Damage due to Foreign Objects (FMD, IEEE Std. 493)	Mechanical Damage due to Foreign Objects (FMD, IEEE Std. 493)	6	FM-29 Ext/Envr Risk, Dust/Dirt/Particulate Accumulation: LTA Maintenance	4	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence	3	72	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	3	3	2	18



Empire II, LLC

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Design Responsibility: Empire II, LLC and BESS OEM

Page 45 of 135

											Documents						
Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.3.2.2	1.3.2.2.1	Protective Device (TBD)	Does not Trip/Open on command (FMD)	Spurious Actuation (FMD, IEEE Std. 493)	6	FM-72 Intermittent failure: Failures that appear and disappear seemingly at random FM-89 Fail to respond to input	5	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence	2	60	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	3	4	2	24
	1.3.2.2.2		Degraded Operation (FMD)	Improper Operating Procedure(s) (IEEE Std. 493) Less than adequate maintenance (IEEE Std. 493)	6	FM-92 Improper Operating procedure implementation of guidance resulting in equipment failure, mis-operation, system degradation	5	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	3	90	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	3	4	2	24
	1.3.2.2.3		Subcomponent Failure - cracked/fractured (FMD)	Spurious Actuation (FMD, IEEE Std. 493) Defective Component (IEEE Std. 493)	6	FM-87 Internal Component Failure - Equipment Liflecycle Failure FM-77 Systematic Failure: Failures that they are related deterministically to a certain cause or causes	3	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence	3	54	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	3	2	2	12
	1.3.2.2.4		Mechanical Failure(s) (FMD)	Spurious Actuation (FMD, IEEE Std. 493) Defective Component (IEEE Std. 493)	6	FM-76 Random Failure: Failures that they do not appear to have any pattern or regularity.	3	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence	3	54	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	3	2	2	12



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 46 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Project Manager: Mr.James Whalen

	oute (Orig.). 2										Documents						
Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.3.2.2	1.3.2.2.5	Protective Device (TBD)	Unknown/Indeterminat e Failures (FMD)	Spurious Actuation (FMD, IEEE Std. 493) Defective Component (IEEE Std. 493)	6	FM-72 Intermittent failure: Failures that appear and disappear seemingly at random	3	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence EC-30 Vol/SoC Monitoring: This may apply at the cell, module, and rack level	2	36	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Refer to Empire II, LLC Procedures Index	3	2	2	12
	1.3.2.2.6		Other - Protective Device Malfunction (FMD, IEEE Std. 493)	Defective Component (IEEE Std. 493)	6	FM-89 Fail to respond to input	5	EC-22 Site Elec Prot: Protection for electrical systems such that a failure of the PCS or associated circuit does not result in adverse effects on the site balance of system electrical gear AC-04 Human Factors: Knowledge of failure condition	3	90	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	3	4	2	24



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 47 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Project Manager: Mr.James Whalen

Documents																	
Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Oc	Dt	RPN
1.3.2.3	1.3.2.3.1	Auto Transfer Switch	Fails To Transfer	Defective Component (IEEE Std. 493) Mechanical Damage due to Foreign Objects (FMD, IEEE Std. 493) Failure to Operate	9	FM-75 Degradation/Age related failure: Failures realized as part of programming lifecycle FM-76 Random Failure: Failures that they do not appear to have any pattern or regularity.	6	EC-35 ESMS Aux System Monitoring to safely S/D upon detection of loss of permissives	4	216	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	5	5	3	75
	1.3.2.3.2		Degraded Operation	Less than adequate maintenance (IEEE Std. 493)	5	FM-79 Internal Failure - Electrical (Corrosion) FM-71 Detectable/preventa ble faults before failure: Failures that they are likely to be detected before they occur, such as by online monitoring, exhaustive testing prior to installation	3	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence	4	60	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	3	2	3	18
	1.3.2.3.3		Generation System Malfunction	Defective Component (IEEE Std. 493) Partial/Total loss of capacity	6	FM-87 Internal Component Failure - Equipment Lifecycle Failure	5	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence	4	120	RA-01: Performance of Scheduled System Maintenance RA-24: Empire II, LLC/Commissioning and testing to demonstrates interdependent system performance of the BESS OEM ESS	BESS OEM/Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	3	4	3	36



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 48 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Project Manager: Mr.James Whalen

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.3.3	1.3.3.1	Aux Transformer (150 KVA)	Excessive/Fast Discharge (IEEE Std. 493, FMD)	ESMS/BMS Control Failure BMS Malfunction Reduced Capacity	9	FC-11 BMS Failure: Cell/module level monitoring and control fails, resulting in inability to shutdown, report adverse conditions, properly monitor, balance or protect the system resulting in adverse condition	4	EC-29 Sys Elec Abuse Tolerance: Refers to ability of the overall system collectively to withstand adverse electrical abuse such as overcharge or dead shorts without failure	3	108	RA-22: BESS OEM BMS Software controls interconnected modules within the BESS OEM ESS to safely detect system degradation and initiate S/D protocols RA-23: RRC ESMS Software controls interdependent system to safely detect system degradation	BESS OEM/Empire II, LLC Engineering	RA-22: BESS OEM BMS Software controls interconnect ed modules within the BESS OEM ESS to safely detect system degradation and initiate S/D protocols RA-23: RRC Software controls interdepende nt system to safely detect system	5	3	2	30
	1.3.3.2		Step-Touch Potential (IEEE Std. 493, FMD)	Insulation Failure - Rodent (IEEE Std. 493) Industrial Safety (Fire, Personnel) Issue	10	FC-28 Ext/Envr Risk, Shipping and Construction: An issue occurs with the system during shipping or construction that results in an adverse condition that may or may not be detected or protected via active controls. Results in Cell Failure	4	EC-28 Insul Monitoring: Continual, or active, monitoring of insulation integrity, ground v float voltage, and other practices to prevent insulation or isolation degradation	3	120	RA-25: Structured Empire II, LLC EngineeringDesign Reviews performance requirement decomposition and verification RA-01: Performance of Scheduled System Maintenance	O&M Provider	Mitigative measures defined in Empire II, LLC's SOPs and O&M Manuals. Refer to the Empire II, LLC Engineering Procedure Index	5	3	2	30
	1.3.3.3		Stray Ground Currents (FMD)	Partial/Total loss of capacity Industrial Safety (Fire, Personnel) Issue Eventual ESS Unavailability	10	FC-33 Elec Risks, Ground Fault/Insulation Fault: This could include localized shorting of cells, shorting between modules, shorting of entire racks or systems and ground fault shorting.		EC-28 Insul Monitoring: Continual, or active, monitoring of insulation integrity, ground v float voltage, and other practices to prevent insulation or isolation degradation	3	120	RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-01: Performance of Scheduled System Maintenance	O&M Provider	Mitigative measures defined in Empire II, LLC's SOPs & EOPs and O&M Manuals	5	3	2	30



Empire II, LLC

Page 49 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.3.3	1.3.3.4	Aux Transformer (150 KVA)	Xfmr Primary/Secondary Failure - Open (FMD)	Electrical Fault resulting in unavailability Eventual ESS Unavailability	8	FC-77 Systematic Failure: Failures that they are related deterministically to a certain cause or causes	4	EC-22 Site Elec Prot: Protection for electrical systems such that a failure of the PCS or associated circuit does not result in adverse effects on the site balance of system electrical gear	3	96	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	O&M Contractor	Empire II, LLC/OEM Engineering, product UL NRTL Safety Certification, Product Manual, and verified during commissioni ng	4	3	2	24
	1.3.3.5		Xfmr Primary/Secondary Failure - Short Circuit (FMD)	Electrical Fault resulting in unavailability Reduced Capacity Eventual ESS Unavailability	8	FC-77 Systematic Failure: Failures that they are related deterministically to a certain cause or causes	4	EC-22 Site Elec Prot: Protection for electrical systems such that a failure of the PCS or associated circuit does not result in adverse effects on the site balance of system electrical gear	3	96	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	O&M Contractor	Empire II, LLC/OEM Engineering, product UL NRTL Safety Certification, Product Manual, and verified during commissioni ng	4	3	2	24
	1.3.3.6		Degraded Output: Loss of voltage transformation (FMD)	Eventual ESS Unavailability Electrical Fault resulting in unavailability	8	FC-77 Systematic Failure: Failures that they are related deterministically to a certain cause or causes	4	EC-22 Site Elec Prot: Protection for electrical systems such that a failure of the PCS or associated circuit does not result in adverse effects on the site balance of system electrical gear	3	96	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	O&M Contractor	Empire II, LLC/OEM Engineering, product UL NRTL Safety Certification, Product Manual, and verified during commissioni ng	4	3	2	24
	1.3.3.7		Degraded Output: Corroded (FMD)	Eventual ESS Unavailability	8	FM-91 Less than adequate resulting in system unavailability, erratic performance, degraded performance	4	EC-22 Site Elec Prot: Protection for electrical systems such that a failure of the PCS or associated circuit does not result in adverse effects on the site balance of system electrical gear	3	96	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	O&M Contractor	Empire II, LLC/OEM Engineering, product UL NRTL Safety Certification, Product Manual, and verified during commissioni ng	4	3	2	24



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 50 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Project Manager: Mr.James Whalen

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.3.4	1.3.4.1	AUX Switchboard (NEMA 3R)	Construction Induced Insulation Damage	Moderate Effect - Moderate degradation of product performance;	6	FM-27 Ext/Envr Risk, Human Factors: An adverse condition caused by the result of human interaction, error, or imperfection	4	AC-12: System Commissioning Performance Verification	3	72	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	O&M Contractor	Empire II, LLC/OEM Engineering, product UL NRTL Safety Certification, Product Manual, and verified during commissioni ng	3	3	2	18
	1.3.4.2		Shorting due to animals (FMD, IEEE Std. 493)	Moderate Effect - Moderate degradation of product performance;	6	FM-93 Foreign object introduction results in system failure, de-energization, short circuit, arc flash events	3	EC-22 Site Elec Prot: Protection for electrical systems such that a failure of the PCS or associated circuit does not result in adverse effects on the site balance of system electrical gear	2	36	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	O&M Contractor	Empire II, LLC/OEM Engineering, product UL NRTL Safety Certification, Product Manual, and verified during commissioni ng	3	2	2	12
	1.3.4.3		Mechanical Damage due to Foreign Objects (FMD, IEEE Std. 493)	Moderate Effect - Moderate degradation of product performance;	6	FM-29 Ext/Envr Risk, Dust/Dirt/Particulate Accumulation: LTA Maintenance	4	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence	2	48	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	O&M Contractor	Empire II, LLC/OEM Engineering, product UL NRTL Safety Certification, Product Manual, and verified during commissioni ng	3	3	2	18
	1.3.4.4		Shorting by tools or metal objects (FMD, IEEE Std. 493)	Moderate Effect - Moderate degradation of product performance;	6	FM-93 Foreign object introduction results in system failure, de-energization, short circuit, arc flash events	4	EC-22 Site Elec Prot: Protection for electrical systems such that a failure of the PCS or associated circuit does not result in adverse effects on the site balance of system electrical gear	2	48	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	O&M Contractor	Empire II, LLC/OEM Engineering, product UL NRTL Safety Certification, Product Manual, and verified during commissioni ng	3	3	2	18



Empire II, LLC

Page 51 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.3.4	1.3.4.5	AUX Switchboard (NEMA 3R)	Degraded Performance	Failure to Operate Eventual ESS Unavailability	1	FM-77 Systematic Failure: Failures that they are related deterministically to a certain cause or causes	6	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	5	30	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC EOPs	RA-01: Performance of Scheduled System Maintenance	5	5	3	75
								management.									



Empire II, LLC

Page 52 of 135

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Oc	Dt	RPN
1.3.4.1	1.3.4.1.1	BESS AUX AC Disconnect	Defective Component (IEEE Std. 493)	Electrical fault resulting in unavailability Reduced Capacity ESMS/BMS Control Failure	9	FM-46 Subcomponent/Sub system Failure: Lifecycle failure of components impacting availability/capabilit y to execute intended design function	3	EC-01 Auto Shutdown: Ability of system to actively shut itself down or disconnect itself EC-29 Sys Elec Abuse Tolerance: Refers to ability of the overall system collectively to withstand adverse electrical abuse	3	81	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	O&M Contractor	Empire II, LLC/OEM Engineering, product UL NRTL Safety Certification, Product Manual, and verified during commissioni ng	5	2	2	20
	1.3.4.1.2		Improper Application (IEEE Std. 493)	Industrial Safety (Fire, Personnel) Issue Reduced Capacity Electrical fault resulting in unavailability	8	FM-39 Human Factors - Design Errors and Omissions	5	AC-09 Human Factors/SME: Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for managing situations	4	160	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	O&M Contractor	Empire II, LLC/OEM Engineering, product UL NRTL Safety Certification, Product Manual, and verified during commissioni ng	4	4	3	48
	1.3.4.1.3		Improper Handling (IEEE Std. 493)	No Immediate Measurable Impact Eventual BESS Unavailability	6	FC-23 Ext/Envr Risk, Mechanical Shock/Drop - The system or component is subject to mechanical shock or drop, mechanical jarring or damaging the system FC-27 Ext/Envr Risk, Human Factors: An adverse condition caused by the result of human interaction	4	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	4	96	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	O&M Contractor	Empire II, LLC/OEM Engineering, product UL NRTL Safety Certification, Product Manual, and verified during commissioni ng	3	3	3	27



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 53 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM
Design Basis: Assumed Typical LFP BESS Project

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Project Manager: Mr.James Whalen

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.3.4.1	1.3.4.1.4	BESS AUX AC Disconnect	Improper Installation (IEEE Std. 493)	Reduced Capacity Electrical fault resulting in unavailability Eventual BESS Unavailability	8	FC-66 Installation Error: A failure due to an error or errors during installation (e.g., ignoring to install the hardware in the required configuration)	5	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling	5	200	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	O&M Contractor	Empire II, LLC/OEM Engineering, product UL NRTL Safety Certification, Product Manual, and verified during commissioni ng	4	4	4	64
	1.3.4.1.5		Less than adequate maintenance (IEEE Std. 493)	Reduced Capacity Eventual BESS Unavailability Electrical fault resulting in unavailability	8	FM-91 Less than adequate resulting in system unavailability, erratic performance, degraded performance	5	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	3	120	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	O&M Contractor	Empire II, LLC/OEM Engineering, product UL NRTL Safety Certification, Product Manual, and verified during commissioni ng	4	4	2	32
	1.3.4.1.6		Improper Operating Procedure(s) (IEEE Std. 493)	Reduced Capacity Eventual BESS Unavailability Electrical fault resulting in unavailability	8	FM-92 Improper Operating procedure implementation of guidance resulting in equipment failure, mis-operation, system degradation	5	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management. AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions	3	120	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	O&M Contractor	Empire II, LLC/OEM Engineering, product UL NRTL Safety Certification, Product Manual, and verified during commissioni ng	4	4	2	32



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 54 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Project Manager: Mr.James Whalen

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.3.4.1	1.3.4.1.7	BESS AUX AC Disconnect	Spurious Actuation (FMD, IEEE Std. 493)	Electrical fault resulting in unavailability	8	mechanisms FM-76 Random Failure: Failures that they do not appear to have any pattern or regularity.	5	EC-22 Site Elec Prot: Protection for electrical systems such that a failure of the PCS or associated circuit does not result in adverse effects on the site balance of system electrical gear	3	120	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	O&M Contractor	Empire II, LLC/OEM Engineering, product UL NRTL Safety Certification, Product Manual, and verified during commissioni ng	4	4	2	32
	1.3.4.1.8		Thermocycling (FMD, IEEE Std. 493)	Reduced Capacity Electrical fault resulting in unavailability	8	FM-29 Ext/Envr Risk, Dust/Dirt/Particulate Accumulation: LTA Maintenance	6	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence	6	288	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	O&M Contractor	Empire II, LLC/OEM Engineering, product UL NRTL Safety Certification, Product Manual, and verified during commissioni ng. (*1) Requires validation substantiatin g RPN reduction	4	5	4	80
	1.3.4.1.9		Mechanical Damage due to Foreign Objects (FMD, IEEE Std. 493)	Eventual BESS Unavailability Electrical fault resulting in unavailability	8	FM-29 Ext/Envr Risk, Dust/Dirt/Particulate Accumulation: LTA Maintenance	6	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence	4	192	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	O&M Contractor	Empire II, LLC/OEM Engineering, product UL NRTL Safety Certification, Product Manual, and verified during commissioni ng	4	5	3	60
	1.3.4.1.10		Shorting by tools or metal objects (FMD, IEEE Std. 493)	Electrical fault resulting in unavailability Reduced Capacity	8	FM-93 Foreign object introduction results in system failure, de-energization, short circuit, arc flash events	6	EC-22 Site Elec Prot: Protection for electrical systems such that a failure of the PCS or associated circuit does not result in adverse effects on the site balance of system electrical gear	4	192	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	O&M Contractor	Empire II, LLC/OEM Engineering, product UL NRTL Safety Certification, Product Manual, and verified during commissioni ng	4	5	3	60



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 55 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Project Manager: Mr.James Whalen

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.3.4.1	1.3.4.1.11	BESS AUX AC Disconnect	Partial/Total loss of capacity	Degraded Performance	7	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence	8	EC-25 Container Monitoring: Monitoring within the container which may detect adverse Container Thermal/Operati ng Environment Conditions	3	168	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	O&M Contractor	Empire II, LLC/OEM Engineering, product UL NRTL Safety Certification, Product Manual, and verified during commissioni ng	3	7	2	42
	1.3.4.1.12		Reduced Capacity	Degraded Performance	7	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence	4	EC-25 Container Monitoring: Monitoring within the container which may detect adverse Container Thermal/Operati ng Environment Conditions	3	84	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	O&M Contractor	Empire II, LLC/OEM Engineering, product UL NRTL Safety Certification, Product Manual, and verified during commissioni ng	3	3	2	18
	1.3.4.1.13		Eventual ESS Unavailability	Degraded Performance	6	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence	4	EC-25 Container Monitoring: Monitoring within the container which may detect adverse Container Thermal/Operati ng Environment Conditions	3	72	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	O&M Contractor	Empire II, LLC/OEM Engineering, product UL NRTL Safety Certification, Product Manual, and verified during commissioni ng	3	3	2	18
	1.3.4.1.14		Electrical Fault resulting in unavailability	Degraded Performance	6	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence	4	EC-25 Container Monitoring: Monitoring within the container which may detect adverse Container Thermal/Operati ng Environment Conditions	3	72	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	O&M Contractor	Empire II, LLC/OEM Engineering, product UL NRTL Safety Certification, Product Manual, and verified during commissioni ng	3	3	2	18



Empire II, LLC

Page 56 of 135

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Documents

Prepared by: Robert Steele, PhD.

