

Appendix O.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

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AHJ Revision Note: 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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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 NFPA 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 defensible 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 as-constructed 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.

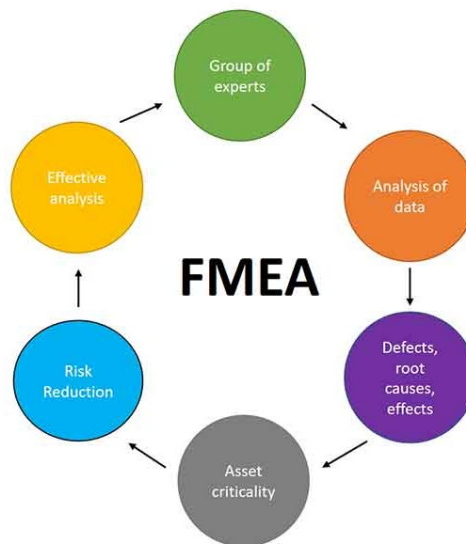


Figure 1: Classical FMEA Approach

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.

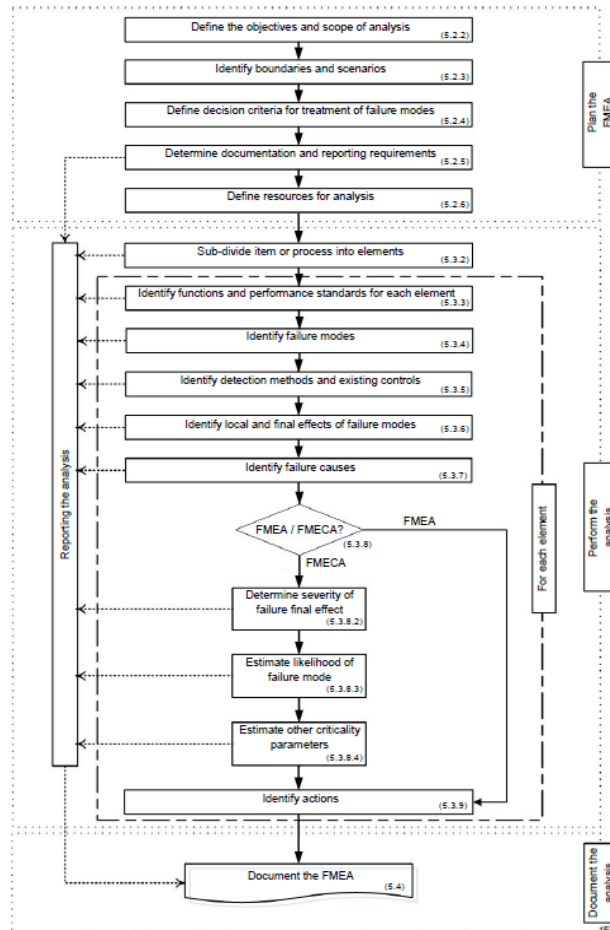


Figure 2: IEC 60812 FMEA Process Flow Chart

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.



- Empire II LLC, Confidential -

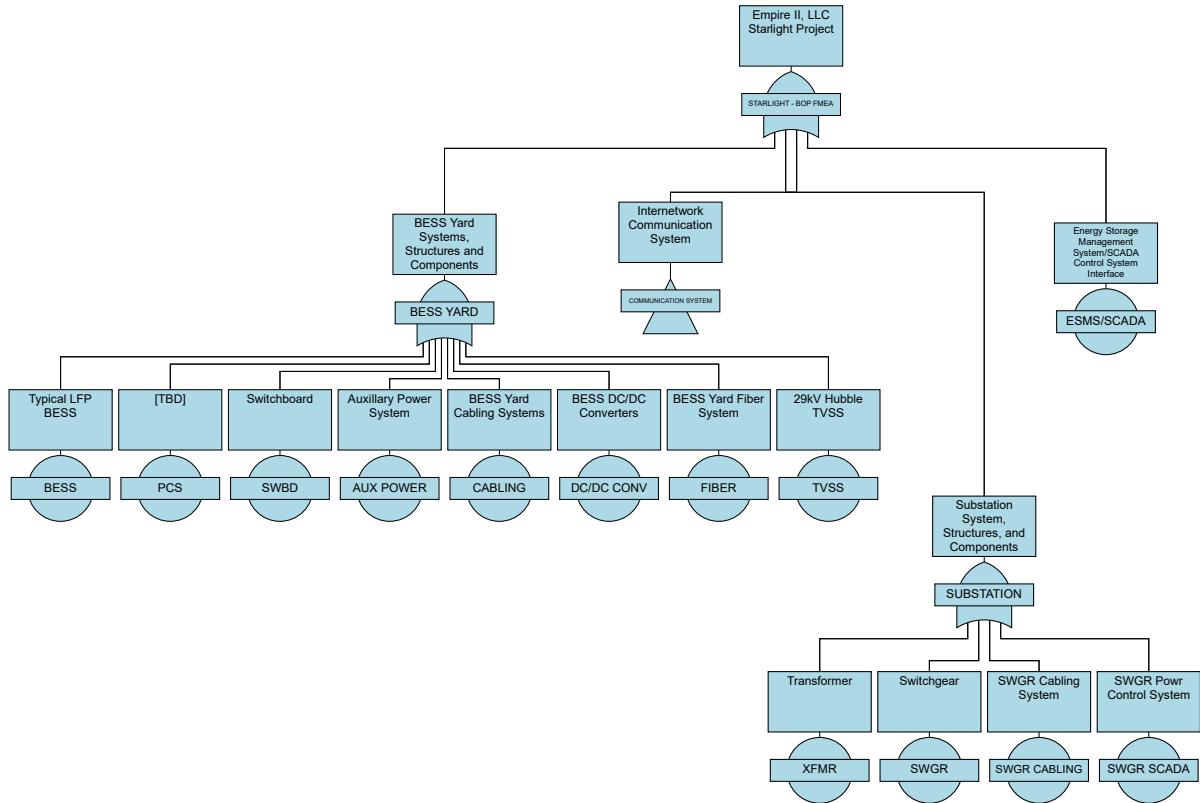


Figure 3: Summary FMEA Elements

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.

- Empire II LLC, Confidential -

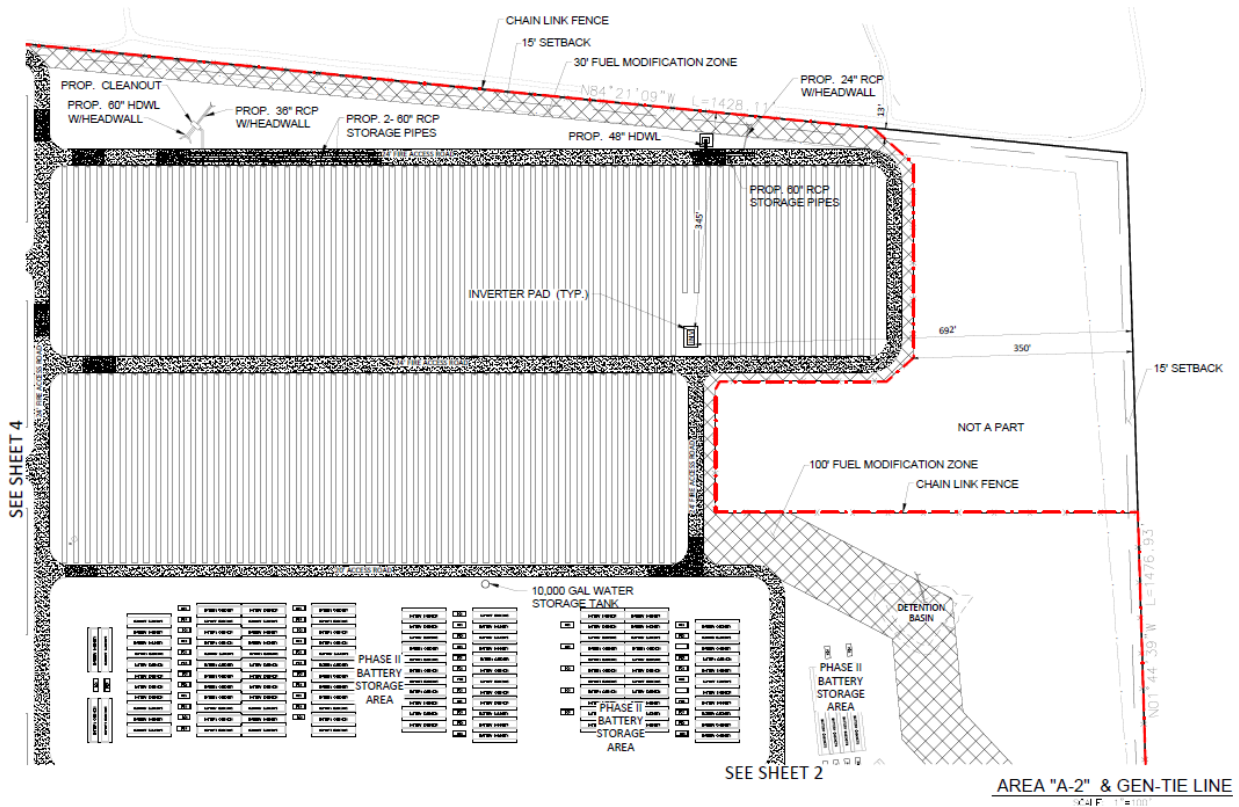


Figure 4: (typ.) Empire Site Layout

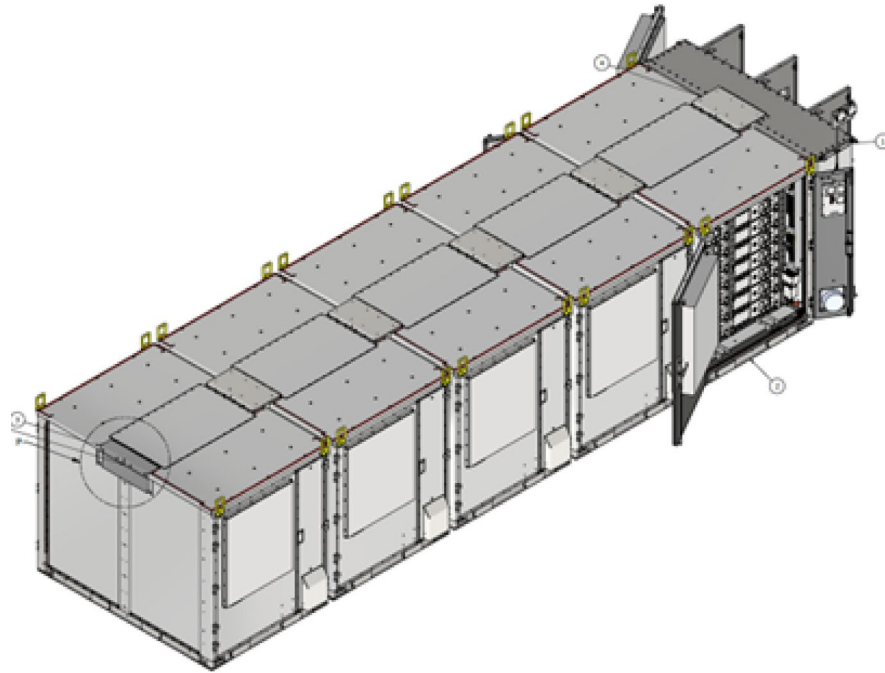


Figure 5: (ass, typ.) BESS OEM 2 LFP System

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 defensible 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.