FMEA Date (Orig.): 23 July 2025

Potential Current Potential failure Recommended cause(s) / Responsibility | Actions ID Item function Effects descriptions Sv Oc Design Dt **RPN** Sv Oc Dt **RPN Parent** mode failure Action(s) and Date Taken Controls mechanisms Opens without 48 1.3.4.1.1 1.3.4.1.1.1 Protective Device Spurious Actuation (FMD, IEEE FM-72 Intermittent EC-26 ESS Volt 160 AC-04 Human Factors: **O&M Contractor** AC-09 (GE Prolec)) command (FMD) Std. 493) failure: Failures that Mon: Overall Knowledge of failure Human Factors/SME Electrical fault resulting in appear and effectiveness of condition for active the voltage unavailability Proper disappear mitigation and response seemingly at monitoring management. training random scheme of the procedures, system. Includes availability of resilience to subject errors, error matter checking, and expertise other and system measurement compétence, intelligence and clear EC-30 Vol/SoC jurisdictional Monitoring: This hierarchy for may apply at the managing cell, module, and situations AC-03 O&M: rack level. Whil Proper maintenance and monitoring of the system conjunction with 1.3.4.1.1.2 Spurious Actuation (FMD, IEEE FM-72 Intermittent FC-26 FSS Volt 72 AC-04 Human Factors: O&M Contractor AC-09 3 Does not Trip/Open on command (FMD) Std. 493) failure: Failures that Mon: Overall Knowledge of failure Human Reduced Capacity appear and effectiveness of condition for active Factors/SME ESMS/BMS Control Failure disappear the voltage mitigation and response Proper seemingly at monitoring management. training AC-08 Human Factors random scheme of the procedures, FM-89 Fail to system. Includes Maint: Proper preventive availability of respond to input résilience to maintenance to minimize subject errors, error the impact of adverse, matter checking, and long term or slow acting expertise environmental effects and system competence. measurement intelligence and clear iurisdictional hierarchy for managing situations AC-03 O&M: Proper maintenance monitoring of the system



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 57 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM
Design Basis: Assumed Typical LFP BESS Project

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Project Manager: Mr.James Whalen

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Oc	Dt	RPN
1.3.4.1.1	1.3.4.1.1.3	Protective Device (GE Prolec))	Degraded Operation (FMD)	Improper Operating Procedure(s) (IEEE Std. 493) Less than adequate maintenance (IEEE Std. 493)	8	FM-92 Improper Operating procedure implementation of guidance resulting in equipment failure, mis-operation, system degradation	5	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	3	120	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	O&M Contractor	AC-09 Human Factors/SME: Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for managing situations	4	4	3	48
	1.3.4.1.1.4		Subcomponent Failure - cracked/fractured (FMD)	Spurious Actuation (FMD, IEEE Std. 493) Defective Component (IEEE Std. 493)	7	FM-87 Internal Component Failure - Equipment Lifecycle Failure FM-77 Systematic Failure: Failures that they are related deterministically to a certain cause or causes	3	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence	3	63	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	O&M Contractor	AC-09 Human Factors/SME: Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for managing situations AC-03 O&M: Proper maintenance and monitoring of the system	5	2	2	20
	1.3.4.1.1.5		Mechanical Failure(s) (FMD)	Spurious Actuation (FMD, IEEE Std. 493) Defective Component (IEEE Std. 493)	7	FM-76 Random Failure: Failures that they do not appear to have any pattern or regularity.	3	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence	3	63	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	O&M Contractor	AC-09 Human Factors/SME: Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for managing situations	5	2	2	20



Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Empire II, LLC

Page 58 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
													AC-03 O&M: Proper maintenance and monitoring of the system				
1.3.4.1.1	1.3.4.1.1.6	Protective Device (GE Prolec))	Unknown/Indeterminat e Failures (FMD)	Spurious Actuation (FMD, IEEE Std. 493) Defective Component (IEEE Std. 493)	7	FM-72 Intermittent failure: Failures that appear and disappear seemingly at random	3	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence EC-30 Vol/SoC Monitoring: This may apply at the cell, module, and rack level. Whil	2	42	AC-04 Human Factors: Knowledge of failure condition for active miligation and response management.	O&M Contractor	AC-09 Human Factors/SME: Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for managing situations AC-03 O&M: Proper maintenance and monitoring of the system in conjunction with		2	2	20



Empire II, LLC

Page 59 of 135

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Documents

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.3.4.1.2	1.3.4.1.2.1	Integrated Transformer	Excessive/Fast Discharge (IEEE Std. 493, FMD)	Reduced Capacity	9	FC-11 BMS Failure: Cell/module level monitoring and control fails, resulting in inability to shutdown, report adverse conditions, properly monitor, balance or protect the system resulting in adverse condition	3	EC-29 Sys Elec Abuse Tolerance: Refers to ability of the overall system collectively to withstand adverse electrical abuse such as overcharge or dead shorts without failure	3	81	RA-22: RRC/BESS OEM BMS Software controls interconnected modules within the BESS OEM ESS to safely detect system degradation and initiate S/D protocols RA-23: RRC ESMS Software controls interdependent system to safely detect system degradation	Starlight Solar Project	RA-22: BESS OEM BMS Software controls interconnect ed modules within the BESS OEM ESS to safely detect system degradation and initiate S/D protocols RA-23: RRC ESMS Software controls interdepende nt system to safely detect system degradation and s/D	4	2	2	16
	1.3.4.1.2.2		Step-Touch Potential (IEEE Std. 493, FMD)	Electrical Fault resulting in unavailability Industrial Safety (Fire, Personnel) Issue	10	FC-28 Ext/Envr Risk, Shipping and Construction: An issue occurs with the system during shipping or construction that results in an adverse condition that may or may not be detected or protected via active controls. Results in Cell Failure	3	EC-28 Insul Monitoring: Continual, or active, monitoring of insulation integrity, ground v float voltage, and other practices to prevent insulation or isolation degradation	3	90	RA-25: Structured Empire II, LLC EngineeringDesign Reviews performance requirement decomposition and verification RA-01: Performance of Scheduled System Maintenance	O&M Provider	Mitigative measures defined in Empire II, LLC's SOPs & EOPs and O&M Manuals. Refer to the Empire II, LLC Engineering Procedure Index	5	2	2	20
	1.3.4.1.2.3		Stray Ground Currents (FMD)	Partial/Total loss of capacity Eventual ESS Unavailability	10	FC-33 Elec Risks, Ground Fault/Insulation Fault: This could include localized shorting of cells, shorting between modules, shorting of entire racks or systems and ground fault shorting.	3	EC-28 Insul Monitoring: Continual, or active, monitoring of insulation integrity, ground v float voltage, and other practices to prevent insulation or isolation degradation	3	90	RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-01: Performance of Scheduled System Maintenance	O&M Provider	Mitigative measures defined in Empire II, LLC's SOPs & EOPs and O&M Manuals. Refer to the Empire II, LLC Engineering Procedure Index	5	2	2	20



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project

Documents

Page 60 of 135

Project Manager: Mr.James Whalen

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.3.4.1.2	1.3.4.1.2.4	Integrated Transformer	Xfmr Primary/Secondary Failure - Open (FMD)	Electrical Fault resulting in unavailability Eventual ESS Unavailability	6	FC-77 Systematic Failure: Failures that they are related deterministically to a certain cause or causes	3	EC-22 Site Elec Prot: Protection for electrical systems such that a failure of the PCS or associated circuit does not result in adverse effects on the site balance of system electrical gear	3	54	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	O&M Contractor	Empire II, LLC/OEM Engineering, product UL NRTL Safety Certification, Product Manual, and verified during commissioni ng	3	2	2	12
	1.3.4.1.2.5		Xfmr Primary/Secondary Failure - Short Circuit (FMD)	Electrical Fault resulting in unavailability Reduced Capacity Eventual ESS Unavailability	6	FC-77 Systematic Failure: Failures that they are related deterministically to a certain cause or causes	3	EC-22 Site Elec Prot: Protection for electrical systems such that a failure of the PCS or associated circuit does not result in adverse effects on the site balance of system electrical gear	3	54	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	O&M Contractor	Empire II, LLC/OEM Engineering, product UL NRTL Safety Certification, Product Manual, and verified during commissioni ng	3	2	2	12
	1.3.4.1.2.6		Degraded Output: Loss of voltage transformation (FMD)	Eventual ESS Unavailability Electrical Fault resulting in unavailability	6	FC-77 Systematic Failure: Failures that they are related deterministically to a certain cause or causes	3	EC-22 Site Elec Prot: Protection for electrical systems such that a failure of the PCS or associated circuit does not result in adverse effects on the site balance of system electrical gear	3	54	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	O&M Contractor	Empire II, LLC/OEM Engineering, product UL NRTL Safety Certification, Product Manual, and verified during commissioni ng	3	2	2	12
	1.3.4.1.2.7		Degraded Output: Corroded (FMD)	Eventual ESS Unavailability	6	FM-91 Less than adequate resulting in system unavailability, erratic performance, degraded performance	3	EC-22 Site Elec Prot: Protection for electrical systems such that a failure of the PCS or associated circuit does not result in adverse effects on the site balance of system electrical gear	3	54	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	O&M Contractor	Empire II, LLC/OEM Engineering, product UL NRTL Safety Certification, Product Manual, and verified during commissioni ng	3	2	2	12



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 61 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.3.5	1.3.5.1	Low Votlage DPHA (NEMA 3R)	Construction Induced Insulation Damage	Defective Component (IEEE Std. 493) Partial/Total loss of capacity	9	FM-27 Ext/Envr Risk, Human Factors: An adverse condition caused by the result of human interaction, error, or imperfection	4	AC-12: System Commissioning Performance Verification	3	108	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	Empire II, LLC/O&M Contractor	RA-01: Performance of Scheduled System Maintenance RA-34: Perform Post-Mainte nance Testing to verify condition has been resolved	4	3	2	24
	1.3.5.2		Shorting due to animals (FMD, IEEE Std. 493)	Failure to Operate Partial/Total loss of capacity	7	FM-93 Foreign object introduction results in system failure, de-energization, short circuit, arc flash events	3	EC-22 Site Elec Prot: Protection for electrical systems such that a failure of the PCS or associated circuit does not result in adverse effects on the site balance of system electrical gear	2	42	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	Empire II, LLC/O&M Contractor	RA-34: Perform Post-Mainte nance Testing to verify condition has been resolved	4	2	2	16
	1.3.5.3		Mechanical Damage due to Foreign Objects (FMD, IEEE Std. 493)	Failure to Operate Eventual ESS Unavailability	7	FM-29 Ext/Envr Risk, Dust/Dirt/Particulate Accumulation: LTA Maintenance	4	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence	2	56	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	Empire II, LLC/O&M Contractor	RA-34: Perform Post-Mainte nance Testing to verify condition has been resolved	3	3	2	18
	1.3.5.4		Shorting by tools or metal objects (FMD, IEEE Std. 493)	Failure to Operate Eventual ESS Unavailability	6	FM-93 Foreign object introduction results in system failure, de-energization, short circuit, arc flash events	4	EC-22 Site Elec Prot: Protection for electrical systems such that a failure of the PCS or associated circuit does not result in adverse effects on the site balance of system electrical gear	2	48	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	Empire II, LLC/O&M Contractor	RA-34: Perform Post-Mainte nance Testing to verify condition has been resolved	3	3	2	18



Empire II, LLC

Page 62 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.3.5	1.3.5.5	Low Votlage DPHA (NEMA 3R)	Eventual ESS Unavailability	Failure to Operate Eventual ESS Unavailability	6	FM-93 Foreign object introduction results in system failure, de-energization, short circuit, arc flash events	4	EC-22 Site Elec Prot: Protection for electrical systems such that a failure of the PCS or associated circuit does not result in adverse effects on the site balance of system electrical gear	2	48	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	Empire II, LLC/O&M Contractor	RA-34: Perform Post-Mainte nance Testing to verify condition has been resolved	3	3	2	18
	1.3.5.6		Degraded Performance	Failure to Operate Eventual ESS Unavailability	6	FM-93 Foreign object introduction results in system failure, de-energization, short circuit, arc flash events	4	EC-22 Site Elec Prot: Protection for electrical systems such that a failure of the PCS or associated circuit does not result in adverse effects on the site balance of system electrical gear	2	48	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	Empire II, LLC/O&M Contractor	RA-34: Perform Post-Mainte nance Testing to verify condition has been resolved	3	3	2	18
	1.3.5.7		Component Defect Resulting in Failure to Operate	Failure to Operate Eventual ESS Unavailability	7	FM-93 Foreign object introduction results in system failure, de-energization, short circuit, arc flash events	4	EC-22 Site Elec Prot: Protection for electrical systems such that a failure of the PCS or associated circuit does not result in adverse effects on the site balance of system electrical gear	2	56	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	Empire II, LLC/O&M Contractor	RA-34: Perform Post-Mainte nance Testing to verify condition has been resolved	3	3	2	18



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 63 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Project Manager: Mr.James Whalen

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.3.5.1	1.3.5.1.1	BESS AUX AC Disconnect	Defective Component (IEEE Std. 493)	Mechanical Damage due to Foreign Objects (FMD, IEEE Std. 493) Eventual ESS Unavailability Degraded Performance	6	FM-46 Subcomponent/Sub system Failure: Lifecycle failure of components impacting availability/capabilit y to execute intended design function	3	EC-01 Auto Shutdown: Ability of system to actively shut itself down or disconnect itself EC-29 Sys Elec Abuse Tolerance: Refers to ability of the overall system collectively to withstand adverse electrical abuse	3	54	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	Empire II, LLC/O&M Contractor	RA-34: Perform Post-Mainte nance Testing to verify condition has been resolved	3	2	2	12
	1.3.5.1.2		Improper Application (IEEE Std. 493)	Degraded Performance Eventual ESS Unavailability Component Defect Resulting in Failure to Operate	6	FM-39 Human Factors - Design Errors and Omissions	5	AC-09 Human Factors/SME: Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for managing situations	4	120	AC-11 Human Factors/RAGAGEP: In addition to analysis required by product standards, good engineering practice should require design review such that design mistakes and weaknesses are identified and corrected in a timely and efficient manner	O&M Contractor	AC-11 Human Factors/RAG AGEP: In addition to analysis required by product standards, good engineering practice should require design mistakes and weaknesses are identified and corrected in a timely and efficient manner	3	4	3	36