Frequent Incident is likely to occur at this facility within the next 5 years.	4	L I K E L I H O O D			High Risk	
Occasional Incident is likely to occur at this facility within the next 15 years.	3					
Seldom Incident has occurred at a similar facility and may reasonably occur at this facility within the next 30 years.	2			Medium Risk		
Unlikely Given current practices and procedures, incident is not likely to occur at this facility.	1		Low Risk			
		C O N S E Q U E N C E				
			1	2	3	4
			Incidental	Minor	Serious	Major
Personnel			Minor or no injury, no lost time.	Single injury, not severe, possible lost time.	One or more severe injuries.	Fatality or permanently disabling injury.
Community			No injury, hazard or annoyance to the public.	Odor or noise complaint from the public.	One or more minor injuries.	One or more severe injuries.
Environmental			Environmentally recordable event with no Agency notification or permit violation.	Release which results in Agency notification or permit violation.	Significant release with serious offsite impact.	Significant release with serious offsite impact and likely to cause immediate or long term health effects.
Facility			Minimal equipment damage at an estimated cost less than US\$100K, negligible downtime.	Some equipment or structural damage at an estimated cost greater than US\$100K, 1 to 10 days of downtime.	Major damage to installation at an estimated cost than US\$1 MM but less than US\$10 MM, 10 to 90 days of downtime.	Major or total destruction to installation estimated at a cost greater than US\$10 MM, downtime in excess of 90 days.

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.



- 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: $RPN = Severity \times Occurrence \times Detection$.

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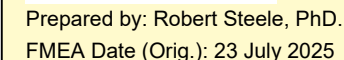
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Attachment A: Starlight Solar BOP IEC 60812 Failure Mode and Effects Analysis

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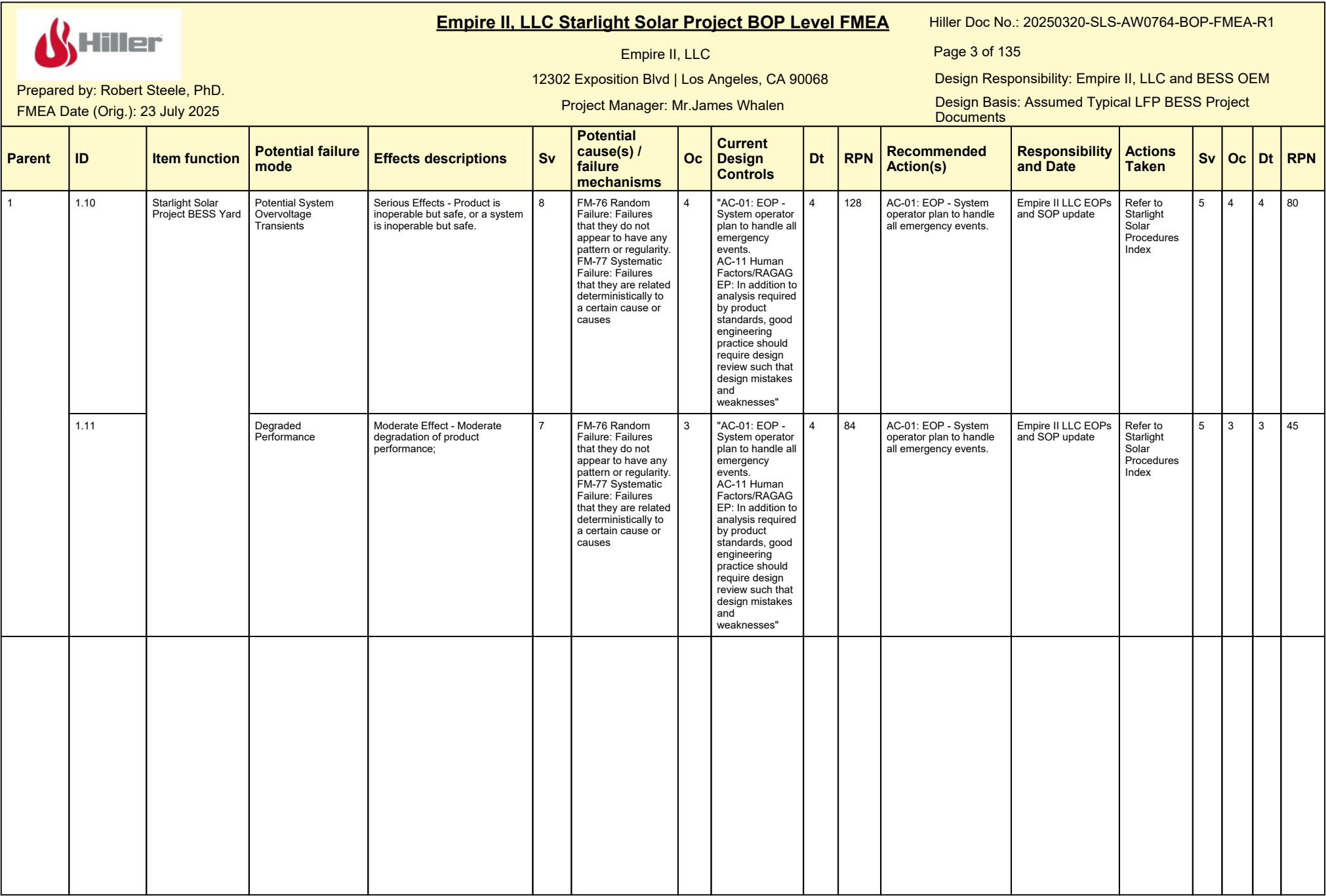
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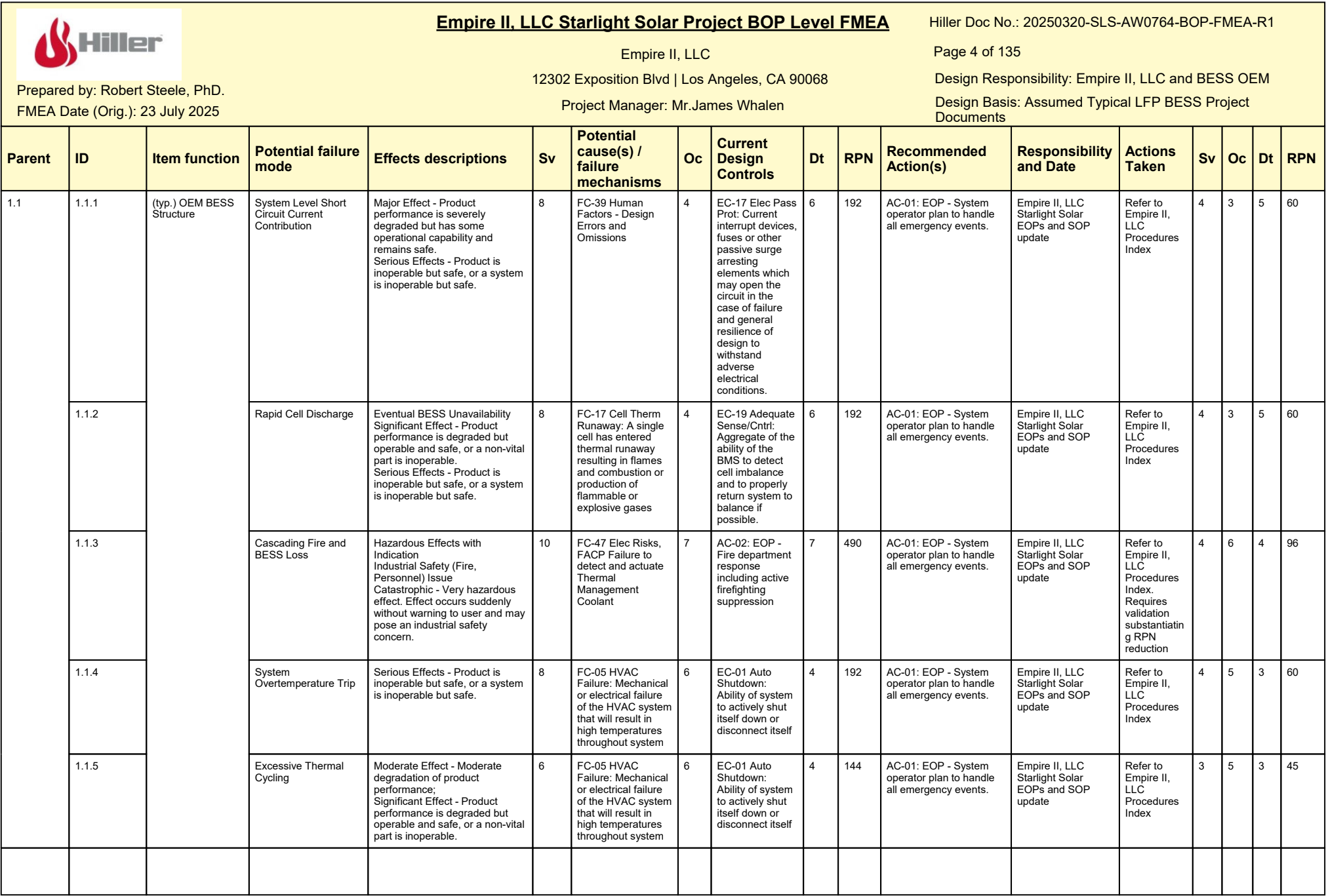
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Project Manager: Mr. James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Oc	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Oc	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/Operating 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







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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	Oc	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/isolation 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 substantiating 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/Balancing 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/isolation 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, PLACEHOLDER Refer to Empire II, LLC Emergency Operating Procedure No. PLACEHOLDER	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/interfacing 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/isolation 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, PLACEHOLDER Refer to Empire II, LLC Emergency Operating Procedure No. PLACEHOLDER	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/isolation 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, PLACEHOLDER	5	6	3	90



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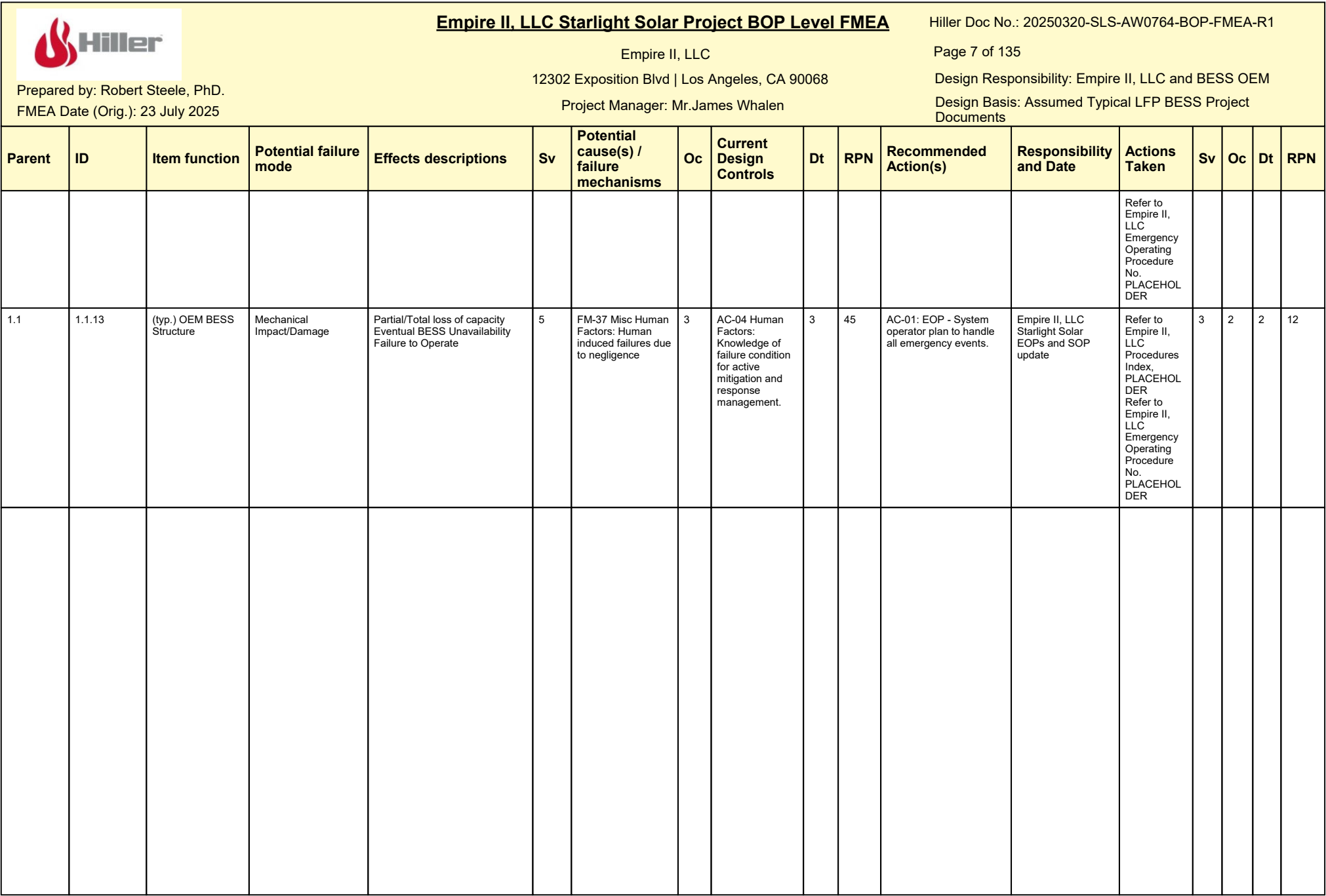
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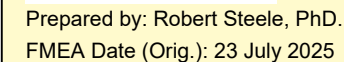
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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Oc	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Oc	Dt	RPN
													Refer to Empire II, LLC Emergency Operating Procedure No. PLACEHOLDER				
1.1	1.1.10	(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, PLACEHOLDER Refer to Empire II, LLC Emergency Operating Procedure No. PLACEHOLDER	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/isolation 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, PLACEHOLDER Refer to Empire II, LLC Emergency Operating Procedure No. PLACEHOLDER	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/Alarms: 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, PLACEHOLDER	5	5	5	125





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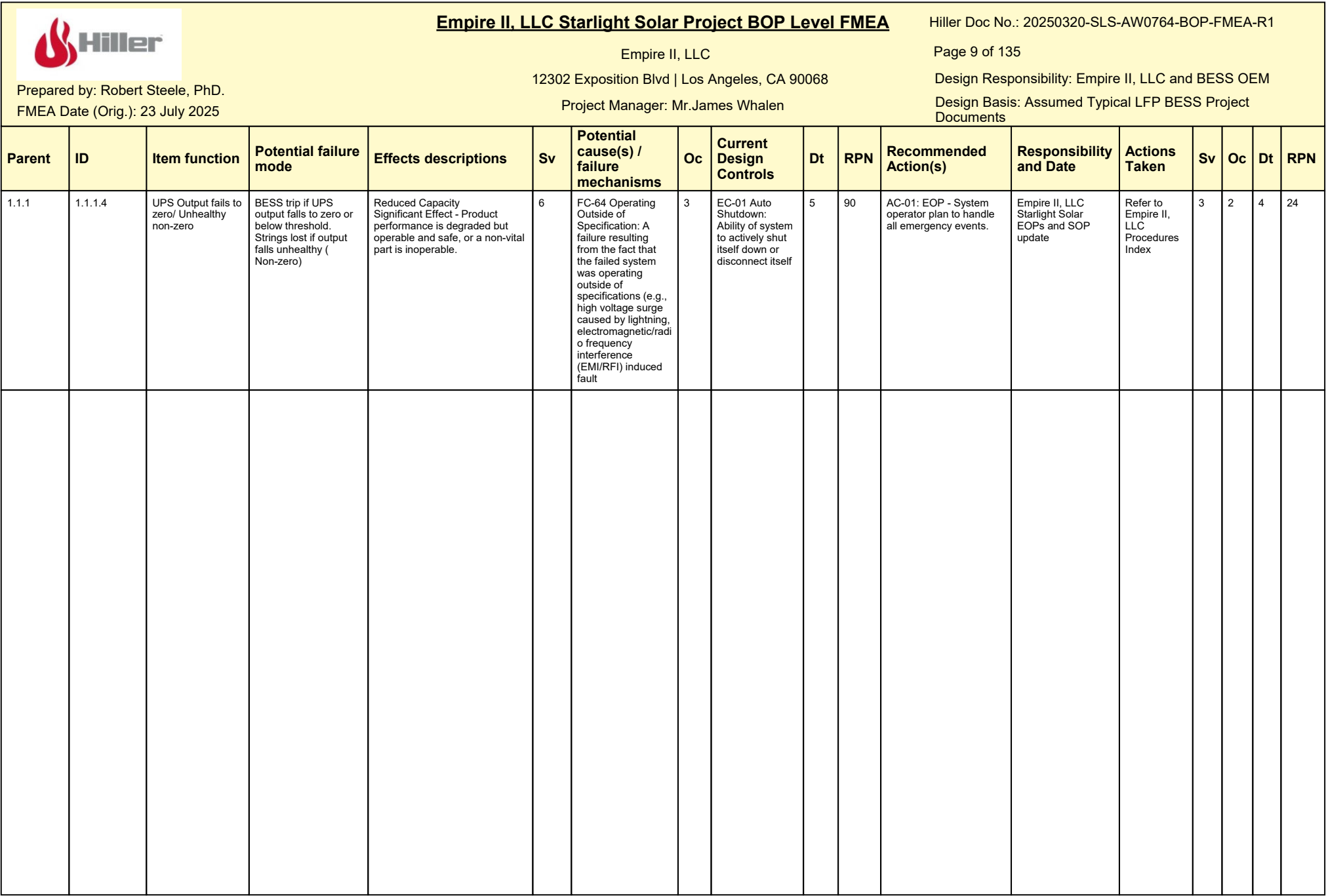
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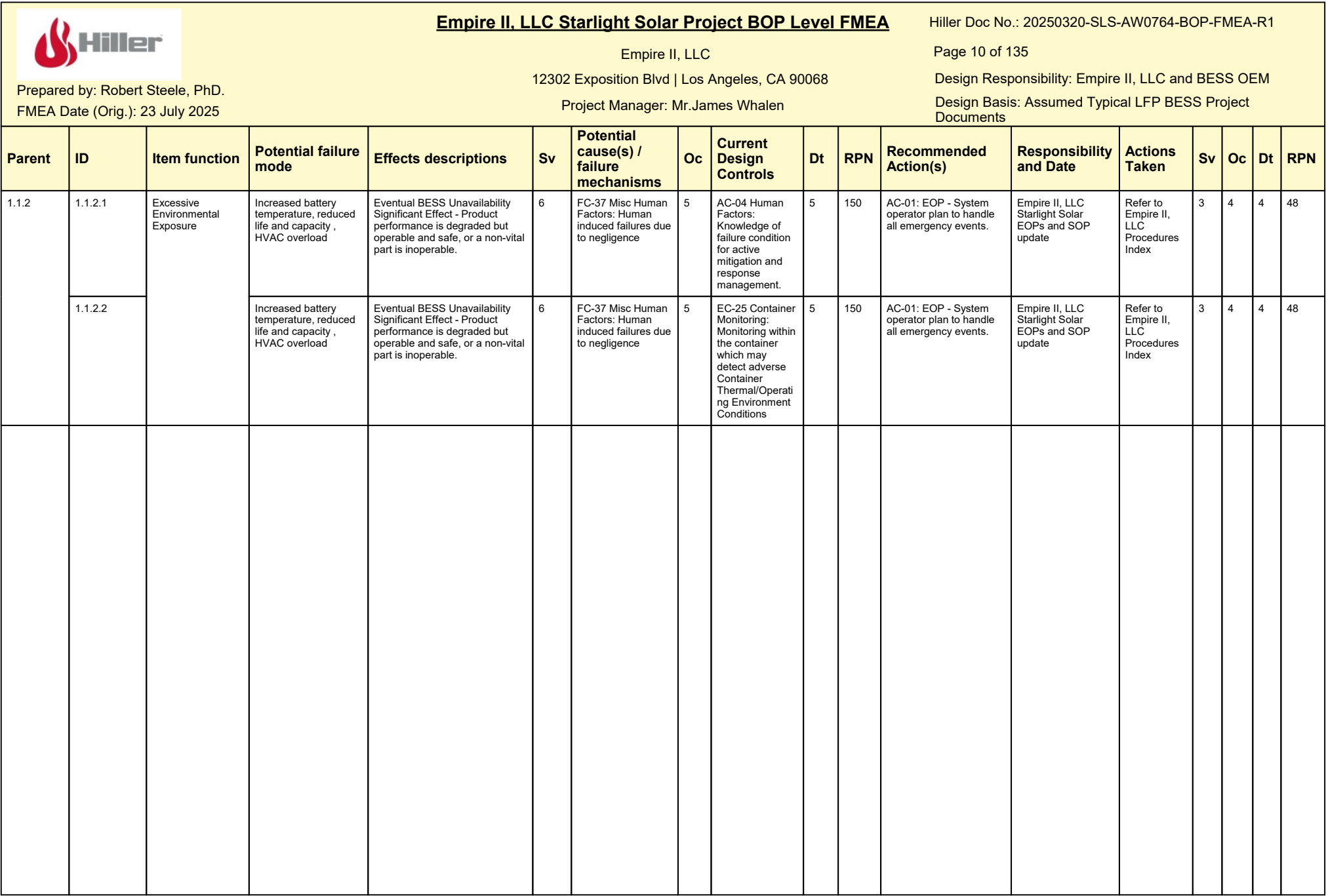
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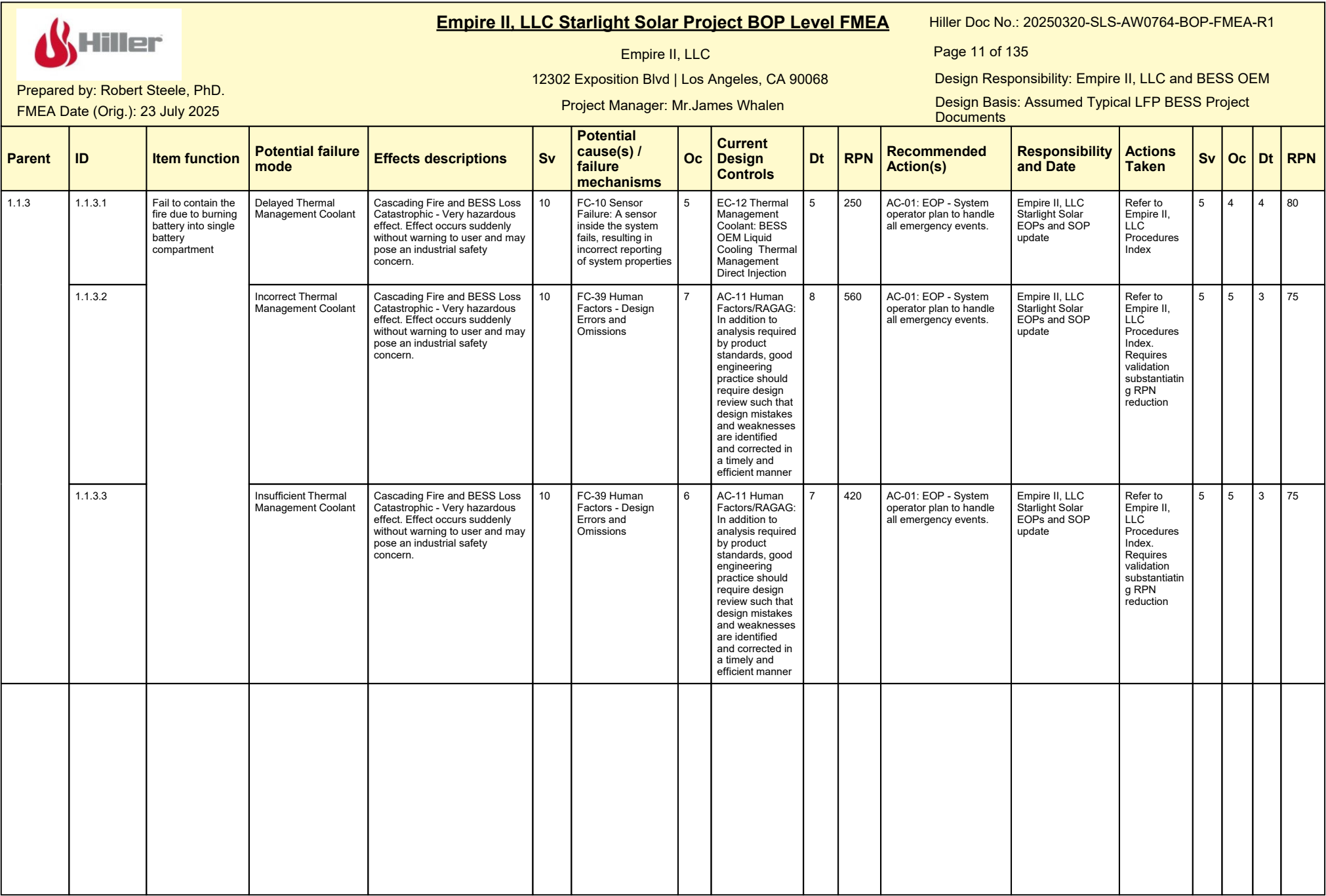