Empire II, LLC

Page 64 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.3.5.1	1.3.5.1.3	BESS AUX AC Disconnect	Improper Handling (IEEE Std. 493)	Degraded Performance Eventual ESS Unavailability	6	FC-23 Ext/Envr Risk, Mechanical Shock/Drop - The system or component is subject to mechanical shock or drop, mechanical jarring or damaging the system FC-27 Ext/Envr Risk, Human Factors: An adverse condition caused by the result of human interaction	4	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	4	96	AC-12: System Commissioning Performance Verification	O&M Contractor	RA-01: Performance of Scheduled System Maintenance	3	3	3	27
	1.3.5.1.4		Improper Installation (IEEE Std. 493)	Degraded Performance Eventual ESS Unavailability Shorting by tools or metal objects (FMD, IEEE Std. 493)	6	FC-66 Installation Error: A failure due to an error or errors during installation (e.g., ignoring to install the hardware in the required configuration)	5	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling	5	150	AC-12: System Commissioning Performance Verification	Empire II, LLC Engineering/O&M Contractor	RA-01: Performance of Scheduled System Maintenance	3	4	4	48
	1.3.5.1.5		Less than adequate maintenance (IEEE Std. 493)	Degraded Performance Eventual ESS Unavailability	6	FM-91 Less than adequate resulting in system unavailability, erratic performance, degraded performance	5	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	3	90	AC-12: System Commissioning Performance Verification	Empire II, LLC Engineering/O&M Contractor	RA-01: Performance of Scheduled System Maintenance	3	4	2	24
	1.3.5.1.6		Improper Operating Procedure(s) (IEEE Std. 493)	Eventual ESS Unavailability	6	FM-92 Improper Operating procedure implementation of guidance resulting in equipment failure, mis-operation, system degradation	5	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	3	90	AC-12: System Commissioning Performance Verification	Empire II, LLC Engineering/O&M Contractor	RA-01: Performance of Scheduled System Maintenance	3	4	2	24



Empire II, LLC

Page 65 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
								AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions									
1.3.5.1	1.3.5.1.7	BESS AUX AC Disconnect	Spurious Actuation (FMD, IEEE Std. 493)	Degraded Performance	6	FM-76 Random Failure: Failures that they do not appear to have any pattern or regularity.	5	EC-22 Site Elec Prot: Protection for electrical systems such that a failure of the PCS or associated circuit does not result in adverse effects on the site balance of system electrical gear	3	90	AC-12: System Commissioning Performance Verification	Empire II, LLC Engineering/O&M Contractor	RA-01: Performance of Scheduled System Maintenance	3	4	2	24
	1.3.5.1.8		Thermocycling (FMD, IEEE Std. 493)	Degraded Performance Eventual ESS Unavailability	6	FM-29 Ext/Envr Risk, Dust/Dirt/Particulate Accumulation: LTA Maintenance	6	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence	6	216	RA-03: ESMS Testing and Commissioning RA-04: BMS Testing and Commissioning	Empire II, LLC/Commissioning	RA-33: Construction Contractor Installation and Commissioni ng	3	5	5	75
	1.3.5.1.9		Mechanical Damage due to Foreign Objects (FMD, IEEE Std. 493)	Shorting by tools or metal objects (FMD, IEEE Std. 493) Degraded Performance	6	FM-29 Ext/Envr Risk, Dust/Dirt/Particulate Accumulation: LTA Maintenance	6	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence	4	144	AC-12: System Commissioning Performance Verification	Empire II, LLC/Commissioning	RA-33: Construction Contractor Installation and Commissioni ng	3	5	3	45



Empire II, LLC

Page 66 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.3.5.1.1	1.3.5.1.1.1	Protective Device (GE Prolec)	Opens without command (FMD)	Spurious Actuation (FMD, IEEE Std. 493)	8	FM-72 Intermittent failure: Failures that appear and disappear seemingly at random	5	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence EC-30 Vol/SoC Monitoring: This may apply at the cell, module, and rack level. Whil	4	160	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	O&M Contractor	AC-09 Human Factors/SME: Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for managing situations AC-03 O&M: Proper maintenance and monitoring of the system in conjunction with	4	4	3	48
	1.3.5.1.1.2		Does not Trip/Open on command (FMD)	Spurious Actuation (FMD, IEEE Std. 493)	9	FM-72 Intermittent failure: Failures that appear and disappear seemingly at random FM-89 Fail to respond to input	4	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence	2	72	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management. AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects	O&M Contractor	AC-09 Human Factors/SME: Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for managing situations AC-03 O&M: Proper maintenance and monitoring of the system	5	3	3	45



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 67 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM
Design Basis: Assumed Typical LFP BESS Project

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Project Manager: Mr.James Whalen

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.3.5.1.1	1.3.5.1.1.3	Protective Device (GE Prolec)	Degraded Operation (FMD)	Improper Operating Procedure(s) (IEEE Std. 493) Less than adequate maintenance (IEEE Std. 493)	8	FM-92 Improper Operating procedure implementation of guidance resulting in equipment failure, mis-operation, system degradation	5	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	3	120	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	O&M Contractor	AC-09 Human Factors/SME: Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for managing situations	4	4	3	48
	1.3.5.1.1.4		Subcomponent Failure - cracked/fractured (FMD)	Spurious Actuation (FMD, IEEE Std. 493) Defective Component (IEEE Std. 493)	7	FM-87 Internal Component Failure - Equipment Lifecycle Failure FM-77 Systematic Failure: Failures that they are related deterministically to a certain cause or causes	3	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence	3	63	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	O&M Contractor	AC-09 Human Factors/SME: Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for managing situations AC-03 O&M: Proper maintenance and monitoring of the system	4	2	3	24
	1.3.5.1.1.5		Mechanical Failure(s) (FMD)	Spurious Actuation (FMD, IEEE Std. 493) Defective Component (IEEE Std. 493)	7	FM-76 Random Failure: Failures that they do not appear to have any pattern or regularity.	3	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence	3	63	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	O&M Contractor	AC-09 Human Factors/SME: Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for managing situations	4	2	3	24



Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Empire II, LLC

Page 68 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
													AC-03 O&M: Proper maintenance and monitoring of the system				
1.3.5.1.1	1.3.5.1.1.6	Protective Device (GE Prolec)	Unknown/Indeterminat e Failures (FMD)	Spurious Actuation (FMD, IEEE Std. 493) Defective Component (IEEE Std. 493)	7	FM-72 Intermittent failure: Failures that appear and disappear seemingly at random	3	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence EC-30 Vol/SoC Monitoring: This may apply at the cell, module, and rack level. Whil	2	42	AC-04 Human Factors: Knowledge of failure condition for active miligation and response management.	O&M Contractor	AC-09 Human Factors/SME: Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for managing situations AC-03 O&M: Proper maintenance and monitoring of the system in conjunction with		2	3	24



Empire II, LLC

Page 69 of 135

Design Responsibility: Empire II, LLC and BESS OEM

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.4	1.4.1	BESS Yard Cabling System	Construction Induced Insulation Damage	Partial/Total loss of capacity Failure to Operate	5	FM-27 Ext/Envr Risk, Human Factors: An adverse condition caused by the result of human interaction, error, or imperfection	4	AC-12: System Commissioning Performance Verification	3	60	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	O&M Contractor	AC-09 Human Factors/SME: Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for managing situations AC-03 O&M: Proper maintenance and monitoring of the system	3	3	2	18
	1.4.2		Cabling System Connection/Splice Failure (IEEE Std. 493)	Failure to Operate Partial/Total loss of capacity	5	FM-94 Primary Power Cabling failure due to high resistance splicing, terminations, exothermic welds	3	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	3	45	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	O&M Contractor	AC-09 Human Factors/SME: Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for managing situations AC-03 O&M: Proper maintenance and monitoring of the system	4	2	2	16



Empire II, LLC

Page 70 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

	T				Ι	Potential					Documents						
Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.4	1.4.3	BESS Yard Cabling System	Design Error - Undersized Cabling Systems (IEEE Std. 493)	Partial/Total loss of capacity Failure to Operate	5	FM-39 Human Factors - Design Errors and Omissions	3	AC-11 Human Factors/RAGAG EP: In addition to analysis required by product standards, good engineering practice should require design review such that design mistakes and weaknesses are identified and corrected in a timely and efficient manner	3	45	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	O&M Contractor	AC-09 Human Factors/SME: Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for managing situations AC-03 O&M: Proper maintenance and monitoring of the system	4	2	2	16
	1.4.4		Protective Device Failure (IEEE Std. 493)	Failure to Operate Partial/Total loss of capacity	7	FM-75 Degradation/Age related failure: Failures realized as part of system/component lifecycle	3	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	3	63	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	O&M Contractor	AC-09 Human Factors/SME : Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for managing situations AC-03 O&M: Proper maintenance and monitoring of the system	3	2	2	12



Page 71 of 135

Empire II, LLC

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.4	1.4.5	BESS Yard Cabling System	Insulation Failure - Rodent (IEEE Std. 493)	Partial/Total loss of capacity Inadvertent System S/D Failure to Operate	5	FM-93 Foreign object introduction results in system failure, de-energization, short circuit, arc flash events	3	AC-12: System Commissioning Performance Verification	7	105	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	O&M Contractor	AC-09 Human Factors/SME: Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for imanaging situations AC-03 O&M: Proper maintenance and monitoring of the system	3	2	6	36
	1.4.6		Mechanical/Structural Failure (FMD, IEEE Std. 493)	Moderate Effect - Moderate degradation of product performance;	5	FM-52 Internal Component Failure - Mechanical	3	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	3	45	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	O&M Contractor	AC-09 Human Factors/SME: Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for managing situations AC-03 O&M: Proper maintenance and monitoring of the system	3	2	2	12



Empire II, LLC

Page 72 of 135

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen Design Responsibility: Empire II, LLC and BESS OEM

Design Basis: Assumed Typical LFP BESS Project

Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

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Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.5	1.5.1	Energy Storage Management System (ESMS)	Failure to Measure Battery Module/Cell Temperatures	Reduced Capacity Eventual BESS Unavailability	9	EC-30 Vol/SoC Monitoring: This may apply at the cell, module, and rack level. While voltage monitoring may be useful more advanced methods such as coulomb counting may be used as well.	6	EC-21 BMS Cntrl: Includes monitoring and shutdown/isolati on capabilities of the affected BMS/module or system if necessary.	4	216	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	O&M Contractor	AC-09 Human Factors/SME: Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for managing situations AC-03 O&M: Proper maintenance and monitoring of the system	3	5	3	45
	1.5.2		Failure to Measure Battery Ampacity Charging/Discharging	Reduced Capacity Eventual BESS Unavailability	9	FC-32 Elec Risks, Hazardous Current Condition: This includes high current issues from the PCS or interconnection	6	EC-30 Vol/SoC Monitoring: This may apply at the cell, module, and rack level. While voltage monitoring may be useful more advanced methods such as coulomb counting may be used as well.	4	216	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	O&M Contractor	AC-09 Human Factors/SME: Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for managing situations AC-03 O&M: Proper maintenance and monitoring of the system	5	5	3	75



Empire II, LLC

Page 73 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.5.3	Energy Storage Management System (ESMS)	Energy Abuse	ESMS/BMS Control Failure Eventual BESS Unavailability Reduced Capacity	9	FC-32 Elec Risks, Hazardous Current Condition: This includes high current issues from the PCS or interconnection	4	EC-27 Inv/PCS Cntrl: Includes monitoring, shutdown/isolati on capabilities, and transient protections	6	216	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	O&M Contractor	AC-09 Human Factors/SME : Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for managing situations AC-03 O&M: Proper maintenance and monitoring of the system	5	3	5	75
1.5.4		Failure to Measure Cell Voltage	ESMS/BMS Control Failure Eventual BESS Unavailability Reduced Capacity	9	FC-10 Sensor Failure: A sensor inside the system fails, resulting in incorrect reporting of system properties		EC-21 BMS Cntrl: Includes monitoring and shutdown/isolati on capabilities of the affected BMS/module or system if necessary.	5	270	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	O&M Contractor	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction AC-03 O&M: Proper maintenance and monitoring of the system	5	5	3	75
1.5.5		Failure to Control Cell/Module/Rack	Reduced Capacity ESMS/BMS Control Failure Eventual BESS Unavailability	9	FC-16 ESMS/BMS Bal Fail: Failure of the system at the cell, module, or rack level to maintain balance, resulting in unstable or unbalanced system. This will result in premature end of life condition or adverse safety condition	6	EC-32 BMS S/D: Ability of the BMS to isolate affected modules or strings without shutting down the entire system if unneeded	6	324	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	O&M Contractor	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction AC-03 O&M: Proper maintenance and monitoring of the system	5	5	3	75
	1.5.4	1.5.3 Energy Storage Management System (ESMS)	1.5.3 Energy Storage Management System (ESMS) Failure to Measure Cell Voltage 1.5.5 Failure to Control	1.5.3 Energy Storage Management System (ESMS) Energy Abuse ESMS/BMS Control Failure Eventual BESS Unavailability Reduced Capacity Failure to Measure Cell Voltage Eswayailability Reduced Capacity ESMS/BMS Control Failure Eventual BESS Unavailability Reduced Capacity Failure to Control Cell/Module/Rack Eswayailability Reduced Capacity Eswayailability Reduced	1.5.4 Energy Storage Management System (ESMS) Energy Abuse EsMS/BMS Control Failure Eventual BESS Unavailability Reduced Capacity Failure to Measure Cell Voltage EsMS/BMS Control Failure Eventual BESS Unavailability Reduced Capacity Failure to Control Cell/Module/Rack EsMS/BMS Control Failure 9	Indigen	Indicate	In term function Potential failure Effects descriptions Sv Caluse(s) / failure mechanisms Control Failure Control Failure Condition: This includes from the PC so interconnection Potential Failure Condition: This includes from the PC so interconnection Potential Failure Condition: This includes from the PC so interconnection Potential Failure Potential Fail	Item function Potential failure mode Effects descriptions Sv Cause(s) / failure mechanisms Controls	Item function Potential failure mode Effects descriptions Sv Caus(s(s) / failure mechanisms Control Sulphane Cont	Energy Storage Energy Abuse ESMS-BMS Control Failure Eventual BESS Unavailability System (ESMS) Eallure to Cell Voltage Eallure to Cell Midedule/Rack Eallure to Cell Midedule	Institute Potential failure Effects descriptions Sv Cause(s) / failure Control Con	Institute Inst	Institute Countries Coun	Institute Inst	Design Effects descriptions Sv Cause(s) / International Control Posign Design Des



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

12302 Exposition Blvd | Los Angeles, CA 90068

Project Manager: Mr.James Whalen

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Page 74 of 135

Design Responsibility: Empire II, LLC and BESS OEM

Design Basis: Assumed Typical LFP BESS Project Documents

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.5	1.5.6	Energy Storage Management System (ESMS)	Fieldbus/Modbus Failure	ESMS/BMS Control Failure Eventual BESS Unavailability Reduced Capacity	9	FC-15 Comms Failure: Failure of the system to properly report an adverse condition to local or remote monitoring. Failure of the system to report failures within itself and to act on those failures, resulting in adverse condition	6	AC-09 Human Factors/SME: Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for managing situations	5	270	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	O&M Contractor	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction AC-03 O&M: Proper maintenance and monitoring of the system	5	5	3	75
	1.5.7		ESMS/BMS Control Failure	Failure to Operate Inadvertent System S/D Partial/Total loss of capacity	5	FC-15 Comms Failure: Failure of the system to properly report an adverse condition to local or remote monitoring. Failure of the system to report failures within itself and to act on those failures, resulting in adverse condition	6	AC-09 Human Factors/SME: Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for managing situations	1	30	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	O&M Contractor	AC-09 Human Factors/SME: Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for managing situations AC-03 O&M: Proper maintenance and monitoring of the system	3	5	3	45



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 75 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Project Manager: Mr.James Whalen

Design Basis: Assumed	Typical LFP BESS Project
Documents	

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.5.1	1.5.1.1	Fiber Network	Fiber Network to respond to input data, Human/Electrical induced failure	Fieldbus/Modbus Failure Failure to Control Cell/Module/Rack	7	FC-39 Human Factors - Design Errors and Omissions	6	AC-11 Human Factors/RAGAG: In addition to analysis required by product standards, good engineering practice should require design review such that design mistakes and weaknesses are identified and corrected in a timely and efficient manner	4	168	RA-05: Auto System S/D RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification	Starlight Solar Project	Credit given based on BESS OEM Software Operations Manual, Communicati ons Architecture, and Commissioni ng Reports	3	5	3	45
	1.5.1.2		Engineering Induced Failure/Miswiring	Fieldbus/Modbus Failure Failure to Control Cell/Module/Rack	7	FM-27 Ext/Envr Risk, Human Factors: An adverse condition caused by the result of human interaction, error, or imperfection	4	AC-12: System Commissioning Performance Verification	4	112	AC-11 Human Factors/RAGAGEP: In addition to analysis required by product standards, good engineering practice should require design review such that design mistakes and weaknesses are identified and corrected in a timely and efficient manner	Construction Contractor	Credit given based on BESS OEM Software Operations Manual, Communicati ons Architecture, and Commissioni ng Reports	4	3	3	36
	1.5.1.3		Broken/Defective Fiber	Failure to Control Cell/Module/Rack	6	FM-52 Internal Component Failure - Mechanical	4	EC-25 Container Monitoring: Monitoring within the container which may detect adverse Container Thermal/Operati ng Environment Conditions	3	72	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling	O&M and Commissioning Contractor	Credit given based on BESS OEM Software Operations Manual, Communicati ons Architecture, and Commissioni ng Reports	3	3	2	18



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 76 of 135

Design Responsibility: Empire II, LLC and BESS OEM

12302 Exposition Blvd | Los Angeles, CA 90068

Design Basis: Assumed Typical LFP BESS Project

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Project Manager: Mr.James Whalen

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Oc	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Oc		
1.5.1.1	1.5.1.1.1	BESS Yard Patch Panel	Construction Induced Failure/Miswiring	Fiber Network to respond to input data, Human/Electrical induced failure	9	FM-27 Ext/Envr Risk, Human Factors: An adverse condition caused by the result of human interaction, error, or imperfection	5	AC-12: System Commissioning Performance Verification	3	135	AC-11 Human Factors/RAGAGP: In addition to analysis required by product standards, good engineering practice should require design review such that design mistakes and weaknesses are identified and corrected in a timely and efficient manner	Construction Contractor	Credit given based on BESS OEM Software Operations Manual, Communicati ons Architecture, and Commissioning Reports	5	4	2	40
	1.5.1.1.2		Comm Component Failure	Failure to Control Cell/Module/Rack Fieldbus/Modbus Failure	7	FM-10 Sensor Failure: A sensor inside the system fails, resulting in incorrect reporting of system properties	5	AC-12: System Commissioning Performance Verification AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation	4	140	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	Construction/Commi ssioning Contractor	Credit given based on BESS OEM Software Operations Manual, Communicati ons Architecture, and Commissioni ng Reports	4	4	3	48
	1.5.1.1.3		Overtemperature - Thermal Management	Fieldbus/Modbus Failure	7	FM-13 Site CTRL Failure: Failure of the site controller or other balance of system controller resulting in adverse condition to the system	4	EC-25 Container Monitoring: Whonitoring within the container which may detect adverse Container Thermal/Operati ng Environment Conditions	3	84	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management. AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing	O&M Contractor	Credit given based on BESS OEM Software Operations Manual, Communicati ons Architecture, and Commissioni ng Reports	4	3	2	24
	1.5.1.1.4		Overtemperature - LTA Maintenance	Fieldbus/Modbus Failure	6	FM-91 Less than adequate maintenance resulting in system unavailability, erratic performance, degraded performance	5	EC-25 Container Monitoring: Monitoring within the container which may detect adverse Container Thermal/Operati ng Environment Conditions	3	90	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management. AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing	O&M Contractor	Credit given based on BESS OEM Software Operations Manual, Communicati ons Architecture, and Commissioni ng Reports	3	4	2	24
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Empire II, LLC

Page 77 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.5.1.2	1.5.1.2.1	(typ.) BESS OEM Level Interface and Control	Construction Induced Failure/Miswiring	Moderate Effect - Moderate degradation of product performance;	5	FM-27 Ext/Envr Risk, Human Factors: An adverse condition caused by the result of human interaction, error, or imperfection	5	AC-12: System Commissioning Performance Verification	3	75	AC-11 Human Factors/RAGAGEP: In addition to analysis required by product standards, good engineering practice should require design review such that design mistakes and weaknesses are identified and corrected in a timely and efficient manner	Construction Contractor	Credit given based on BESS OEM Software Operations Manual, Communicati ons Architecture, and Commissioni ng Reports	3	4	2	24
	1.5.1.2.2		Comm Component Failure	Moderate Effect - Moderate degradation of product performance;	7	FM-10 Sensor Failure: A sensor inside the system fails, resulting in incorrect reporting of system properties	4	AC-12: System Commissioning Performance Verification AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections	4	112	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	Construction/Commi ssioning Contractor	Credit given based on BESS OEM Software Operations Manual, Communicati ons Architecture, and Commissioni ng Reports	4	3	3	36
	1.5.1.2.3		Overtemperature - Thermal Management	Minor Effect - Minor degradation of product performance that generally does not require repair.	4	FM-13 Site CTRL Failure: Failure of the site controller or other balance of system controller resulting in adverse condition to the system	4	EC-25 Container Monitoring within the container which may detect adverse Container Thermal/Operati ng Environment Conditions	3	48	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management. AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing	O&M Contractor	Credit given based on BESS OEM Software Operations Manual, Communicati ons Architecture, and Commissioni ng Reports	2	3	2	12
	1.5.1.2.4		Overtemperature - LTA Maintenance	Moderate Effect - Moderate degradation of product performance;	5	FM-91 Less than adequate maintenance resulting in system unavailability, erratic performance, degraded performance	5	EC-25 Container Monitoring: Monitoring within the container which may detect adverse Container Thermal/Operati ng Environment Conditions	3	75	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management. AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing	O&M Contractor	Credit given based on BESS OEM Software Operations Manual, Communicati ons Architecture, and Commissioni ng Reports	3	4	2	24



Empire II, LLC

Page 78 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Project Manager: Mr.James Whalen

	(Documents						
Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.5.2	1.5.2.1	BMS/EMCU Software Failures	Failure to Operate, Software Induced Error	Fieldbus/Modbus Failure Failure to Control Cell/Module/Rack	9	FC-45 Loss of BMS due to Software Induced Problem/Failure	6	AC-11 Human Factors/RAGAG EP: In addition to analysis required by product standards, good engineering practice should require design review such that design mistakes and weaknesses are identified and corrected in a timely and efficient manner	8	432	RA-04: BMS Testing and Commissioning RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of subject matter expertise and system competence	Starlight Solar Project	Refer to Empire II, LLC Procedures Index. Requires validation substantiatin g RPN reduction	4	5	4	80



Empire II, LLC

Page 79 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.5.2.1	1.5.2.1.1	BMS/EMCU software error allows continuous operation	Software coding does not command performance	Failure to Operate Battery Management System (BMS) Failure Serious Effects - Product is inoperable but safe, or a system is inoperable but safe.	8	FC-45 Loss of BMS due to Software Induced Problem/Failure	4	AC-11 Human Factors/RAGAG: In addition to analysis required by product standards, good engineering practice should require design review such that design mistakes and weaknesses are identified and corrected in a timely and efficient manner	8	256	RA-04: BMS Testing and Commissioning RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of subject matter expertise and system competence	Starlight Solar Project	Mitigative measures defined in Empire II, LLC's SOPs & EOPs and O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	4	3	5	60



Empire II, LLC

Page 80 of 135

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen Design Responsibility: Empire II, LLC and BESS OEM
Design Basis: Assumed Typical LFP BESS Project

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

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Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.5.2.2	1.5.2.2.1	BMS/EMCU software error does not allow continuous operation	Coding - Failure to Operate	Failure to Operate, Software Induced Error Software Errors, Software Programming, PLC error Battery Management System (BMS) Failure Serious Effects - Product is inoperable but safe, or a system is inoperable but safe.	10	FC-39 Human Factors - Design Errors and Omissions	6	AC-11 Human Factors/RAGAG EP: In addition to analysis required by product standards, good engineering practice should require design review such that design mistakes and weaknesses are identified and corrected in a timely and efficient manner	8	480	RA-04: BMS Testing and Commissioning RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of subject matter expertise and system competence	Starlight Solar Project	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	5	3	75
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Empire II, LLC

Page 81 of 135

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

	rate (Orig.). 2	20 July 2020									Documents						
Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Oc	Dt	RPN
1.5.3	1.5.3.1	BMS/EMCU Master Controller Failures	Failure to Control Cell/Module/Rack	Moderate Effect - Moderate degradation of product performance;	7	FC-16 ESMS/BMS Bal Fait: Failure of the system at the cell, module, or rack level to maintain balance, resulting in unstable or unbalanced system. This will result in premature end of life condition or adverse safety condition	6	EC-32 BMS S/D: Ability of the BMS to isolate affected modules or strings without shutting down the entire system if unneeded	8	336	RA-04: BMS Testing and Commissioning RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of subject matter expertise and system competence	Starlight Solar Project	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	4	5	3	60
	1.5.3.2		Fieldbus/Modbus Failure	Moderate Effect - Moderate degradation of product performance;	7	FC-15 Comms Failure: Failure of the system to properly report an adverse condition to local or remote monitoring. Failure of the system to report failures within itself and to act on those failures, resulting in adverse condition	6	AC-09 Human Factors/SME: Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for managing situations	8	336	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Empire II, LLC	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	4	5	3	60



Empire II, LLC

Page 82 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.5.3.1	1.5.3.1.1	BMS Contactor //Disconnect fails to interrupt	Contactor energize or de-energize, Failed Relay Coil	Failure to Operate Batteries overheat, potential for off-gas	10	FC-46 Subcomponent/Sub system Failure: Lifecycle failure of components impacting availability/capabilit y to execute intended design function	4	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	8	320	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Starlight Solar Project	Mitigative measures defined in Empire II, LLC's SOPs & EOPs and O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	5	3	5	75
	1.5.3.1.2		Individual contacts welded, No positive guidance of contacts (for relays this failure is not assumed if they are built and tested according to EN 50205 or equivalent)	Failure to Operate Batteries overheat, potential for off-gas Major Effect - Product performance is severely degraded but has some operational capability and remains safe.	8	FC-46 Subcomponent/Sub system Failure: Lifecycle failure of components impacting availability/capabilit y to execute intended design function	5	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	7	280	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLC /BESS OEM Design Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Starlight Solar Project	Mitigative measures defined in Empire II, LLC's SOPs & EOPs and O&M Manuals. Refer to Empire II, LLC Procedure Index	4	4	6	96
	1.5.3.1.3		No positive opening (for position switches this failure is not assumed if they are built and tested according to IEC 60947-5-1, or equivalent), Failed sub-component	Failure to Operate Battery Management System (BMS) Failure Major Effect - Product performance is severely degraded but has some operational capability and remains safe.	7	FC-46 Subcomponent/Sub system Failure: Lifecycle failure of components impacting availability/capabilit y to execute intended design function	4	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	6	168	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLC Design Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Empire II, LLC Engineering	Mitigative measures defined in Empire II, LLC's SOPs & EOPs and O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	4	3	5	60



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 83 of 135

Prepared by: Robert Steele, PhD.

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM
Design Basis: Assumed Typical LFP BESS Project

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Project Manager: Mr.James Whalen

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.5.3.2	1.5.3.2.1	BMS Software Failures	Failure to Operate, Software Induced Error	Fieldbus/Modbus Failure Failure to Control Cell/Module/Rack	6	FC-45 Loss of BMS due to Software Induced Problem/Failure	6	AC-11 Human Factors/RAGAG EP: In addition to analysis required by product standards, good engineering practice should require design review such that design mistakes and weaknesses are identified and corrected in a timely and efficient manner	8	288	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Starlight Solar Project	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	3	5	5	75



Empire II, LLC

Page 84 of 135

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

I WILA L	Pale (Orig.). 2	20 July 2020									Documents						
Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Oc	Dt	RPN
1.5.3.2.1	1.5.3.2.1.1	BMS software error allows continuous operation	Software coding does not command performance	Moderate Effect - Moderate degradation of product performance;	5	FC-45 Loss of BMS due to Software Induced Problem/Failure	4	AC-11 Human Factors/RAGAG: In addition to analysis required by product standards, good engineering practice should require design review such that design mistakes and weaknesses are identified and corrected in a timely and efficient manner	8	160	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Empire II, LLC	Mitigative measures defined in Empire II, LLC's SOPs & EOPs and O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	3	3	7	63
	1.5.3.2.1.2		Software Fails to respond to voltage/current data, Human/Electrical induced failure	Moderate Effect - Moderate degradation of product performance;	5	FC-39 Human Factors - Design Errors and Omissions	5	AC-11 Human Factors/RAGAG: In addition to analysis required by product standards, good engineering practice should require design review such that design mistakes and weaknesses are identified and corrected in a timely and efficient manner	5	125	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Empire II, LLC	Mitigative measures defined in Empire II, LLC's SOPs & EOPs and O&M Manuals. Refer to Empire II, LLC Engineering Procedure Index	3	4	4	48



Page 85 of 135

Empire II, LLC

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

I WILA L	rate (Orig.).	23 July 2023									Documents						
Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.5.3.2.2	1.5.3.2.2.1	BMS software error does not allow continuous operation	Coding - Failure to Operate	Failure to Operate, Software Induced Error	5	FC-39 Human Factors - Design Errors and Omissions	6	AC-11 Human Factors/RAGAG EP: In addition to analysis required by product standards, good engineering practice should require design review such that design mistakes and weaknesses are identified and corrected in a timely and efficient manner	8	240	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Starlight Solar Project	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	3	5	4	60



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 86 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.5.4	1.5.4.1	BMS power supply failure	Loss of external 24VDC Power, Component I/O failure	Energy Abuse Failure to Control Cell/Module/Rack Catastrophic - Very hazardous effect. Effect occurs suddenly without warning to user and may pose an industrial safety concern. Serious Effects - Product is inoperable but safe, or a system is inoperable but safe.	10	FC-10 Sensor Failure: A sensor inside the system fails, resulting in incorrect reporting of system properties	4	EC-21 BMS Cntrl: Includes monitoring and shutdown/isolati on capabilities of the affected BMS/module or system if necessary.	6	240	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	BESS OEM	Refer to Empire II, LLC Procedures Index	5	3	5	75
	1.5.4.2		External Communication Failure - not transmitting data	Failure to Control Cell/Module/Rack Major Effect - Product performance is severely degraded but has some operational capability and remains safe. Fieldbus/Modbus Failure	9	FC-15 Comms Failure: Failure of the system to properly report an adverse condition to local or remote monitoring. Failure of the system to report failures within itself and to act on those failures, resulting in adverse condition	4	EC-21 BMS Cntrl: Includes monitoring and shutdown/isolati on capabilities of the affected BMS/module or system if necessary.	4	144	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Starlight Solar Project	Refer to Empire II, LLC Procedures Index	4	3	3	36



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 87 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

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nt ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.5.5.1	ESMS/EMCU - General	Operator Error	Premature Operation Batteries overheat, potential for off-gas Failure to Operate	10	FC-37 Misc Human Factors: Human induced failures due to negligence	3	AC-09 Human Factors/SME: Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for managing situations	5	150	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Starlight Solar Project	Refer to Empire II, LLC Procedures Index	5	2	4	40
1.5.5.2		Software Errors	Premature Operation Failure to Operate Batteries overheat, potential for off-gas	10	FC-62 Programming Error: A failure resulting from an error in the system software or firmware.	4	AC-09 Human Factors/SME: Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for managing situations	8	320	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Starlight Solar Project	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	3	5	75
1.5.5.3		Cyber Security Challenges	Failure to Operate Batteries overheat, potential for off-gas Loss of BMS Control	10	FC 38 Human Factors Failures due to malfeasance	4	AC-01: EOP - System operator plan to handle all emergency events (PLACE HOLDER TO Empire II, LLCMANUALS).	9	360	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Starlight Solar Project	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	3	5	75
1.5.5.4		Redundant Failure Detection/System Intelligence: Ability of system to determine a sensor has failed, to operate safely without that sensor to shut down, or operate safely indefinitely without sensor.	Loss of ESMS Control Loss of BMS Control	9	FC-12 ESMS Failure: Failure of the controller at the rack or system level which results in adverse condition to the system	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	8	360	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Starlight Solar Project	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	4	4	80
			without sensor.	without sensor.	without sensor.	without sensor.	without sensor.	abnormal system	abnormal system	abnormal system	abnormal system RA-27: Proper training performance procedures, availability of	abnormal system RA-27: Proper training performance procedures, availability of	abnormal system RA-27: Proper training performance procedures, availability of	abnormal system RA-27: Proper training performance procedures, availability of	abnormal system RA-27: Proper training performance procedures, availability of	abnormal system RA-27: Proper training performance procedures, availability of