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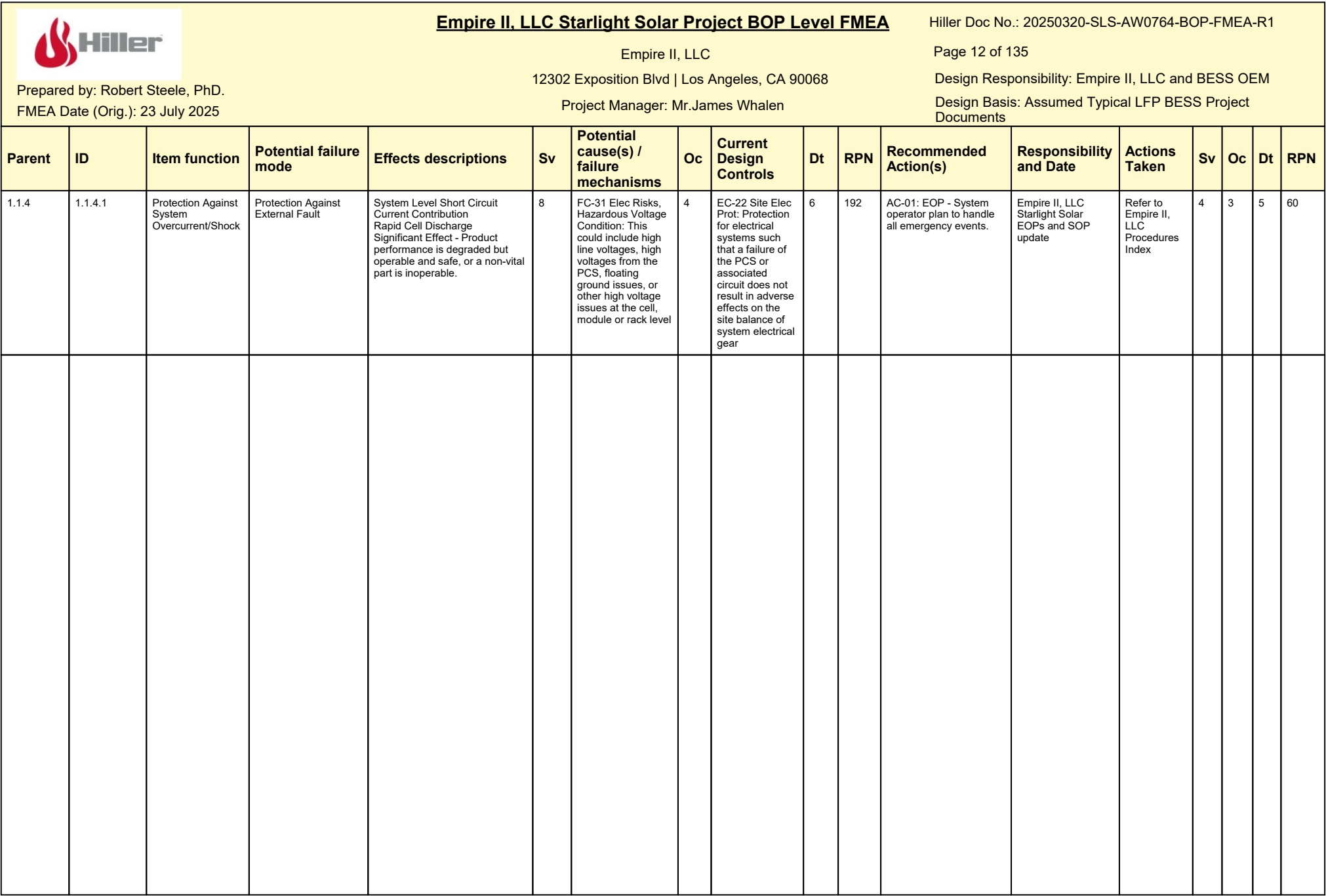
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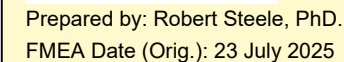
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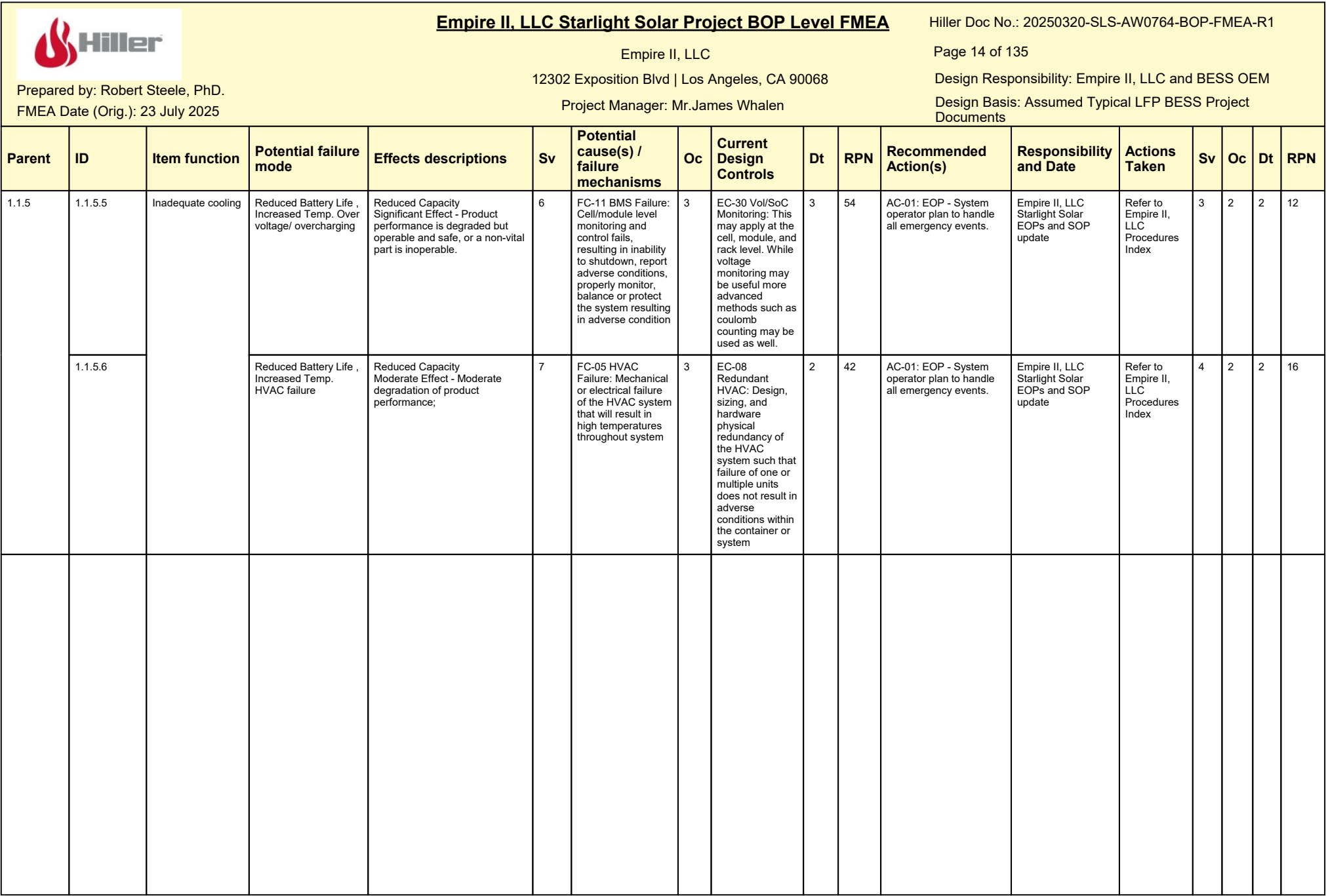