Empire II, LLC

Page 88 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.5.5	1.5.5.5	ESMS/EMCU - General	System Shutdown/Disconnect: Ability of system to actively shut itself down or disconnect itself. This is the aggregate of the BMS or inverter's shutdown ability as well as physical disconnects and the BoS controller's ability to shut down.	Failure to Operate Loss of BMS Control Premature Operation	7	FC-69 Execution-sequenc e-dependent: Failures that typically occur because an expected sequence of events does not occur in the order expected.	5	AC-09 Human Factors/SME: Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for managing situations	7	245	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Starlight Solar Project	Refer to Empire II, LLC Procedures Index	4	4	6	96
	1.5.5.6		Passive Circuit Protection and Design: Current interrupt devices, fuses or other passive surge arresting elements which may open the circuit in the case of failure and general resilience of design to withstand adverse electrical conditions.	Failure to Operate Loss of ESMS Control Loss of BMS Control	9	FC-12 ESMS Failure: Failure of the controller at the rack or system level which results in adverse condition to the system	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	8	360	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Starlight Solar Project	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	4	4	80
	1.5.5.7		Cell Electrical Abuse Tolerance due to loss of ESMS: Ability of the cell to withstand electrical abuse such as overcharge, over discharge, high currents, or other adverse electrical abuse.	Battery Management System (BMS) Failure Loss of BMS Control Loss of ESMS Control Industrial Safety (Fire, Personnel) Issue Major Effect - Product performance is severely degraded but has some operational capability and remains safe.	10	Internal Component Failure - Electrical Abuse	5	EC-17 Elec Pass Prot: Current interrupt devices, fuses or other passive surge arresting elements which may open the circuit in the case of failure and general resilience of design to withstand adverse electrical conditions.	7	350	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLC Design Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Empire II, LLC Engineering	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	4	4	80
	1.5.5.8		Interdependent System Induced Failure: Failure of interdependent subsystem fails and introduces a failure mechanism to ESMS	Failure to Operate Loss of Control HVAC	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	4	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	5	140	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLC Design Reviews performance requirement decomposition and verification	Starlight Solar Project	Refer to Empire II, LLC Procedures Index	4	3	4	48



Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Empire II, LLC

Page 89 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project Documents

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
											RA-27: Proper training procedures, availability of SME						



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 90 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.5.6	1.5.6.1	ESMS/EMCU - Market Dispatch Unit	Operator Error	Premature Operation Batteries overheat, potential for off-gas Failure to Operate	8	FC-37 Misc Human Factors: Human induced failures due to negligence	3	AC-09 Human Factors/SME: Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for managing situations	5	120	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Starlight Solar Project	Refer to Empire II, LLC Procedures Index	4	2	4	32
	1.5.6.2		Software Errors	Premature Operation Failure to Operate Batteries overheat, potential for off-gas	8	FC-62 Programming Error: A failure resulting from an error in the system software or firmware.	4	AC-09 Human Factors/SME: Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for managing situations	8	256	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Starlight Solar Project	Refer to Empire II, LLC Procedures Index	4	3	7	84
	1.5.6.3		Cyber Security Challenges	Failure to Operate Batteries overheat, potential for off-gas Loss of BMS Control	10	FC 38 Human Factors Failures due to malfeasance	4	AC-01: EOP - System operator plan to handle all emergency events (PLACE HOLDER TO Empire II, LLCMANUALS).	9	360	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Starlight Solar Project	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	3	5	75
	1.5.6.4		Redundant Failure Detection/System Intelligence: Ability of system to determine a sensor has failed, to operate safely without that sensor to shut down, or operate safely indefinitely without sensor.	Loss of ESMS Control Loss of BMS Control	9	FC-12 ESMS Failure: Failure of the controller at the rack or system level which results in adverse condition to the system	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	8	360	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Starlight Solar Project	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	3	5	75



Empire II, LLC

Project Manager: Mr.James Whalen

Page 91 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project Documents

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.5.6	1.5.6.5	ESMS/EMCU - Market Dispatch Unit	System Shutdown/Disconnect: Ability of system to actively shut itself down or disconnect itself. This is the aggregate of the BMS or inverter's shutdown ability as well as physical disconnects and the BoS controller's ability to shut down.	Failure to Operate Loss of BMS Control Premature Operation	7	FC-69 Execution-sequenc e-dependent: Failures that typically occur because an expected sequence of events does not occur in the order expected.	5	EC-01 Auto Shutdown: Ability of system to actively shut itself down or disconnect itself	7	245	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Starlight Solar Project	Refer to Empire II, LLC Procedures Index	4	4	6	96
	1.5.6.6		Passive Circuit Protection and Design: Current interrupt devices, fuses or other passive surge arresting elements which may open the circuit in the case of failure and general resilience of design to withstand adverse electrical conditions.	Failure to Operate Loss of ESMS Control Loss of BMS Control	9	FC-12 ESMS Failure: Failure of the controller at the rack or system level which results in adverse condition to the system	5	EC-17 Elec Pass Prot: Current interrupt devices, fuses or other passive surge arresting elements which may open the circuit in the case of failure and general resilience of design to withstand adverse electrical conditions.	8	360	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLC Design Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Starlight Solar Project	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	4	4	80
	1.5.6.7		Cell Electrical Abuse Tolerance due to loss of ESMS: Ability of the cell to withstand electrical abuse such as overcharge, over discharge, high currents, or other adverse electrical abuse.	Battery Management System (BMS) Failure Loss of BMS Control Loss of ESMS Control	9	Internal Component Failure - Electrical Abuse	5	EC-20 Act Cell Prot: Active cell protections which may mitigate thermal runaway such as module fans, liquid cooling systems, module scale Thermal Management Coolant systems, or other mitigation measures	7	315	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Starlight Solar Project	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	4	4	80



Empire II, LLC

Page 92 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM
Design Basis: Assumed Typical LFP BESS Project

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Documents

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1.5.6	1.5.6.8	ESMS/EMCU - Market Dispatch Unit	Interdependent System Induced Failure: Failure of interdependent subsystem fails and introduces a failure mechanism to ESMS	Failure to Operate Loss of Control HVAC	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	4	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance		140	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Starlight Solar Project	Refer to Empire II, LLC Procedures Index	4	3	4	48



Empire II, LLC

Page 93 of 135 Design Responsibility: Empire II, LLC and BESS OEM

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.5.7	1.5.7.1	ESMS/EMCU - BESS OEM Array Controller	Loss of Communication	Failure to Operate Battery Management System (BMS) Failure	7	FC-62 Programming Error: A failure resulting from an error in the system software or firmware.	4	AC-11 Human Factors/RAGAG EP: In addition to analysis required by product standards, good engineering practice should require design review such that design mistakes and weaknesses are identified and corrected in a timely and efficient manner	2	56	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Starlight Solar Project	Refer to Empire II, LLC Procedures Index	4	3	4	48
	1.5.7.2		Processor Lockup	Failure to Operate Loss of ESMS Control Loss of BMS Control	9	FC-62 Programming Error: A failure resulting from an error in the system software or firmware.	4	AC-09 Human Factors/SME: Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for managing situations	3	108	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LtCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Starlight Solar Project	Refer to Empire II, LLC Procedures Index	5	3	2	30
	1.5.7.3		Communications Timeout	Loss of ESMS Control Failure to Operate Battery Management System (BMS) Failure Major Effect - Product performance is severely degraded but has some operational capability and remains safe.	9	FC-69 Execution-sequenc e-dependent: Failures that typically occur because an expected sequence of events does not occur in the order expected.	4	EC-31 ESMS/BMS CTRL: Ability of the BMS and balancing system to adequately balance the circuit including sizing of the balancing resistors or transistors	4	144	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Starlight Solar Project	Refer to Empire II, LLC Procedures Index	5	3	3	45
	1.5.7.4		Loss of Control Power	Failure to Operate Loss of BMS Control	7	FC-12 ESMS Failure: Failure of the controller at the rack or system level which results in adverse condition to the system	5	EC-01 Auto Shutdown: Ability of system to actively shut itself down or disconnect itself	3	105	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Starlight Solar Project	Refer to Empire II, LLC Procedures Index	4	4	2	32



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 94 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.5.7	1.5.7.5	ESMS/EMCU - BESS OEM Array Controller	Incorrect Firmware Programming	Premature Operation Loss of ESMS Control Failure to Operate Loss of BMS Control	9	FC-62 Programming Error: A failure resulting from an error in the system software or firmware.	6	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	6	324	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Starlight Solar Project	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	4	4	80
	1.5.7.6		Unable to reset	Battery Management System (BMS) Failure Failure to Operate Loss of BMS Control Loss of ESMS Control	10	FC-77 Systematic Failure: Failures that they are related deterministically to a certain cause or causes	7	EC-32 BMS S/D: Ability of the BMS to isolate affected modules or strings without shutting down the entire system if unneeded	3	210	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Starlight Solar Project	Refer to Empire II, LLC Procedures Index	5	6	2	60
	1.5.7.7		Incorrect/False Output	Premature Operation Failure to Operate Loss of ESMS Control Battery Management System (BMS) Failure	10	FC-57 Spurious Output: System or component produces spurious signals due to subsystem failure or transient.	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	8	400	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Starlight Solar Project	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	4	4	80
	1.5.7.8		Subcomponent Failure/Damage	Failure to Operate Loss of ESMS Control Premature Operation	9	FC-46 Subcomponent/Sub system Failure: Lifecycle failure of components impacting availability/capabilit y to execute intended design function	6	EC-21 BMS CTRL: Includes monitoring and shutdown/isolati on capabilities of the affected BMS/module or system if necessary.	7	378	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Starlight Solar Project	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	4	4	80



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 95 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Oc	Dt	RPN
1.5.7	1.5.7.9	ESMS/EMCU - BESS OEM Array Controller	Software programming error	Failure to Operate Loss of BMS Control Loss of ESMS Control	9	FC-62 Programming Error: A failure resulting from an error in the system software or firmware.	4	AC-11 Human Factors/RAGAG EP: In addition to analysis required by product standards, good engineering practice should require design review such that design mistakes and weaknesses are identified and corrected in a timely and efficient manner	7	252	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Starlight Solar Project	Refer to Empire II, LLC Procedures Index	5	O	ο	90



Empire II, LLC

Page 96 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Basis: Assumed Typical LFP BESS Project

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Design Responsibility: Empire II, LLC and BESS OEM

Documents

Prepared by: Robert Steele, PhD. Project Manager: Mr.James Whalen FMEA Date (Orig.): 23 July 2025

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.5.8	1.5.8.1	ESMS/EMCU BESS Controller	Subsystem Component Failure: Broken, Short, Open	Failure to Operate Batteries overheat, potential for off-gas Significant Effect - Product performance is degraded but operable and safe, or a non-vital part is inoperable.	10	FC-46 Subcomponent/Sub system Failure: Lifecycle failure of components impacting availability/capabilit y to execute intended design function	4	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	4	160	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Empire II, LLC Engineering	Refer to Empire II, LLC Procedures Index	5	3	3	45
	1.5.8.2		Software Errors, Software Programming, PLC error	Failure to Operate Batteries overheat, potential for off-gas Moderate Effect - Moderate degradation of product performance;	10	FC-49 FACP Software Error: Human induced software error resulting in system degradation/unavail ability	4	AC-11 Human Factors/RAGAG EP: In addition to analysis required by product standards, good engineering practice should require design review such that design mistakes and weaknesses are identified and corrected in a timely and efficient manner	4	160	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Empire II, LLC	Refer to Empire II, LLC Procedures Index	5	3	3	45
	1.5.8.3		Operator Error, Training, Distraction	Batteries overheat, potential for off-gas Failure to Operate Moderate Effect - Moderate degradation of product performance;	10	AC-09 Human Factors/SME: Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for managing situations	4	AC-09 Human Factors/SME: Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for managing situations	5	200	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Empire II, LLC	Refer to Empire II, LLC Procedures Index	5	3	4	60



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 97 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Project Manager: Mr.James Whalen

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.6	1.6.1	BESS Yard Fiber Network	Fiber Network to respond to input data, Human/Electrical induced failure	Failure to Operate Partial/Total loss of capacity	6	FC-39 Human Factors - Design Errors and Omissions	5	AC-11 Human Factors/RAGAG: In addition to analysis required by product standards, good engineering practice should require design review such that design mistakes and weaknesses are identified and corrected in a timely and efficient manner	5	150	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Starlight Solar Project	Refer to Empire II, LLC Procedures Index	3	4	4	48
	1.6.2		Engineering Induced Failure/Miswiring	Failure to Operate Partial/Total loss of capacity	6	FM-27 Ext/Envr Risk, Human Factors: An adverse condition caused by the result of human interaction, error, or imperfection	6	AC-12: System Commissioning Performance Verification	4	144	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Starlight Solar Project	Refer to Empire II, LLC Procedures Index	3	5	3	45
	1.6.3		Broken/Defective Fiber	Failure to Operate Partial/Total loss of capacity	6	FM-52 Internal Component Failure - Mechanical	4	EC-25 Container Monitoring: Monitoring within the container which may detect adverse Container Thermal/Operati ng Environment Conditions	2	48	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Starlight Solar Project	Refer to Empire II, LLC Procedures Index	3	3	3	27
	1.6.4		Fieldbus/Modbus Failure	Failure to Operate Partial/Total loss of capacity	6	FC-15 Comms Failure: Failure of the system to properly report an adverse condition to local or remote monitoring. Failure of the system to report failures within itself and to act on those failures, resulting in adverse condition	6	AC-09 Human Factors/SME: Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for managing situations	7	252	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Starlight Solar Project	Refer to Empire II, LLC Procedures Index	3	5	6	90



Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 98 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Oc	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.6	1.6.5	BESS Yard Fiber Network	Intermittent Operation	Failure to Operate Partial/Total loss of capacity	6	FC-72 Intermittent failure: Failures that appear and disappear seemingly at random	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	6	180	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Starlight Solar Project	Refer to Empire II, LLC Procedures Index	3	4	5	60
	1.6.6		Cyber Security Attack	Failure to Operate Partial/Total loss of capacity	10	FC 38 Human Factors Failures due to malfeasance	4	AC-09 Human Factors/SME: Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for managing situations	8	320	RA-17: Knowledge of failure condition for active mitigation and response management. RA-25: Structured Empire II, LLCDesign Reviews performance requirement decomposition and verification RA-27: Proper training procedures, availability of SME	Starlight Solar Project	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	3	4	60



Empire II, LLC

Page 99 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
1.7	1.7.1	(Earthing) Bonding and Grounding Plan	Construction Induced Electrode Conductor Insulation Damage	Degraded Performance	8	FM-27 Ext/Envr Risk, Human Factors: An adverse condition caused by the result of human interaction, error, or imperfection	6	AC-12: System Commissioning Performance Verification	2	96	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	4	5	2	40
	1.7.2		Cabling System Connection/Splice Failure (IEEE Std. 493)	Degraded Performance	8	FM-27 Ext/Envr Risk, Human Factors: An adverse condition caused by the result of human interaction, error, or imperfection	6	AC-12: System Commissioning Performance Verification	2	96	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	4	5	2	40
	1.7.3		Design Error - Undersized Cabling Systems (IEEE Std. 493)	Degraded Performance Industrial Safety (Fire, Personnel) Issue	10	FM-39 Human Factors - Design Errors and Omissions	6	AC-12: System Commissioning Performance Verification	2	120	AC-11 Human Factors/RAGAGEP: In addition to analysis required by product standards, good engineering practice should require design review such that design mistakes and weaknesses are identified and corrected in a timely and efficient manner	Empire II, LLC Engineering	Credit given for Empire II, LLC Engineering/ BESS OEM Engineering, product UL NRTL Safety Certification, Product Manual, and verified during commissioni	5	5	2	50
	1.7.4		Insulation Failure - Rodent (IEEE Std. 493)	Degraded Performance	5	FM-93 Foreign object introduction results in system failure, de-energization, short circuit, arc flash events	6	AC-12: System Commissioning Performance Verification	2	60	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	3	5	2	30



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 100 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Oc	Dt	RPI
1.8	1.8.1	TVSS (24.4kV MCOV)	Failure to Operate	Failure to Operate Potential System Overvoltage Transients	5	FM-82 Internal Component Failure - Equipment Lifecycle Failure	4	EC-01 Auto Shutdown: Ability of system to actively shut itself down or disconnect itself	3	60	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence	Empire II, LLC Engineering and O&M Contractor	RA-01: Performance of Scheduled System Maintenance	3	3	2	18
	1.8.2		Erratic Operation	Electrical fault resulting in unavailability Potential System Overvoltage Transients	8	FM-31 Elec Risks, Hazardous Voltage Condition: This could include high line voltages, high voltages from the PCS, floating ground issues, or other high voltage issues at the cell, module or rack level	4	EC-01 Auto Shutdown: Ability of system to actively shut itself down or disconnect itself	3	96	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence	Empire II, LLC Engineering and O&M Contractor	RA-01: Performance of Scheduled System Maintenance	4	3	2	24
	1.8.3		Overtemperature	Failure to Operate Electrical fault resulting in unavailability Partial/Total loss of capacity	8	FM-82 Internal Component Failure - Equipment Lifecycle Failure	4	EC-01 Auto Shutdown: Ability of system to actively shut itself down or disconnect itself	3	96	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence	Empire II, LLC Engineering and O&M Contractor	RA-01: Performance of Scheduled System Maintenance	4	3	2	24