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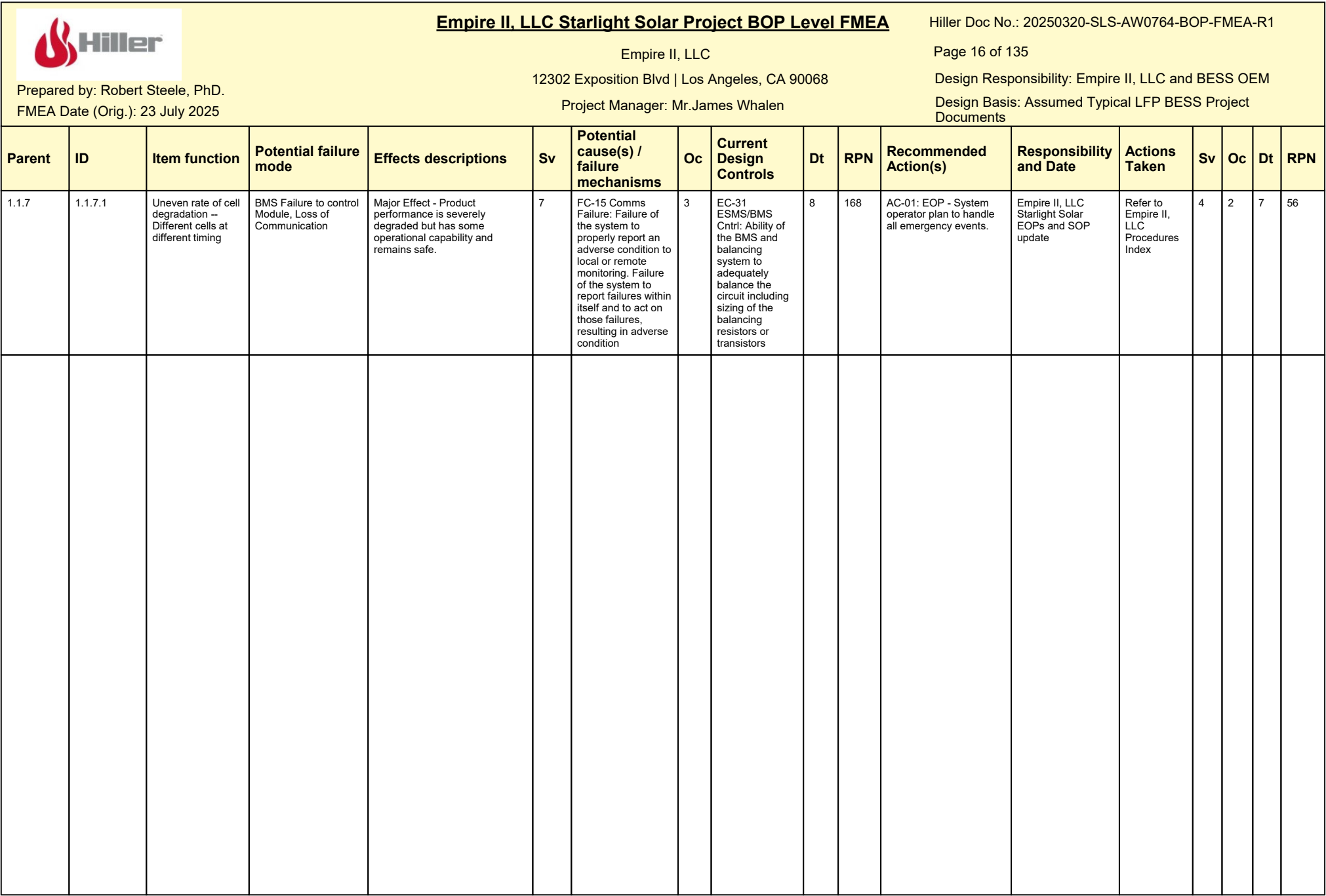
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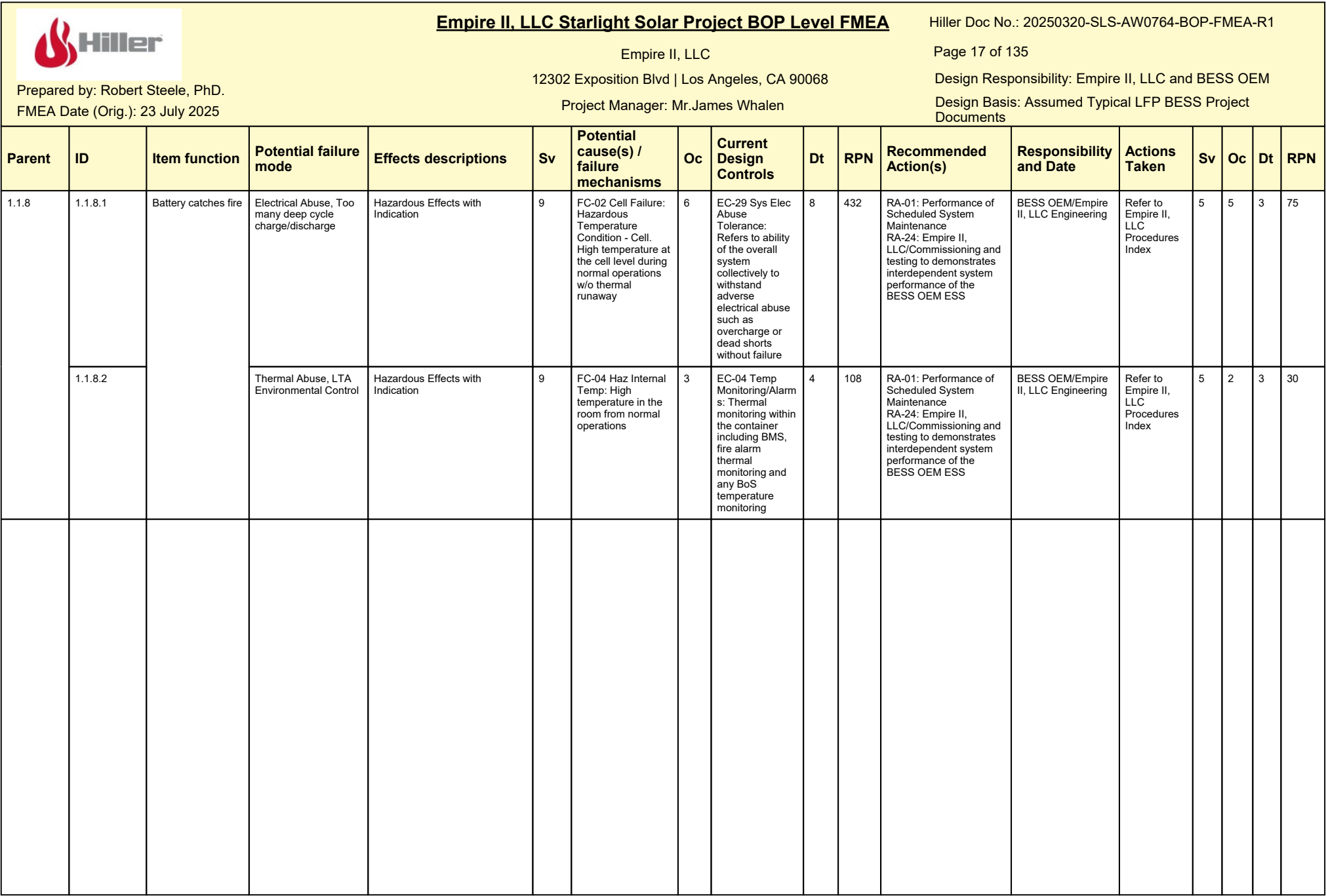
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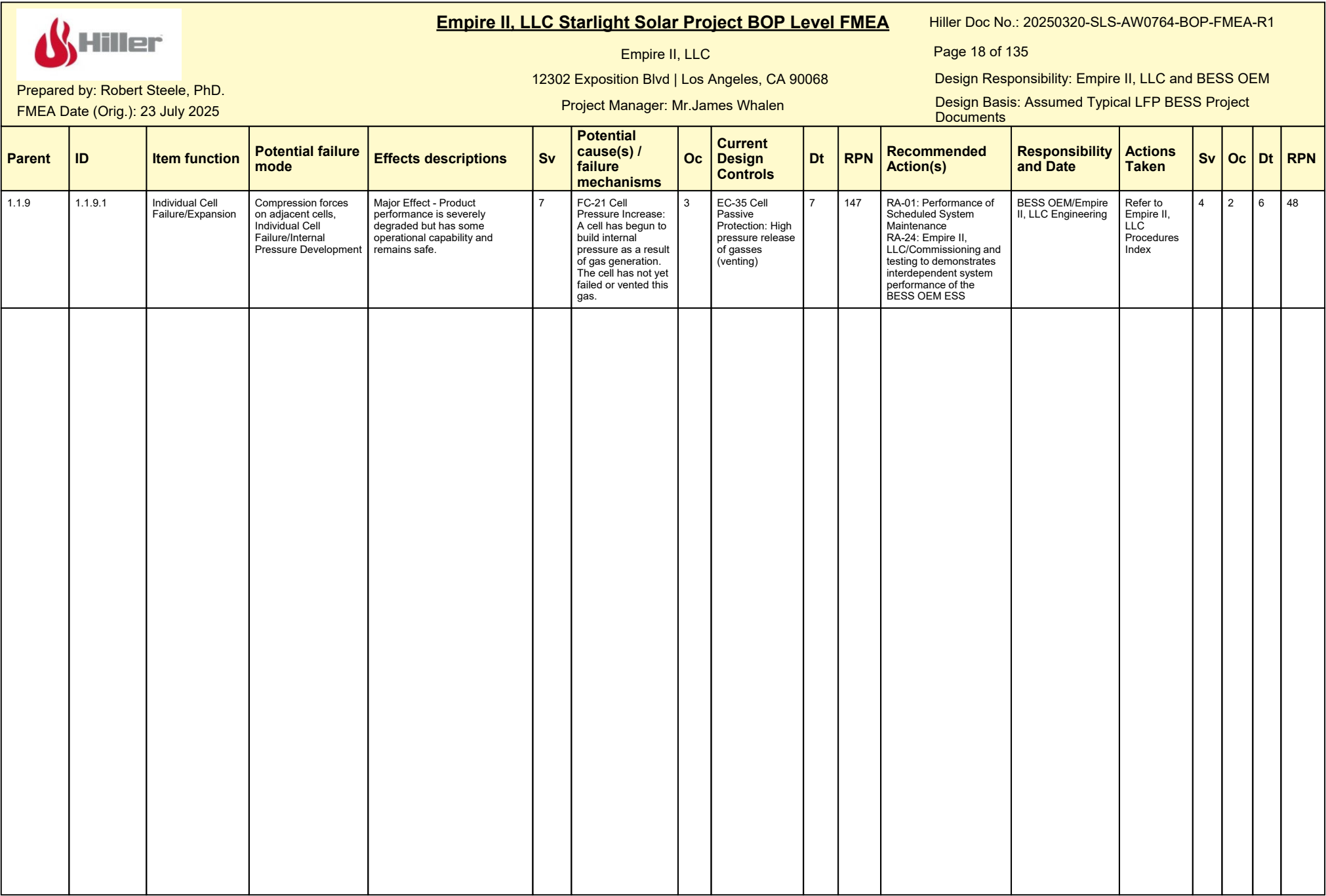
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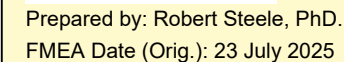
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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Oc	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Oc	Dt	RPN
1.1.6	1.1.6.1	Loose electrical 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