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 101 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
2	2.1	Starlight Solar Project Energy Storage Management System (ESMS)/SCADA Primary System Control	Premature Operation	Significant Effect - Product performance is degraded but operable and safe, or a non-vital part is inoperable.	6	FC-72 Intermittent failure: Failures that appear and disappear seemingly at random	7	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	6	252	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	3	6	5	90
	2.2		Failure to Operate	Major Effect - Product performance is severely degraded but has some operational capability and remains safe.	7	FC-74 Sudden Failure: Failures that they occur comparatively rapidly (as opposed to gradual degradation or age-related failure).	8	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	4	224	"AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation"	Construction and Commissioning Forces	AC-12: System Comissionin g Performance Verification	6	5	3	90
	2.3		Batteries overheat, potential for off-gas	Catastrophic - Very hazardous effect. Effect occurs suddenly without warning to user and may pose an industrial safety concern.	9	FC-02 Cell Failure: Hazardous Temperature Condition - Cell. High temperature at the cell level during normal operations Wo thermal runaway	6	AC-01: EOP - System operator plan to handle all emergency events	6	324	"AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation"	Construction and Commissioning Forces	AC-12: System Comissionin g Performance Verification	6	4	3	72
	2.4		Battery Management System (BMS) Failure	Major Effect - Product performance is severely degraded but has some operational capability and remains safe. Interdependent System Induced Failure	7	FC-31 Elec Risks, Hazardous Voltage Condition: This could include high line voltages, high voltages from the PCS, floating ground issues, or other high voltage issues at the cell, module or rack level	7	EC-01 Auto Shutdown: Ability of system to actively shut itself down or disconnect itself	4	196	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	4	6	3	72



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 102 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Documents

Parei	t ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
2	2.5	Starlight Solar Project Energy Storage Management System (ESMS)/SCADA Primary System Control	Loss of ESMS Control	Hazardous Effects with Indication	9	FC-12 ESMS Failure: Failure of the controller at the rack or system level which results in adverse condition to the system	8	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	4	288	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	5	4	100
	2.6		Loss of BMS Control	Major Effect - Product performance is severely degraded but has some operational capability and remains safe.	7	FC-44 Module Failure: Loss of BMS Control	8	EC-31 ESMS/BMS Cntrl: Ability of the BMS and balancing system to adequately balance the circuit including sizing of the balancing resistors or transistors	4	224	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	4	7	3	84
	2.7		Loss of Control HVAC	Interdependent System Induced Failure	9	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-25 Container Monitoring: Monitoring within the container which may detect adverse Container Thermal/Operati ng Environment Conditions	5	225	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	5	4	4	80
	2.8		Loss of Control FACP	Interdependent System Induced Failure	10	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	4	FC-46 Subcomponent/ Subsystem Failure: Lifecycle failure of components impacting availability/capab ility to execute intended design function	5	200	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	5	3	4	60



Empire II, LLC

Page 103 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
2.1	2.1.1	Communications	Intermittent Operation	Moderate Effect - Moderate degradation of product performance;	6	FC-72 Intermittent failure: Failures that appear and disappear seemingly at random	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	5	150	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	3	4	4	48
	2.1.2		Degraded Operation	Minor Effect - Minor degradation of product performance that generally does not require repair.	6	FC-20 Lifecycle Failure: A cell or cells have reached end of life, resulting in an adverse electrical condition which could exacerbate imbalance or other adverse electrical conditions	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	5	150	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	3	4	4	48
	2.1.3		Failure to Operate	Hazardous Effects with Indication Interdependent System Induced Failure	9	FC-01: Electrical Failure	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	5	225	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	5	4	4	80
	2.1.4		Cascading HVAC Failure Impacting ESMS	Moderate Effect - Moderate degradation of product performance;	6	FC-05 HVAC Failure: Mechanical or electrical failure of the HVAC system that will result in high temperatures throughout system	3	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	4	72	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	3	2	3	18



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 104 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
2.1	2.1.5	Communications	Cyber Security Attack	Major Effect - Product performance is severely degraded but has some operational capability and remains safe.	10	FC 38 Human Factors Failures due to malfeasance	5	AC-09 Human Factors/SME: Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for managing situations	9	450	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	4	4	80
	2.1.6		Failure to Provide System Status	Moderate Effect - Moderate degradation of product performance;	7	FC-45 Loss of BMS due to Software Induced Problem/Failure	6	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	4	168	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	4	5	3	60



Empire II, LLC

Page 105 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Design Responsibility: Empire II, LLC and BESS OEM

Documents

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
2.1.1	2.1.1.1	Starlight Solar EMS Controller	Software Induced Failure, Programing	Major Effect - Product performance is severely degraded but has some operational capability and remains safe.	7	FC-49 FACP Software Error: Human induced software error resulting in system degradation/unavail ability	5	AC-08 Human Factors Maint: Proper preventive maintenance to minimize the impact of adverse, long term or slow acting environmental effects resulting in degradation	3	105	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	4	4	2	32
	2.1.1.2		Comms/HVAC Interface Failure	Intermittent Operation Failure to Operate Degraded Operation Cascading HVAC Failure Impacting ESMS	9	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-04 Temp Monitoring/Alarm s: Thermal monitoring within the container including BMS, fire alarm thermal monitoring and any BoS temperature monitoring	4	180	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	5	4	3	60
	2.1.1.3		Failure to Operate	Failure to Operate	9	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-04 Temp Monitoring/Alarm s: Thermal monitoring within the container including BMS, fire alarm thermal monitoring and any BoS temperature monitoring	5	225	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	5	4	3	60
	2.1.1.4		Human Factors - Error	Failure to Provide System Status	5	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-35 BMS S/D: Ability of the BMS to isolate affected racks or strings without shutting down the entire system if unneeded	4	100	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	3	4	3	36



Empire II, LLC

Page 106 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
2.1.1	2.1.1.5	Starlight Solar EMS Controller	Interdependent System Induced Failure - Degraded Operation	Degraded Operation Failure to Operate	9	FM-77 Systematic Failure: Failures that they are related deterministically to a certain cause or causes	6	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence	5	270	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	Empire II, LLC EOPs	AC-01: EOP - System operator plan to handle all emergency events.	5	4	3	60
	2.1.1.6		Interdependent System Induced Failure - Failure to Operate	Degraded Operation Failure to Operate	9	FM-77 Systematic Failure: Failures that they are related deterministically to a certain cause or causes	6	EC-26 ESS Volt Mon: Overall effectiveness of the voltage monitoring scheme of the system. Includes resilience to errors, error checking, and other measurement intelligence	5	270	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	Empire II, LLC EOPs	RA-01: Performance of Scheduled System Maintenance	5	4	3	60



Empire II, LLC

Page 107 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
2.1.1.1	2.1.1.1	BESS OEM EMCU/ESMS Interface	Subcomponent Failure, End of Design Life	Intermittent Operation Moderate Effect - Moderate degradation of product performance;	7	FC-46 Subcomponent/Sub system Failure: Lifecycle failure of components impacting availability/capabilit y to execute intended design function	4	EC-01 Auto Shutdown: Ability of system to actively shut itself down or disconnect itself	3	84	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	4	3	2	24
	2.1.1.1.2		Electrical Failure: Internal Fault, Lifecycle Failure	Degraded Operation Intermittent Operation	5	FC-59 Inadvertent AC PNL B Breaker Trip: Molded Case Circuit Breaker trip due to bimetallic memory, voltage sEmpire II, LLC, instantaneous overcurrent	4	EC-17 Elec Pass Prot: Current interrupt devices, fuses or other passive surge arresting elements which may open the circuit in the case of failure and general resilience of design to withstand adverse electrical conditions.	3	60	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	3	3	2	18
	2.1.1.1.3		Improper Output, Programming, Overtemp/voltage, EMI	Intermittent Operation Failure to Operate Moderate Effect - Moderate degradation of product performance;	9	FC-39 Human Factors - Design Errors and Omissions	4	AC-11 Human Factors/RAGAG EP: In addition to analysis required by product standards, good engineering practice should require design review such that design mistakes and weaknesses are identified and corrected in a timely and efficient manner	7	252	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	5	3	6	90



Empire II, LLC Starlight Solar Project BOP Level FMEA Empire II, LLC

Page 108 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
2.1.1.1	2.1.1.1.4	BESS OEM EMCU/ESMS Interface	Input Failure Response	Intermittent Operation Failure to Operate Degraded Operation	9	FC-15 Comms Failure: Failure of the system to properly report an adverse condition to local or remote monitoring. Failure of the system to report failures within itself and to act on those failures, resulting in adverse condition	3	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	4	108	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	5	2	3	30



Empire II, LLC

Page 109 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

											Documents						
Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
2.1.1.2	2.1.1.2.1	BESS-Inverter (PCS) Interface	Loss of Power, Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Failure to Operate Serious Effects - Product is inoperable but safe, or a system is inoperable but safe.	9	FC-59 Inadvertent AC PNL B Breaker Trip: Molded Case Circuit Breaker trip due to bimetallic memory, voltage sEmpire II, LLC, instantaneous overcurrent	5	EC-17 Elec Pass Prot: Current interrupt devices, fuses or other passive surge arresting elements which may open the circuit in the case of failure and general resilience of design to withstand adverse electrical conditions.	4	180	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	5	4	3	60
	2.1.1.2.2		Loss of AC Power (120VAC)	Failure to Operate Failure to Provide System Status Degraded Operation	9	FM-59 Inadvertent Protective Device Operation: Protective Device actuation due to voltage transient/sEmpire II, LLC, instantaneous overcurrent	5	EC-17 Elec Pass Prot: Current interrupt devices, fuses or other passive surge arresting elements which may open the circuit in the case of failure and general resilience of design to withstand adverse electrical conditions.	4	180	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	5	4	3	60



Empire II, LLC

Page 110 of 135

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Design Responsibility: Empire II, LLC and BESS OEM

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
2.1.1.3	2.1.1.3.1	BCPC/PLC	Subsystem Component Failure: Broken, Short, Open	Failure to Operate Degraded Operation	4	FC-46 Subcomponent/Sub system Failure: Lifecycle failure of components impacting availability/capabilit y to execute intended design function	4	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	4	64	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	2	3	3	18
	2.1.1.3.2		Software Errors, Software Programming, PLC error	Software Induced Failure, Programing	7	FC-49 FACP Software Error: Human induced software error resulting in system degradation/unavail ability	3	AC-11 Human Factors/RAGAG EP: In addition to analysis required by product standards, good engineering practice should require design review such that design mistakes and weaknesses are identified and corrected in a timely and efficient manner	4	84	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	4	2	3	24
	2.1.1.3.3		Operator Error, Training, Distraction	Human Factors - Error	7	AC-09 Human Factors/SME: Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for managing situations	3	AC-09 Human Factors/SME: Proper training procedures, availability of subject matter expertise and system competence, and clear jurisdictional hierarchy for managing situations	5	105	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	4	2	4	32
	2.1.1.3.4		Interdependent System Induced Failure - Degraded Performance	Interdependent System Induced Failure - Degraded Operation Interdependent System Induced Failure - Failure to Operate	6	FM-76 Random Failure: Failures that they do not appear to have any pattern or regularity.	6	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	5	180	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC EOPs	RA-17: Knowledge of failure condition for active mitigation and response management	5	4	3	60



Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Empire II, LLC

Page 111 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

											Documents						
Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
2.1.1.3	2.1.1.3.5	BCPC/PLC	Interdependent System Induced Failure - Failure to Operate	Interdependent System Induced Failure - Degraded Operation Interdependent System Induced Failure - Failure to Operate	6	FM-76 Random Failure: Failures that they do not appear to have any pattern or regularity.	5	RA-17: Knowledge of failure condition for active mitigation and response management.	4	120	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC EOPs	RA-17: Knowledge of failure condition for active mitigation and response management	5	4	3	60



Empire II, LLC

Page 112 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

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2.1.1.3.1	2.1.1.3.1.1	BCPC/PLC Enclosure HMI FACP Interface Control	RS485 TO DC METER (X4): Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Subsystem Component Failure: Broken, Short, Open	9	FC-46 Subcomponent/Sub system Failure: Lifecycle failure of components impacting availability/capabilit y to execute intended design function	6	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	7	378	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	4	4	80
	2.1.1.3.1.2		Fast-Stop Emergency Button Failure, Fail to respond to input	Interdependent System Induced Failure - Failure to Operate	7	FC-3 Comms Failure: Failure of the system to properly report an adverse condition to local or remote monitoring. Failure of the system to report failures within itself and to act on those failures, resulting in adverse condition	6	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	8	336	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	4	4	80
	2.1.1.3.1.3		Temperature Probes: Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Induced Failure - Degraded Performance	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	7	245	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	4	4	80
	2.1.1.3.1.4		Humidity/Temp Sensor Failure: Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Induced Failure - Degraded Performance	7	FC-10 Sensor Failure: A sensor inside the system fails, resulting in incorrect reporting of system properties	3	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	6	126	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	2	2	5	20



Empire II, LLC

Page 113 of 135

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

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2.1.1.3.1	2.1.1.3.1.5	BCPC/PLC Enclosure HMI FACP Interface Control	Door Contact Switch Induced Failure: Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Induced Failure - Failure to Operate	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	5	175	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	4	4	4	64
	2.1.1.3.1.6		HVAC System Induced Failure, Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Induced Failure - Degraded Performance	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	5	175	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	5	4	4	80
	2.1.1.3.1.7		FACP System Induced Failure, Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Induced Failure - Degraded Performance Interdependent System Induced Failure - Failure to Operate	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	4	140	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	5	4	3	60
	2.1.1.3.1.8		Fail to Operate	Interdependent System Induced Failure - Degraded Performance	7	FM-77 Systematic Failure: Failures that they are related deterministically to a certain cause or causes	5	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	4	140	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC EOPs	RA-17: Knowledge of failure condition for active mitigation and response management	5	4	3	60



Page 114 of 135

Empire II, LLC

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
2.1.1.3.1	2.1.1.3.1.9	BCPC/PLC Enclosure HMI FACP Interface Control	Degraded Performance	Interdependent System Induced Failure - Degraded Performance	7	FM-77 Systematic Failure: Failures that they are related deterministically to a certain cause or causes	5	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	5	175	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC EOPs	RA-17: Knowledge of failure condition for active mitigation and response management	5	4	4	80
	2.1.1.3.1.10		Interdependent System Induced Failure - Failure to Operate	Interdependent System Induced Failure - Failure to Operate Interdependent System Induced Failure - Degraded Performance	7	FM-77 Systematic Failure: Failures that they are related deterministically to a certain cause or causes	7	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	6	294	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC EOPs	RA-17: Knowledge of failure condition for active mitigation and response management	5	4	3	60
	2.1.1.3.1.11		Interdependent System Induced Failure - Degraded Performance	Interdependent System Induced Failure - Degraded Performance Interdependent System Induced Failure - Failure to Operate	7	FM-77 Systematic Failure: Failures that they are related deterministically to a certain cause or causes	6	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	5	210	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC EOPs	RA-17: Knowledge of failure condition for active mitigation and response management	5	4	3	60
	2.1.1.3.1.12		Interdependent System Induced Failure - Failure to Operate	Interdependent System Induced Failure - Failure to Operate Interdependent System Induced Failure - Degraded Performance	7	FM-77 Systematic Failure: Failures that they are related deterministically to a certain cause or causes	6	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	5	210	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC EOPs	RA-17: Knowledge of failure condition for active mitigation and response management	5	4	3	60



Empire II, LLC

Page 115 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

						Potential					Documents						
Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
2.1.1.3.1.1	2.1.1.3.1.1.1	BCPC/EMCU/BMS Temp Sensors FACP Interface Control	RS485 TO DC METER (X4): Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Induced Failure - Degraded Performance	1	FC-46 Subcomponent/Sub system Failure: Lifecycle failure of components impacting availability/capabilit y to execute intended design function	6	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	7	42	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	4	4	80
	2.1.1.3.1.1.2		Fast-Stop Emergency Button Failure, Fail to respond to input	Interdependent System Induced Failure - Failure to Operate	9	FC-3 Comms Failure: Failure of the system to properly report an adverse condition to local or remote monitoring. Failure of the system to report failures within itself and to act on those failures, resulting in adverse condition	6	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	8	432	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	4	4	80
	2.1.1.3.1.1.3		Temperature Probes: Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Induced Failure - Degraded Performance	1	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	7	35	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	4	4	80
	2.1.1.3.1.1.4		Humidity/Temp Sensor Failure: Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Induced Failure - Degraded Performance	1	FC-10 Sensor Failure: A sensor inside the system fails, resulting in incorrect reporting of system properties	3	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	6	18	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	2	2	5	20



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 116 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

	(3-)										Documents						
Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Oc	Dt	RPN
2.1.1.3.1.1	2.1.1.3.1.1.5	BCPC/EMCU/BMS Temp Sensors FACP Interface Control	Door Contact Switch Induced Failure: Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Induced Failure - Degraded Performance	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	5	175	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	4	4	4	64
	2.1.1.3.1.1.6		HVAC System Induced Failure, Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Induced Failure - Failure to Operate Interdependent System Induced Failure - Degraded Performance	1	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	5	25	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	5	4	4	80
	2.1.1.3.1.1.7		FACP System Induced Failure, Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Induced Failure - Degraded Performance Interdependent System Induced Failure - Failure to Operate	8	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	4	160	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	5	4	3	60



Empire II, LLC

Page 117 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

						Potential					Documents						
Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
2.1.1.3.1.2	2.1.1.3.1.2.1	BMS/EMCU E-Stop FACP Interface Control	RS485 TO DC METER (X4): Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Fast-Stop Emergency Button Failure, Fail to respond to input	8	FC-46 Subcomponent/Sub system Failure: Lifecycle failure of components impacting availability/capabilit y to execute intended design function	6	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	7	336	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	4	4	80
	2.1.1.3.1.2.2		Fast-Stop Emergency Button Failure, Fail to respond to input	Fail to Operate	8	FC-3 Comms Failure: Failure of the system to properly report an adverse condition to local or remote monitoring. Failure of the system to report failures within itself and to act on those failures, resulting in adverse condition	6	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	8	384	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	4	4	80
	2.1.1.3.1.2.3		Temperature Probes: Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Degraded Performance	8	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	7	280	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	4	4	80
	2.1.1.3.1.2.4		Humidity/Temp Sensor Failure: Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Degraded Performance	7	FC-10 Sensor Failure: A sensor inside the system fails, resulting in incorrect reporting of system properties	3	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	6	126	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	2	2	5	20



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II. LLC

Page 118 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Documents

Project Manager: Mr. James Whalen

Potential Current Potential failure Recommended cause(s) / Responsibility | Actions ID Effects descriptions Sv Oc Dt **RPN** Sv Oc Dt **RPN Parent** Item function Design Action(s) and Date Taken mode failure Controls mechanisms 2.1.1.3.1.2 2.1.1.3.1.2.5 BMS/EMCU Door Contact Switch Degraded Performance FC-56 EC-36 ESMS 200 AC-06: Human Factors: Construction and AC-12: E-Stop FACP Induced Failure: Fail to Operate Interdependent Monitorina: Quality control or other Commissioning System **ESMS** Interface Control Failure of System Induced processes put in place to Forces Commissioni interdependent/interco Failure: Failure of prevent mishandling of programming systems that may result Performance nnected sys cascades interdependent/inter evaluates and induces connected sys system operation in adverse or hazardous Verification sys/component failure cascades and and initiates conditions or mishandling AC-04 Human Factors: induces system shutdown upon Knowledge of failure sys/component detection of condition for active failure abnormal system mitigation performance FC-56 200 2.1.1.3.1.2.6 **HVAC System** Degraded Performance EC-36 ESMS AC-06: Human Factors: Construction and AC-12: System Induced Failure, Fail to Operate Interdependent Monitoring: Quality control or other Commissioning Failure of System Induced **ESMS** processes put in place to Forces Commissioni interdependent/interco Failure: Failure of programming prevent mishandling of nnected sys cascades interdependent/inter systems that may result Performance evaluates and induces connected sys system operation in adverse or hazardous Verification sys/component failure cascades and and initiates conditions or mishandling AC-04 Human Factors: induces system sys/component shutdown upon Knowledge of failure condition for active failure detection of abnormal system mitigation performance AC-12: 2.1.1.3.1.2.7 FC-56 EC-36 ESMS 160 FACP System Induced Fail to Operate AC-06: Human Factors: Construction and Failure, Failure of Degraded Performance Interdependent Monitorina: Quality control or other Commissioning System interdependent/interco System Induced **FSMS** processes put in place to Forces Commissioni nnected svs cascades Failure: Failure of programming prevent mishandling of and induces interdependent/inter evaluates systems that may result Performance sys/component failure connected sys system operation in adverse or hazardous Verification cascades and and initiates conditions or mishandling AC-04 Human Factors: induces system shutdown upon Knowledge of failure sys/component failure detection of condition for active abnormal system mitigation performance



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 119 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Oc	Dt	RPN
2.1.1.3.1.3	2.1.1.3.1.3.1	BMS/EMCU Door Alarms FACP Interface Control	RS485 TO DC METER (X4): Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Induced Failure - Failure to Operate	6	FC-46 Subcomponent/Sub system Failure: Lifecycle failure of components impacting availability/capabilit y to execute intended design function	6	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	7	252	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	4	4	80
	2.1.1.3.1.3.2		Fast-Stop Emergency Button Failure, Fail to respond to input	Interdependent System Induced Failure - Failure to Operate	7	FC-3 Comms Failure: Failure of the system to properly report an adverse condition to local or remote monitoring. Failure of the system to report failures within itself and to act on those failures, resulting in adverse condition	6	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	8	336	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	4	4	80
	2.1.1.3.1.3.3		Temperature Probes: Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Induced Failure - Failure to Operate	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	7	245	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	4	4	80
	2.1.1.3.1.3.4		Humidity/Temp Sensor Failure: Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Induced Failure - Failure to Operate	7	FC-10 Sensor Failure: A sensor inside the system fails, resulting in incorrect reporting of system properties	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	6	210	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	2	4	5	40



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 120 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

											Documents						
Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
2.1.1.3.1.3	2.1.1.3.1.3.5	BMS/EMCU Door Alarms FACP Interface Control	Door Contact Switch Induced Failure: Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Induced Failure - Failure to Operate	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	5	175	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	4	4	4	64
	2.1.1.3.1.3.6		HVAC System Induced Failure, Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Induced Failure - Failure to Operate	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	5	175	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	5	4	4	80
	2.1.1.3.1.3.7		FACP System Induced Failure, Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Induced Failure - Failure to Operate	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	4	140	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	5	4	3	60



Empire II, LLC

Page 121 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

	(- 3 /										Documents						
Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RP
2.1.1.3.1.4	2.1.1.3.1.4.1	BMS/EMCU Flammable Gas Detection FACP Interface Control	RS485 TO DC METER (X4): Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Induced Failure - Degraded Performance	6	FC-46 Subcomponent/Sub system Failure: Lifecycle failure of components impacting availability/capabilit y to execute intended design function	6	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	7	252	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	4	4	80
	2.1.1.3.1.4.2		Fast-Stop Emergency Button Failure, Fail to respond to input	Interdependent System Induced Failure - Failure to Operate	7	FC-3 Comms Failure: Failure of the system to properly report an adverse condition to local or remote monitoring. Failure of the system to report failures within itself and to act on those failures, resulting in adverse condition	6	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	8	336	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	4	4	80
	2.1.1.3.1.4.3		Temperature Probes: Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Induced Failure - Degraded Performance	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	7	245	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	4	4	80
	2.1.1.3.1.4.4		Humidity/Temp Sensor Failure: Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Induced Failure - Degraded Performance	7	FC-10 Sensor Failure: A sensor inside the system fails, resulting in incorrect reporting of system properties	2	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	6	84	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	2	4	5	40



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 122 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Project Manager: Mr.James Whalen

										Documents						
ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
2.1.1.3.1.4.5	BMS/EMCU Flammable Gas Detection FACP Interface Control	Door Contact Switch Induced Failure: Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Induced Failure - Degraded Performance	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	5	175	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	4	4	4	64
2.1.1.3.1.4.6		HVAC System Induced Failure, Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Induced Failure - Degraded Performance	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	5	175	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	5	4	4	80
2.1.1.3.1.4.7		FACP System Induced Failure, Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Induced Failure - Failure to Operate	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	4	140	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	5	4	3	60
	2.1.1.3.1.4.5 2.1.1.3.1.4.6	2.1.1.3.1.4.5 BMS/EMCU Flammable Gas Detection FACP Interface Control	Double Section Potential failure mode	Digital Digi	Discription Door Contact Switch Induced Failure - Degraded Performance Topic - Degraded	Item function Potential failure mode Effects descriptions Sv Cause(s) / failure mechanisms	Item function Potential failure mode Effects descriptions Sv Potential cause(s) / failure mechanisms	Item function Potential failure mode Effects descriptions Sv Potential cause(s) / failure mechanisms Corporations	Item function Potential failure mode Effects descriptions Sv Potential cause(s) / failure Controls Dt	In Item function Potential failure mode Effects descriptions Sv Cause(s) / Gailure Cause(s) / Gailur	Item function Potential failure mode Effects descriptions Sv Potential cause(s) / failure mechanisms Cordinate Switch Control	Item function Potential failure Effects descriptions Sv Potential cause(s) / failure mochanisms Control	Item function Potential failure mode Effects descriptions Sv Potential cause(s) / cause(s) / large mode Current Design Control Curre	Item function Potential failure mode Pot	Item function Potential failure mode Effects descriptions Sv failure Cause(s) / failure Controls Contro	Item function Potential failure Effects descriptions Sv Potential cause(s) / failure Cause(s) / failur



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

12302 Exposition Blvd | Los Angeles, CA 90068

Project Manager: Mr.James Whalen

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Page 123 of 135

Design Responsibility: Empire II, LLC and BESS OEM

Design Basis: Assumed Typical LFP BESS Project Documents

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
2.1.1.3.2	2.1.1.3.2.1	Thermal Management Controller FACP Interface Control	RS485 TO DC METER (X4): Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Induced Failure - Degraded Performance Interdependent System Induced Failure - Failure to Operate	7	FC-46 Subcomponent/Sub system Failure: Lifecycle failure of components impacting availability/capabilit y to execute intended design function	6	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	7	294	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	4	4	80
	2.1.1.3.2.2		Fast-Stop Emergency Button Failure, Fail to respond to input	Interdependent System Induced Failure - Failure to Operate	7	FC-3 Comms Failure: Failure of the system to properly report an adverse condition to local or remote monitoring. Failure of the system to report failures within itself and to act on those failures, resulting in adverse condition	6	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	8	336	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	4	4	80
	2.1.1.3.2.3		Temperature Probes: Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Induced Failure - Degraded Performance	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	7	245	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	4	4	80
	2.1.1.3.2.4		Humidity/Temp Sensor Failure: Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Induced Failure - Degraded Performance	7	FC-10 Sensor Failure: A sensor inside the system fails, resulting in incorrect reporting of system properties	4	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	6	168	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	2	3	5	30



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 124 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Project Manager: Mr.James Whalen

Documents

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
2.1.1.3.2	2.1.1.3.2.5	Thermal Management Controller FACP Interface Control	Door Contact Switch Induced Failure: Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Induced Failure - Degraded Performance	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	5	175	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	4	4	4	64
	2.1.1.3.2.6		HVAC System Induced Failure, Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Induced Failure - Failure to Operate	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	5	175	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	5	4	4	80
	2.1.1.3.2.7		FACP System Induced Failure, Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Induced Failure - Degraded Performance Interdependent System Induced Failure - Failure to Operate	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	4	140	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	5	4	3	60
	2.1.1.3.2.8		Failure to Operate	Interdependent System Induced Failure - Degraded Performance Interdependent System Induced Failure - Failure to Operate	7	FM-77 Systematic Failure: Failures that they are related deterministically to a certain cause or causes	7	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	6	294	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC EOPs	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	6	5	3	90
	2.1.1.3.2.9		Degraded Performance	Interdependent System Induced Failure - Failure to Operate Interdependent System Induced Failure - Degraded Performance	6	FM-77 Systematic Failure: Failures that they are related deterministically to a certain cause or causes	7	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	6	252	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC/EOPs	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	6	5	3	90
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Empire II, LLC

Project Manager: Mr.James Whalen

Page 125 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Design Basis: Assumed Typical LFP BESS Project Documents

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
2.1.1.3.2	2.1.1.3.2.10	Thermal Management Controller FACP Interface Control	Interdependent System Induced Failure - Degraded Operation	Interdependent System Induced Failure - Degraded Performance	7	FM-77 Systematic Failure: Failures that they are related deterministically to a certain cause or causes	6	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	5	210	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC/EOPs	RA-17: Knowledge of failure condition for active mitigation and response management	5	4	3	60
	2.1.1.3.2.11		Interdependent System Induced Failure - Failed to Operate	Interdependent System Induced Failure - Degraded Performance	7	FM-77 Systematic Failure: Failures that they are related deterministically to a certain cause or causes	6	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	5	210	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC EOPs	RA-17: Knowledge of failure condition for active mitigation and response management	5	4	3	60
	2.1.1.3.2.12		Interdependent System Induced Failure - Failure to Operate	Interdependent System Induced Failure - Degraded Performance	7	FM-77 Systematic Failure: Failures that they are related deterministically to a certain cause or causes	6	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	5	210	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC/EOPs	RA-17: Knowledge of failure condition for active mitigation and response management	5	4	3	60
	2.1.1.3.2.13		Interdependent System Induced Failure - Failure to Operate	Interdependent System Induced Failure - Degraded Performance	7	FM-77 Systematic Failure: Failures that they are related deterministically to a certain cause or causes	6	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	5	210	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC EOPs	RA-17: Knowledge of failure condition for active mitigation and response management	5	4	3	60



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 126 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM
Design Basis: Assumed Typical LFP BESS Project

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Documents

Project Manager: Mr.James Whalen

Parer	t ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
2.1.1.3.	2.1 2.1.1.3.2.1.1	FACP Interface Communication Peripheral	Improper Output	Intermittent Operation Degraded Operation	5	FC-57 Spurious Output: System or component produces spurious signals due to subsystem failure or transient.	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	9	225	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	3	4	5	60
	2.1.1.3.2.1.2		Failure to Operate	Failure to Operate	5	FC-57 Spurious Output: System or component produces spurious signals due to subsystem failure or transient.	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	4	100	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	3	4	3	36
	2.1.1.3.2.1.3		Degraded Performance	Degraded Performance	5	FC-57 Spurious Output: System or component produces spurious signals due to subsystem failure or transient.	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	4	100	AC-06: Human Factors: Quality control or other processes put in place to prevent mishandling of systems that may result in adverse or hazardous conditions or mishandling AC-04 Human Factors: Knowledge of failure condition for active mitigation	Construction and Commissioning Forces	AC-12: System Commissioni ng Performance Verification	3	4	3	36
	2.1.1.3.2.1.4		Interdependent System Failure - Degraded Performance	Interdependent System Induced Failure - Degraded Operation Interdependent System Induced Failure - Failure to Operate	7	FM-77 Systematic Failure: Failures that they are related deterministically to a certain cause or causes	7	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	6	294	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC EOPs	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	6	5	3	90
	2.1.1.3.2.1.5		Interdependent System Failure - Failure to Operate	Interdependent System Induced Failure - Degraded Operation Interdependent System Induced Failure - Failure to Operate	7	FM-77 Systematic Failure: Failures that they are related deterministically to a certain cause or causes	7	AC-04 Human Factors: Knowledge of failure condition for active mitigation and response management.	6	294	AC-01: EOP - System operator plan to handle all emergency events.	Empire II, LLC EOPs	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	6	5	3	90



Empire II, LLC

Page 127 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

						Potential					Documents						
Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
2.1.1.3.2.1.	2.1.1.3.2.1.1.	Smoke Detection FACP Interface Control	RS485 TO DC METER (X4): Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Failure to Operate Degraded Performance	5	FC-46 Subcomponent/Sub system Failure: Lifecycle failure of components impacting availability/capabilit y to execute intended design function	6	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	7	210	RA-23: BESS OEM ESMS Software controls interdependent system to safely detect system degradation and initiate S/D protocols	Empire II, LLC EngineeringCommis sioning and Engineering	RA-23: BESS OEM ESMS Software controls interdepende nt system to safely detect system degradation and initiate S/D protocols	3	5	6	90
	2.1.1.3.2.1.1.		Fast-Stop Emergency Button Failure, Fail to respond to input	Degraded Performance Failure to Operate	6	FC-15 Comms Failure: Failure of the system to properly report an adverse condition to local or remote monitoring. Failure of the system to report failures within itself and to act on those failures, resulting in adverse condition	6	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	8	288	RA-01: Performance of Scheduled System Maintenance	Empire II, LLC Engineering	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	5	3	75
	2.1.1.3.2.1.1.		Temperature Probes: Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Degraded Performance Improper Output	5	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	7	175	RA-01: Performance of Scheduled System Maintenance RA-21: BESS OEM ESMS Software controls monitors interdependent system to safely detect system degradation and initiate S/D protocols	Empire II, LLC Engineering	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	4	3	60
	2.1.1.3.2.1.1.		Humidity/Temp Sensor Failure: Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Improper Output Degraded Performance	5	FC-10 Sensor Failure: A sensor inside the system fails, resulting in incorrect reporting of system properties	4	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	6	120	RA-07: Environmental Temperature Monitoring and Alarms RA-21: BESS OEM ESMS Software controls monitors interdependent system to safely detect system degradation and initiate S/D protocols	Empire II, LLC Engineering	RA-07: Environment al Temperature Monitoring and Alarms	2	3	5	30