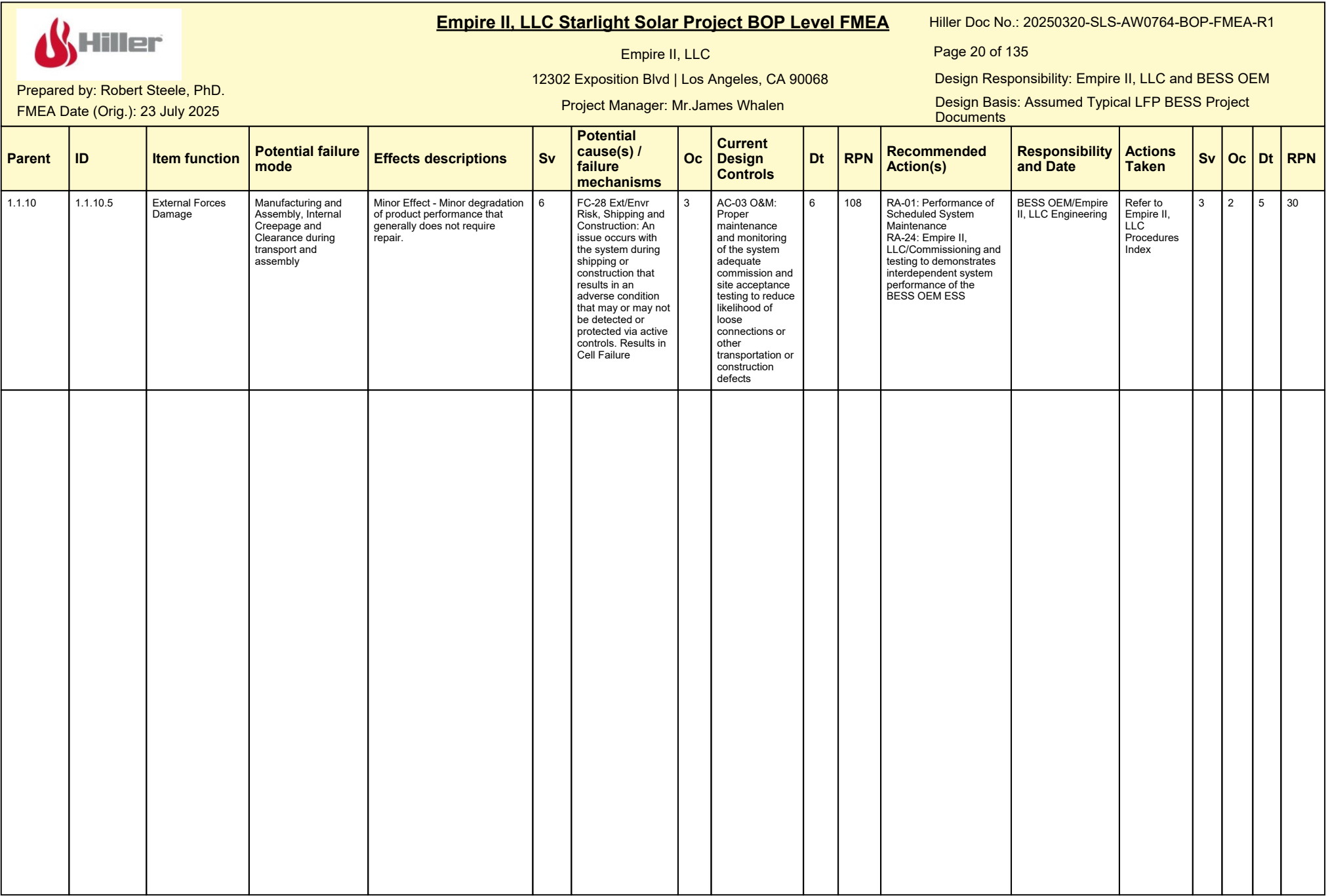


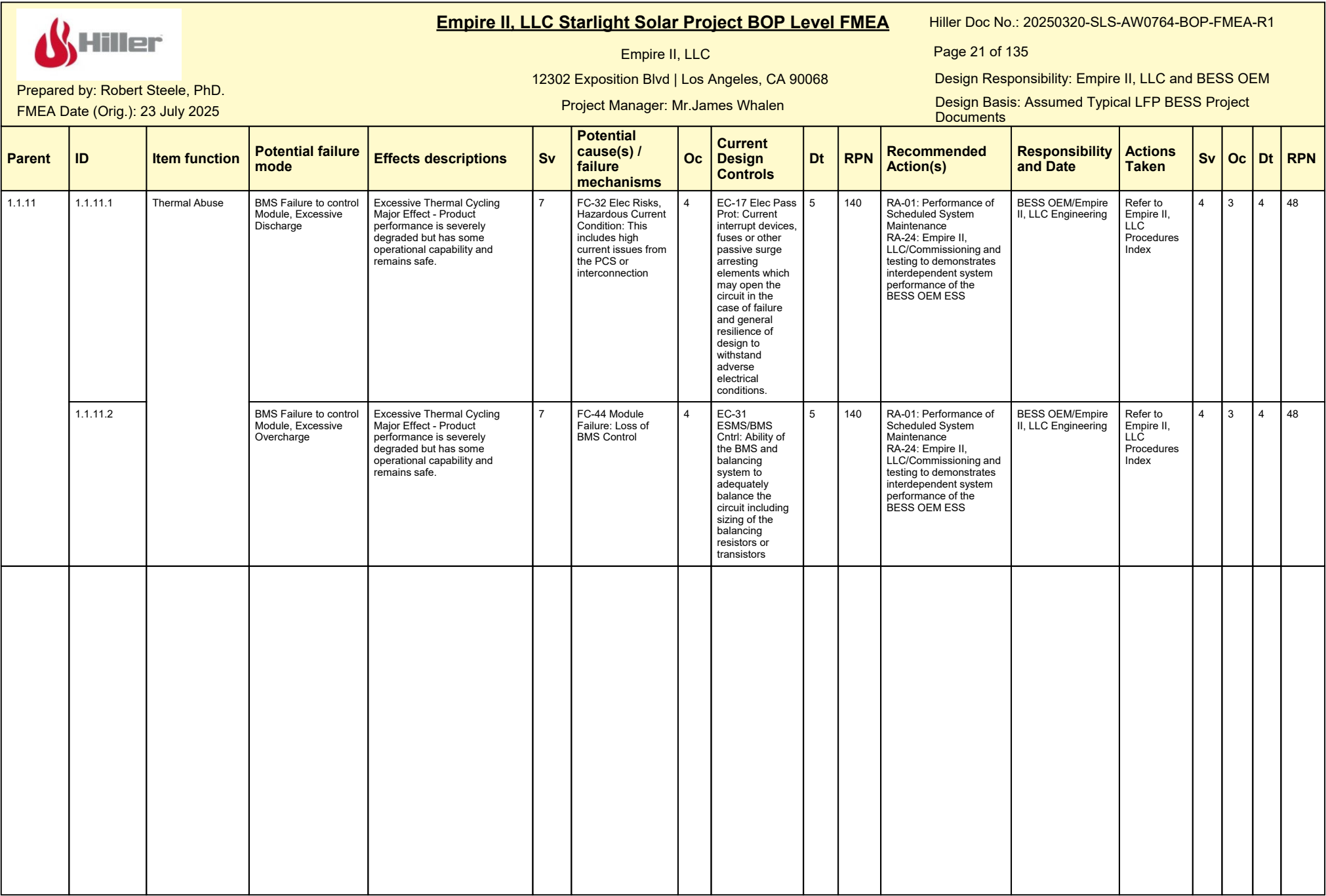
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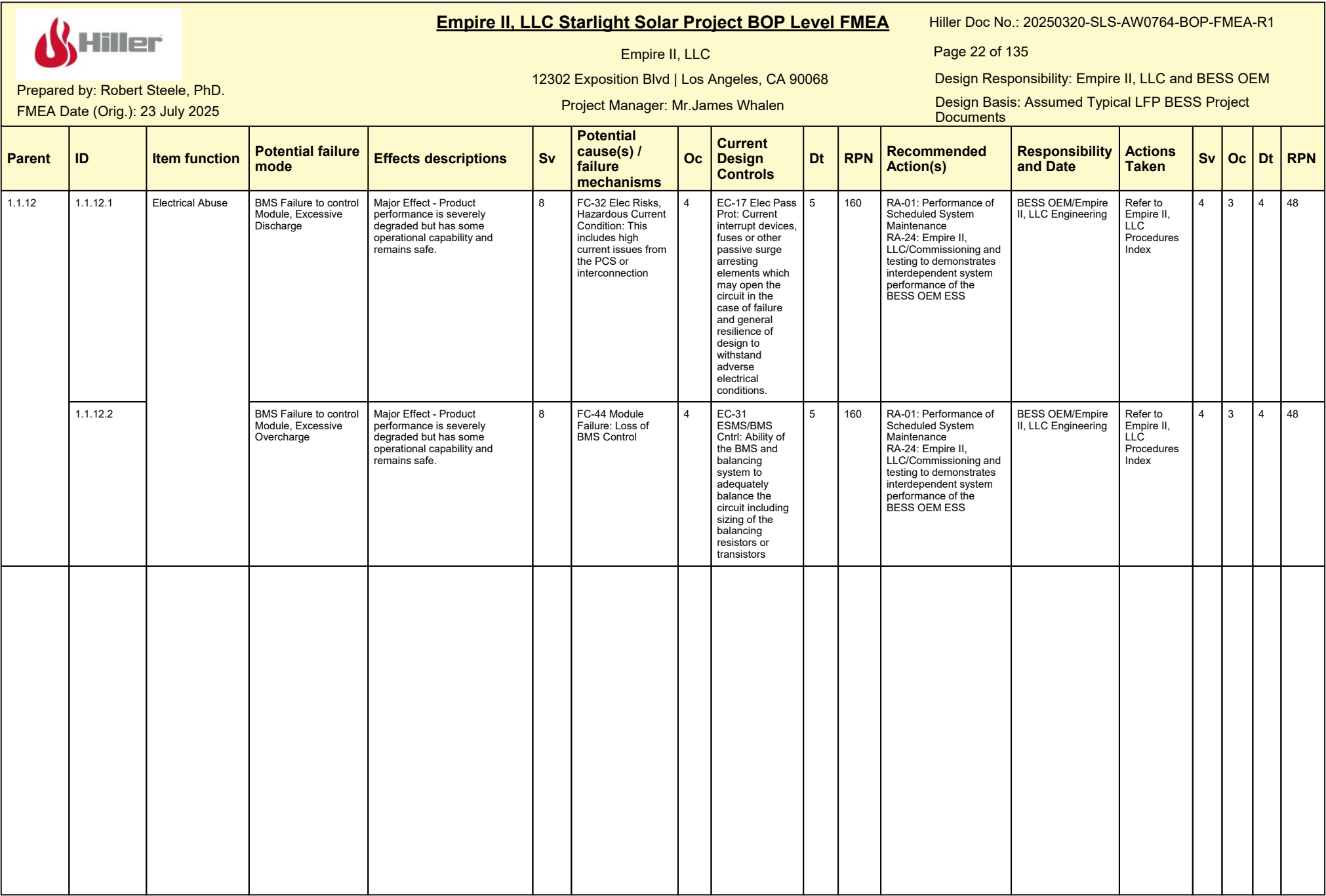
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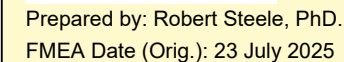
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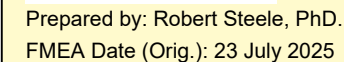


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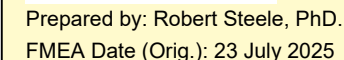
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Design Responsibility: Empire II, LLC and BESS OEM

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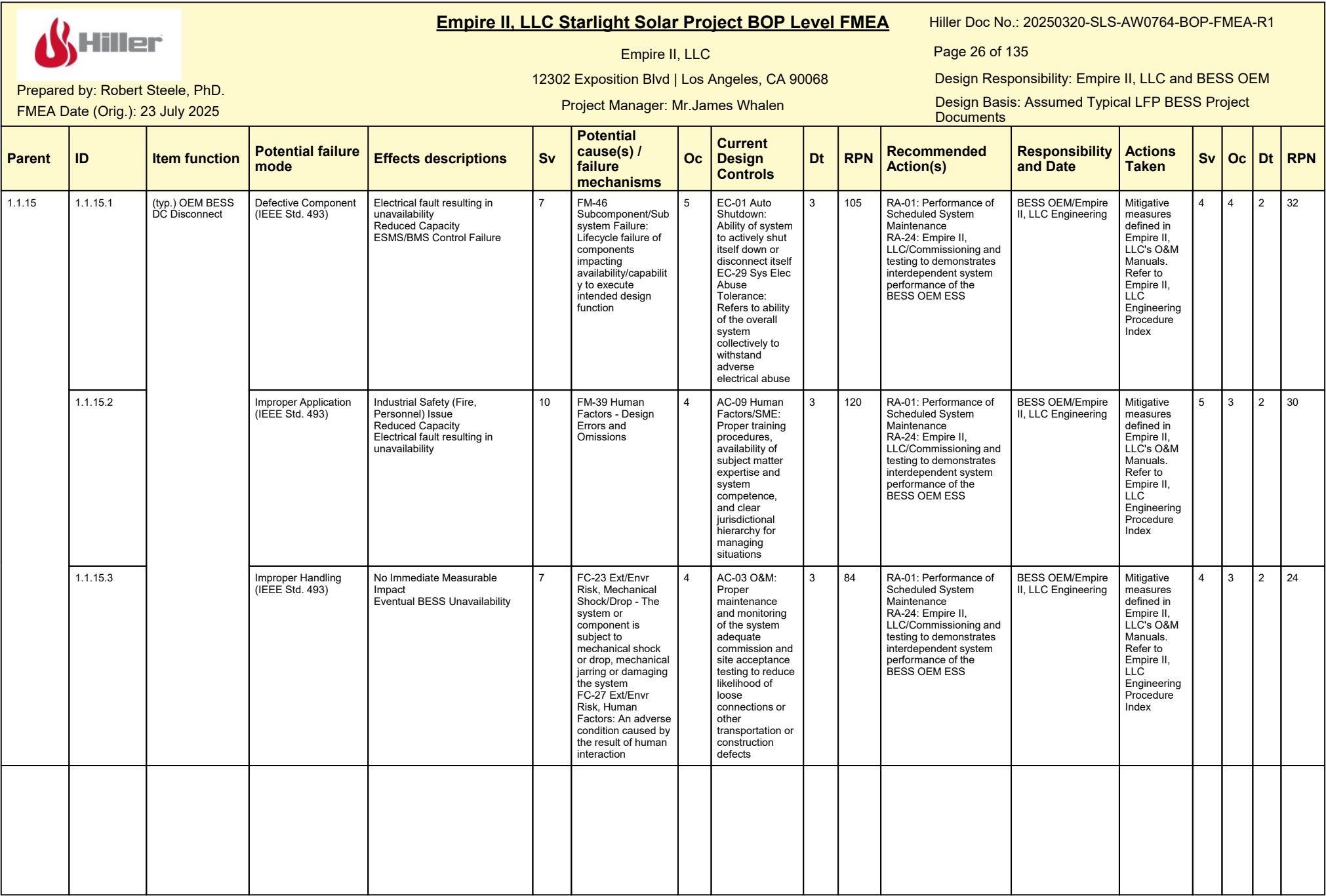


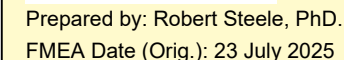
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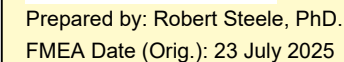


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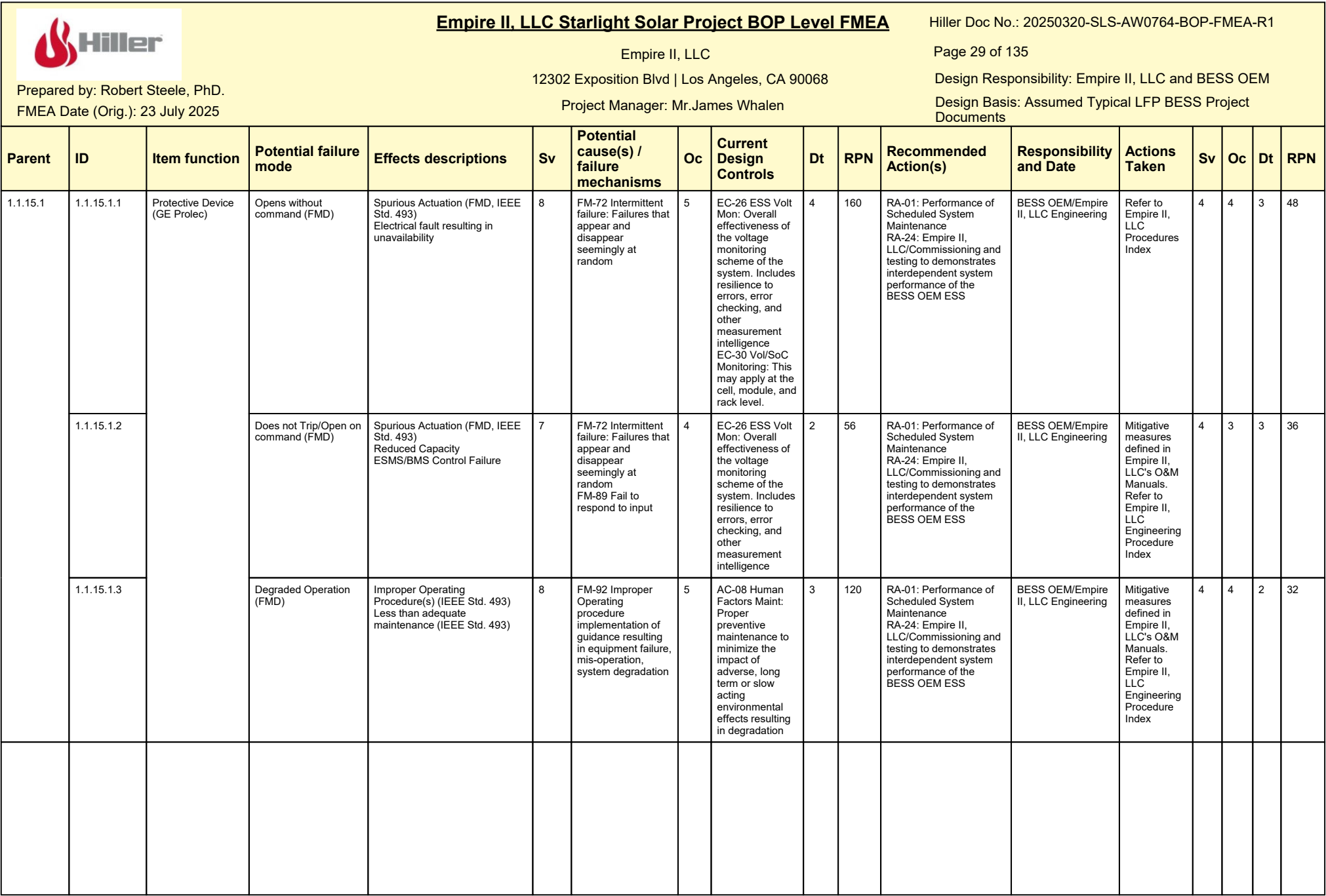
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Design Responsibility: Empire II, LLC and BESS OEM

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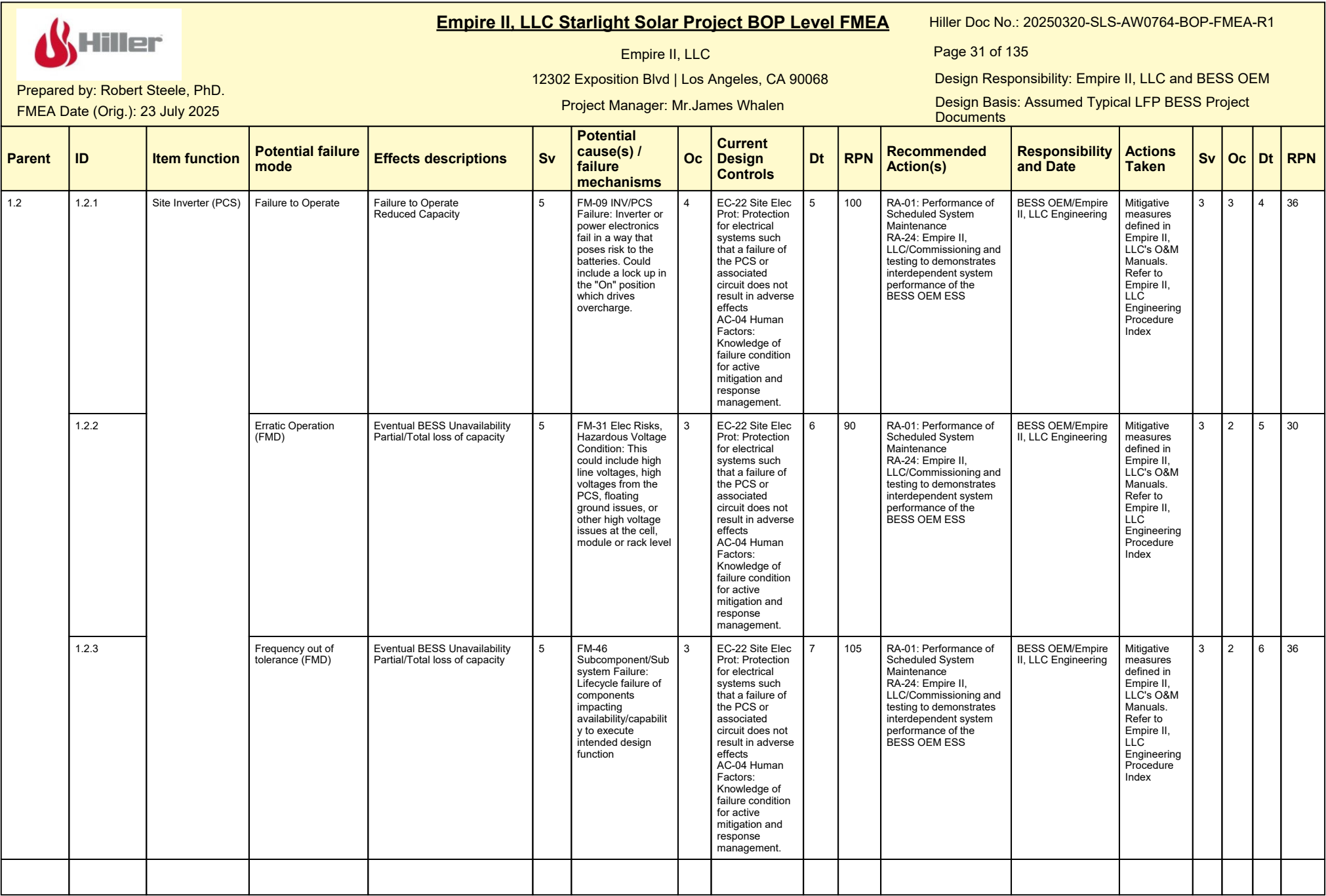
Prepared by: Robert Steele, PhD.
FMEA Date (Orig.): 23 July 2025

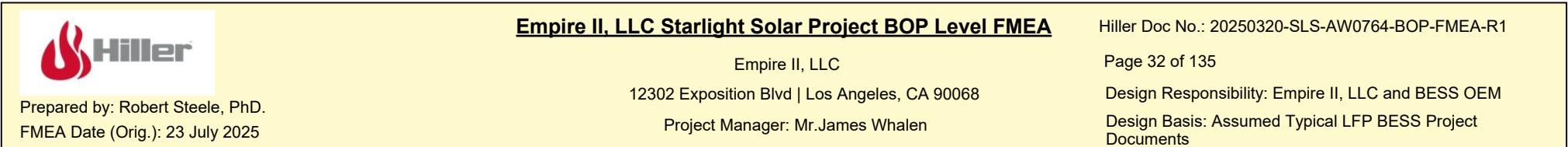
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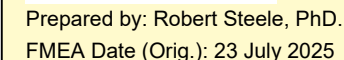
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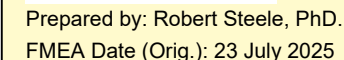
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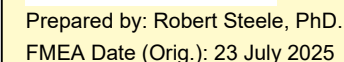
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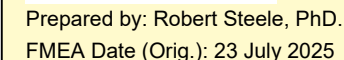