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 128 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Project Manager: Mr.James Whalen

Documents

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
													RA-21: BESS OEM ESMS Software controls monitors interdepende nt system to safely detect system degradation and initiate S/D protocols				
2.1.1.3.2.1.	2.1.1.3.2.1.1.	Smoke Detection FACP Interface Control	Door Contact Switch Induced Failure: Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Degraded Performance Failure to Operate	1	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	5	25	RA-21: BESS OEM ESMS Software controls monitors interdependent system to safely detect system degradation and initiate S/D protocols	Empire II, LLC Engineering	RA-21: BESS OEM ESMS Software controls monitors interdepende nt system to safely detect system degradation and initiate S/D protocols	4	4	4	64
	2.1.1.3.2.1.1.		HVAC System Induced Failure, Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Degraded Performance Improper Output	5	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	5	125	RA-21: BESS OEM ESMS Software controls monitors interdependent system to safely detect system degradation and initiate S/D protocols	Empire II, LLC Engineering	RA-21: BESS OEM ESMS Software controls monitors interdepende nt system to safely detect system degradation and initiate S/D protocols	5	4	4	80
	2.1.1.3.2.1.1.		FACP System Induced Failure, Failure of interdependent/interconnected sys cascades and induces sys/component failure	Degraded Performance Improper Output	5	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	4	100	RA-21: BESS OEM ESMS Software controls monitors interdependent system to safely detect system degradation and initiate S/D protocols	Empire II, LLC Engineering	RA-21: BESS OEM ESMS Software controls monitors interdepende nt system to safely detect system degradation and initiate S/D protocols	5	4	3	60



Empire II, LLC

Page 129 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM

Design Basis: Assumed Typical LFP BESS Project

Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Project Manager: Mr.James Whalen De

Prepared by: Robert Steele, PhD.
FMEA Date (Orig.): 23 July 2025

			Data attack to			Potential		Current			B	B	A -41				
Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	cause(s) / failure mechanisms	Ос	Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
2.1.1.3.2.1.	2.1.1.3.2.1.2.	IEC CGI FACP Interface Control	RS485 TO DC METER (X4): Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Failure - Degraded Performance Interdependent System Failure - Failure to Operate	7	FC-46 Subcomponent/Sub system Failure: Lifecycle failure of components impacting availability/capabilit y to execute intended design function	6	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	7	294	RA-23: BESS OEM ESMS Software controls interdependent system to safely detect system degradation and initiate S/D protocols	Empire II, LLC Engineering	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	5	3	75
	2.1.1.3.2.1.2.		Fast-Stop Emergency Button Failure, Fail to respond to input	Interdependent System Failure - Failure to Operate	7	FC-15 Comms Failure: Failure of the system to properly report an adverse condition to local or remote monitoring. Failure of the system to report failures within itself and to act on those failures, resulting in adverse condition	6	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	8	336	RA-01: Performance of Scheduled System Maintenance	Empire II, LLC Engineering	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	5	3	75
	2.1.1.3.2.1.2.		Temperature Probes: Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Failure - Degraded Performance	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	7	245	RA-01: Performance of Scheduled System Maintenance RA-21: BESS OEM ESMS Software controls monitors interdependent system to safely detect system degradation and initiate S/D protocols	Empire II, LLC Engineering	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	4	3	60
	2.1.1.3.2.1.2.		Humidity/Temp Sensor Failure: Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Failure - Degraded Performance	7	FC-10 Sensor Failure: A sensor inside the system fails, resulting in incorrect reporting of system properties	4	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	6	168	RA-07: Environmental Temperature Monitoring and Alarms RA-21: BESS OEM ESMS Software controls monitors interdependent system to safely detect system degradation and initiate S/D protocols	Empire II, LLC Engineering	RA-07: Environment al Temperature Monitoring and Alarms	2	3	5	30



Empire II, LLC

Page 130 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
													RA-21: BESS OEM ESMS Software controls monitors interdepende nt system to safely detect system degradation and initiate S/D protocols				
2.1.1.3.2.1.	2.1.1.3.2.1.2.	IEC CGI FACP Interface Control	Door Contact Switch Induced Failure: Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Failure - Degraded Performance	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	5	175	RA-21: BESS OEM ESMS Software controls monitors interdependent system to safely detect system degradation and initiate S/D protocols	Empire II, LLC Engineering	RA-21: BESS OEM ESMS Software controls monitors interdepende nt system to safely detect system degradation and initiate S/D protocols	4	4	4	64
	2.1.1.3.2.1.2.		HVAC System Induced Failure, Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Failure - Failure to Operate	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	5	175	RA-21: BESS OEM ESMS Software controls monitors interdependent system to safely detect system degradation and initiate S/D protocols	Empire II, LLC Engineering	RA-21: BESS OEM ESMS Software controls monitors interdepende nt system to safely detect system degradation and initiate S/D protocols	5	4	4	80
	2.1.1.3.2.1.2.		FACP System Induced Failure, Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Failure - Degraded Performance	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	4	140	RA-21: BESS OEM ESMS Software controls monitors interdependent system to safely detect system degradation and initiate S/D protocols	Empire II, LLC Engineering	RA-21: BESS OEM ESMS Software controls monitors interdepende nt system to safely detect system degradation and initiate S/D protocols	5	4	3	60



Empire II, LLC

Page 131 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068

Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
2.1.1.3.2.1.	2.1.1.3.2.1.3.	Humidity Monitoring FACP Interface Control	RS485 TO DC METER (X4): Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Failure - Degraded Performance	7	FC-46 Subcomponent/Sub system Failure: Lifecycle failure of components impacting availability/capabilit y to execute intended design function	6	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	7	294	RA-23: BESS OEM ESMS Software controls interdependent system to safely detect system degradation and initiate S/D protocols	Empire II, LLC Engineering	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	5	4	100
	2.1.1.3.2.1.3.		Fast-Stop Emergency Button Failure, Fail to respond to input	Interdependent System Failure - Failure to Operate	9	FC-15 Comms Failure: Failure of the system to properly report an adverse condition to local or remote monitoring. Failure of the system to report failures within itself and to act on those failures, resulting in adverse condition	6	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	8	432	RA-01: Performance of Scheduled System Maintenance	Empire II, LLC Engineering	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	5	3	75
	2.1.1.3.2.1.3.		Temperature Probes: Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Failure - Degraded Performance	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	7	245	RA-01: Performance of Scheduled System Maintenance RA-21: BESS OEM ESMS Software controls monitors interdependent system to safely detect system degradation and initiate S/D protocols	Empire II, LLC Engineering	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	4	3	60
	2.1.1.3.2.1.3.		Humidity/Temp Sensor Failure: Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Failure - Degraded Performance	7	FC-10 Sensor Failure: A sensor inside the system fails, resulting in incorrect reporting of system properties	4	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	6	168	RA-07: Environmental Temperature Monitoring and Alarms RA-21: BESS OEM ESMS Software controls monitors interdependent system to safely detect system degradation and initiate S/D protocols	Empire II, LLC Engineering	RA-07: Environment al Temperature Monitoring and Alarms	2	3	5	30



Empire II, LLC

Page 132 of 135

Prepared by: Robert Steele, PhD. FMEA Date (Orig.): 23 July 2025

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
													RA-21: BESS OEM ESMS Software controls monitors interdepende nt system to safely detect system degradation and initiate S/D protocols				
2.1.1.3.2.1.	2.1.1.3.2.1.3.	Humidity Monitoring FACP Interface Control	Door Contact Switch Induced Failure: Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Failure - Degraded Performance	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	5	175	RA-21: BESS OEM ESMS Software controls monitors interdependent system to safely detect system degradation and initiate S/D protocols	Empire II, LLC Engineering	RA-21: BESS OEM ESMS Software controls monitors interdepende nt system to safely detect system degradation and initiate S/D protocols	4	4	4	64
	2.1.1.3.2.1.3.		HVAC System Induced Failure, Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Failure - Degraded Performance	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	5	175	RA-21: BESS OEM ESMS Software controls monitors interdependent system to safely detect system degradation and initiate S/D protocols	Empire II, LLC Engineering	RA-21: BESS OEM ESMS Software controls monitors interdepende nt system to safely detect system degradation and initiate S/D protocols	5	4	4	80
	2.1.1.3.2.1.3.		FACP System Induced Failure, Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Failure - Degraded Performance	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	4	140	RA-21: BESS OEM ESMS Software controls monitors interdependent system to safely detect system degradation and initiate S/D protocols	Empire II, LLC Engineering	RA-21: BESS OEM ESMS Software controls monitors interdepende nt system to safely detect system degradation and initiate S/D protocols	5	4	3	60



Empire II, LLC

Page 133 of 135

12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM Design Basis: Assumed Typical LFP BESS Project

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Documents

Prepared by: Robert Steele, PhD.

FMEA Date (Orig.): 23 July 2025

Project Manager: Mr.James Whalen

P	arent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
2. 4	1.1.3.2.1.	2.1.1.3.2.1.4.	Exhaust Fan Control FACP Interface Control	RS485 TO DC METER (X4): Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Failure - Degraded Performance	7	FC-46 Subcomponent/Sub system Failure: Lifecycle failure of components impacting availability/capabilit y to execute intended design function	6	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	7	294	RA-23: BESS OEM ESMS Software controls interdependent system to safely detect system degradation and initiate S/D protocols	Empire II, LLC Engineering	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	5	3	75
		2.1.1.3.2.1.4.		Fast-Stop Emergency Button Failure, Fail to respond to input	Interdependent System Failure - Degraded Performance	7	FC-15 Comms Failure: Failure of the system to properly report an adverse condition to local or remote monitoring. Failure of the system to report failures within itself and to act on those failures, resulting in adverse condition	6	AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site acceptance testing to reduce likelihood of loose connections or other transportation or construction defects	8	336	RA-01: Performance of Scheduled System Maintenance	Empire II, LLC Engineering	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	5	3	75
		2.1.1.3.2.1.4.		Temperature Probes: Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Failure - Degraded Performance	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	7	245	RA-01: Performance of Scheduled System Maintenance RA-21: BESS OEM ESMS Software controls monitors interdependent system to safely detect system degradation and initiate S/D protocols	Empire II, LLC Engineering	Refer to Owners Procedures Index. Requires validation substantiatin g RPN reduction	5	4	3	60
		2.1.1.3.2.1.4.		Humidity/Temp Sensor Failure: Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Failure - Degraded Performance	7	FC-10 Sensor Failure: A sensor inside the system fails, resulting in incorrect reporting of system properties	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	6	210	RA-07: Environmental Temperature Monitoring and Alarms RA-21: BESS OEM ESMS Software controls monitors interdependent system to safely detect system degradation and initiate S/D protocols	Empire II, LLC Engineering	RA-07: Environment al Temperature Monitoring and Alarms	2	4	5	40



FMEA Date (Orig.): 23 July 2025

Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

Page 134 of 135

Prepared by: Robert Steele, PhD.

12302 Exposition Blvd | Los Angeles, CA 90068 Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Documents															1		
Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
													RA-21: BESS OEM ESMS Software controls monitors interdepende nt system to safely detect system degradation and initiate S/D protocols				
2.1.1.3.2.1.	2.1.1.3.2.1.4.	Exhaust Fan Control FACP Interface Control	Door Contact Switch Induced Failure: Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Failure - Degraded Performance	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	5	175	RA-21: BESS OEM ESMS Software controls monitors interdependent system to safely detect system degradation and initiate S/D protocols	Empire II, LLC Engineering	RA-21: BESS OEM ESMS Software controls monitors interdepende nt system to safely detect system degradation and initiate S/D protocols	4	4	4	64
	2.1.1.3.2.1.4.		HVAC System Induced Failure, Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Failure - Degraded Performance	8	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	5	200	RA-21: BESS OEM ESMS Software controls monitors interdependent system to safely detect system degradation and initiate S/D protocols	Empire II, LLC Engineering	RA-21: BESS OEM ESMS Software controls monitors interdepende nt system to safely detect system degradation and initiate S/D protocols	5	4	4	80
	2.1.1.3.2.1.4.		FACP System Induced Failure, Failure of interdependent/interco nnected sys cascades and induces sys/component failure	Interdependent System Failure - Degraded Performance	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/inter connected sys cascades and induces sys/component failure	5	EC-36 ESMS Monitoring: ESMS programming evaluates system operation and initiates system shutdown upon detection of abnormal system performance	4	140	RA-21: BESS OEM ESMS Software controls monitors interdependent system to safely detect system degradation and initiate S/D protocols	Empire II, LLC Engineering	RA-21: BESS OEM ESMS Software controls monitors interdepende nt system to safely detect system degradation and initiate S/D protocols	5	4	3	60



Empire II, LLC Starlight Solar Project BOP Level FMEA

Empire II, LLC

12302 Exposition Blvd | Los Angeles, CA 90068

Hiller Doc No.: 20250320-SLS-AW0764-BOP-FMEA-R1

Page 135 of 135

Design Responsibility: Empire II, LLC and BESS OEM

•	•	23 July 2025			F	Project Manager: N	∕Ir.Jaı	mes Whalen			Design Basi Documents	is: Assumed Typic	al LFP BES	S Pr	oject		
Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Ос	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Ос	Dt	RPN
3	3.1	Starlight Solar Project Fire Alarm Panel (FAA)	False Indication (FMD)	Major Effect - Product performance is severely degraded but has some operational capability and remains safe. Failure to Determine FACP Status	7	FM-86 Internal Component Failure - Overtemperature FM-87 Internal Component Failure - Equipment Lifecycle Failure FM-75 Degradation/Age related failure: Failures realized as part of programming lifecycle	6	EC-36 FAA Alarm and Annuciation: Ability of the FAA to detect component failure and alarm/annuciate for Operations Response	5	210	AC-01: EOP - System operator plan to handle all emergency events. AC-02: EOP - Fire department response including active firefighting suppression AC-03 O&M: Proper maintenance and monitoring of the system in conjunction with adequate commission and site	Empire II, LLC/BESS OEM/O&M Contractor	AC-01: EOP - System operator plan to handle all emergency events. RA-01: Performance of Scheduled System Maintenance RA-05: Auto System S/D	6	4	4	96
	3.2		Failure to Operate on Demand (FMD)	Hazardous Effects with Indication Major Effect - Product performance is severely degraded but has some operational capability and remains safe. Failure to Determine FACP Status	9	FM-86 Internal Component Failure - Overtemperature FM-87 Internal Component Failure - Equipment Lifecycle Failure FM-75 Degradation/Age related failure: Failures realized as part of programming lifecycle	3	EC-36 FAA Alarm and Annunciation: Ability of the FAA to detect component faillure and alarm/annunciat e for Operations Response	2	54	AC-01: EOP - System operator plan to handle all emergency events. AC-02: EOP - Fire department response including active firefighting suppression AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site	Empire II, LLC/O&M Contractor	AC-01: EOP - System operator plan to handle all emergency events. RA-01: Performance of Scheduled System Maintenance RA-05: Auto System S/D	5	2	2	20
	3.3		Spurious Operation (FMD)	Failure to Determine FACP Status Hazardous Effects with Indication Interdependent System Induced Failure	9	FM-86 Internal Component Failure - Overtemperature FM-87 Internal Component Failure - Equipment Lifecycle Failure FM-75 Degradation/Age related failure: Failures realized as part of programming lifecycle	3	EC-36 FAA Alarm and Annunciation: Ability of the FAA to detect component failure and alarm/annunciat e for Operations Response	2	54	AC-01: EOP - System operator plan to handle all emergency events. AC-02: EOP - Fire department response including active firefighting suppression AC-03 O&M: Proper maintenance and monitoring of the system adequate commission and site	Empire II, LLC/O&M Contractor	AC-01: EOP - System operator plan to handle all emergency events. RA-01: Performance of Scheduled System Maintenance RA-05: Auto System S/D	5	2	2	20
	3.4		Degraded Alarm (FMD)	Failure to Determine FACP Status Major Effect - Product performance is severely degraded but has some operational capability and remains safe.	7	FM-86 Internal Component Failure - Overtemperature FM-87 Internal Component Failure - Equipment Lifecycle Failure FM-75 Degradation/Age related failure: Failures realized as part of programming lifecycle	7	EC-36 FAA Alarm and Annuciation: Ability of the FAA to detect component failure and alarm/annuciate for Operations Response	5	245	AC-01: EOP - System operator plan to handle all emergency events. AC-02: EOP - Fire department response including active firefighting suppression AC-03 O&M: Proper maintenance and monitoring of the system in conjunction with adequate commission and site	Empire II, LLC/O&M Contractor	AC-01: EOP - System operator plan to handle all emergency events. RA-01: Performance of Scheduled System Maintenance RA-05: Auto System S/D	5	4	4	80