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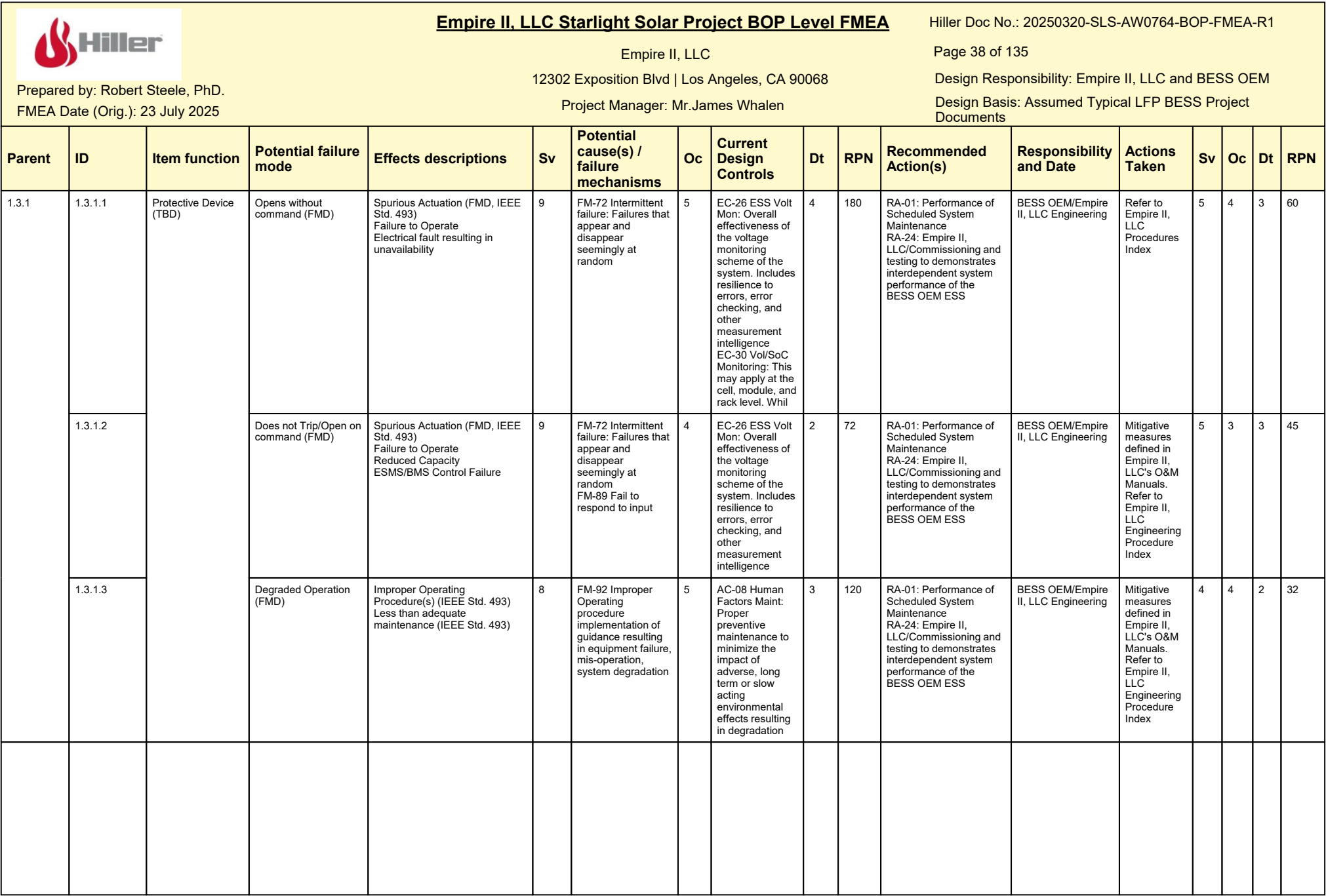
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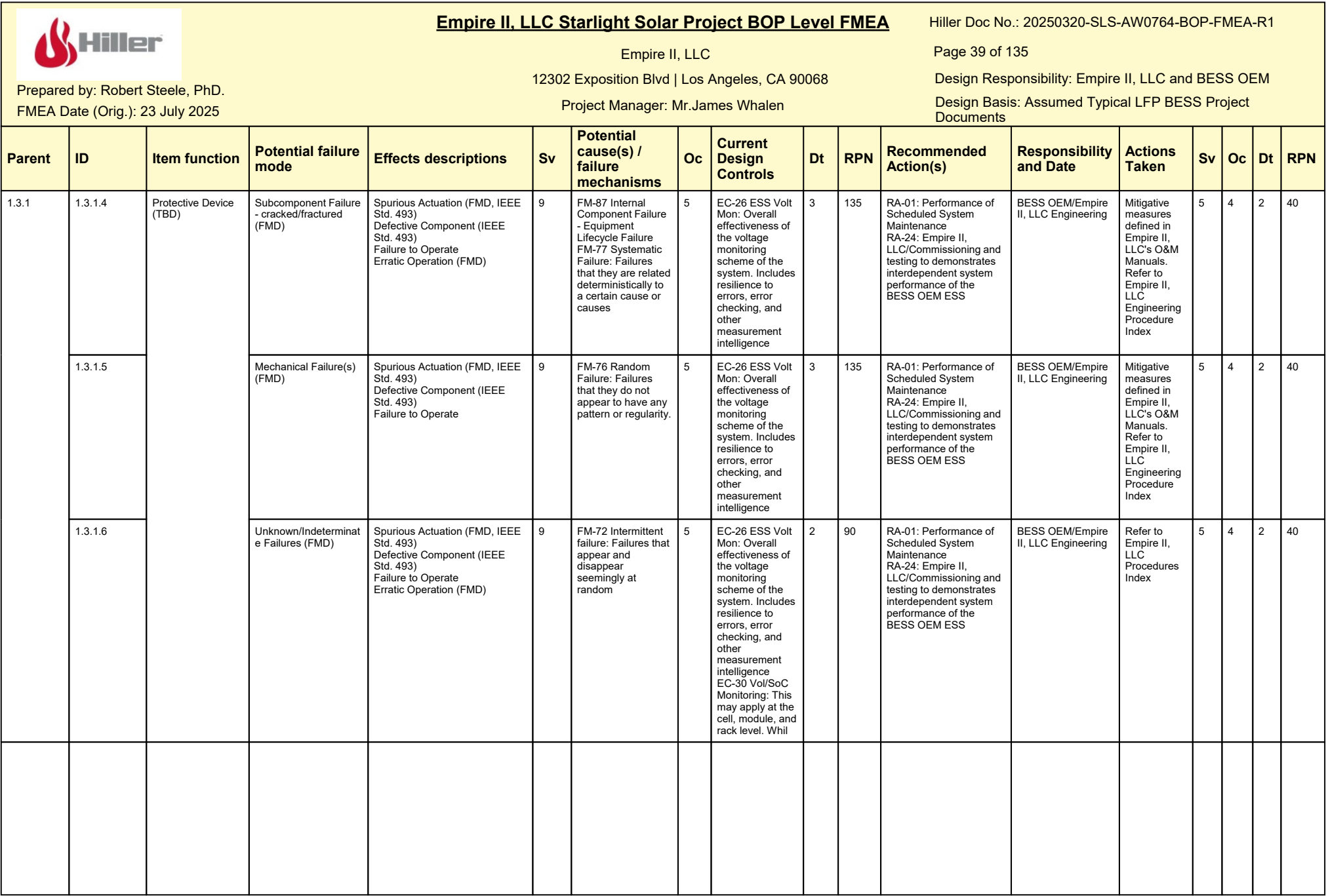
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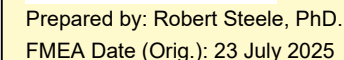
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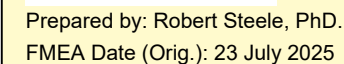
Design Responsibility: Empire II, LLC and BESS OEM

FMEA Date (Orig.): 23 July 2025

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	Oc	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Oc	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/capability 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



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Design Basis: Assumed Typical LFP BESS Project Documents

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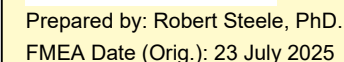
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FMEA Date (Orig.): 23 July 2025

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	Oc	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Oc	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



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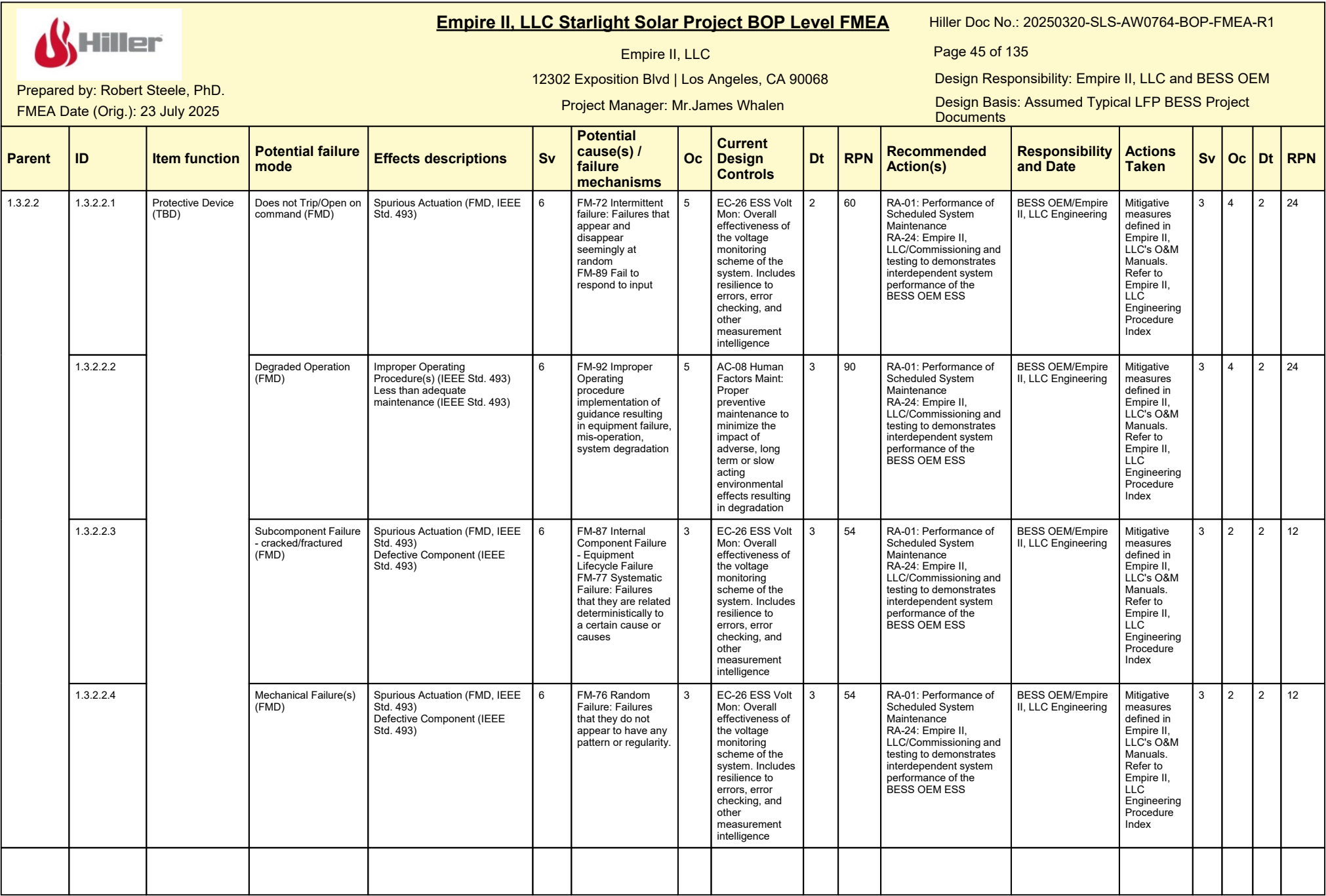
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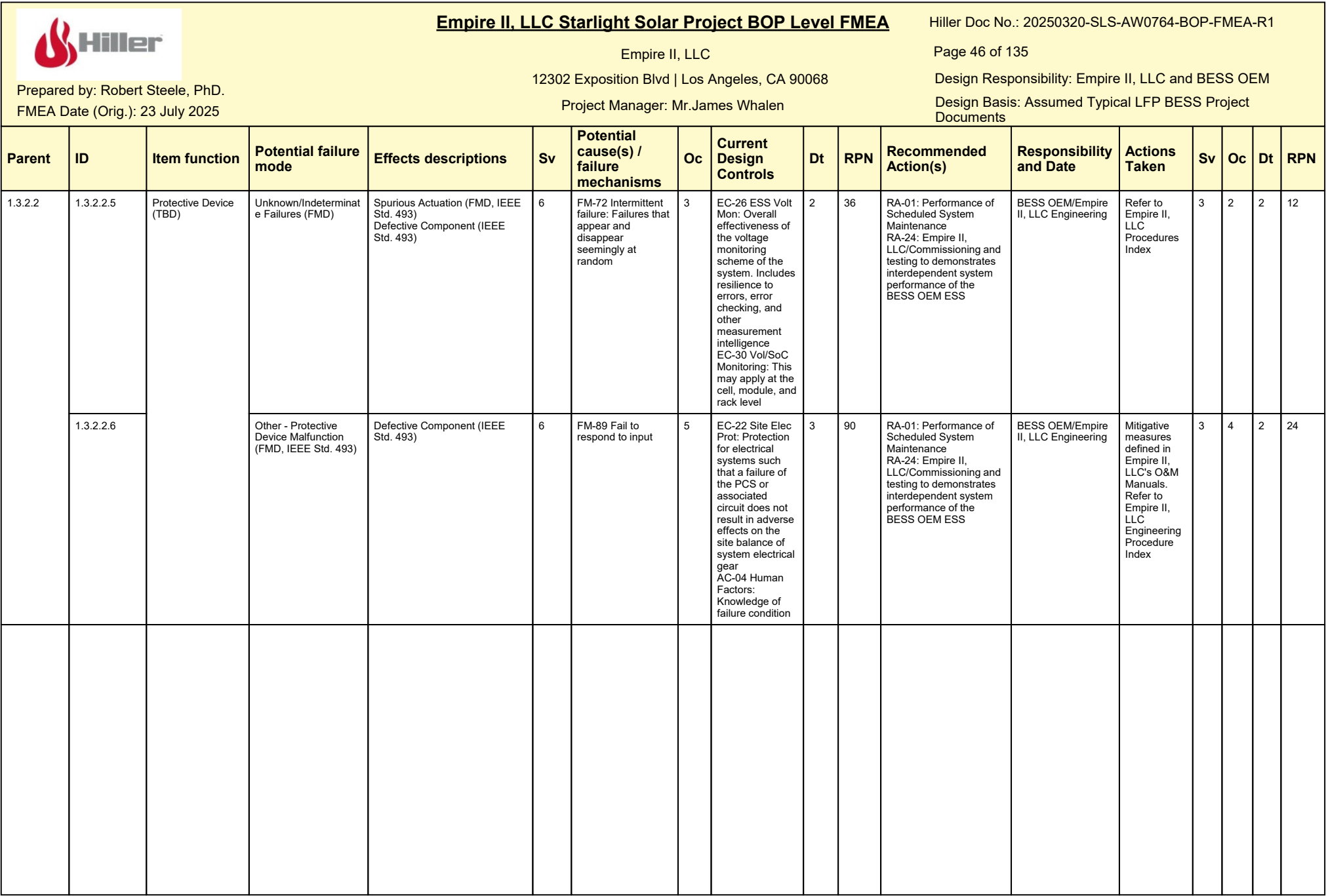
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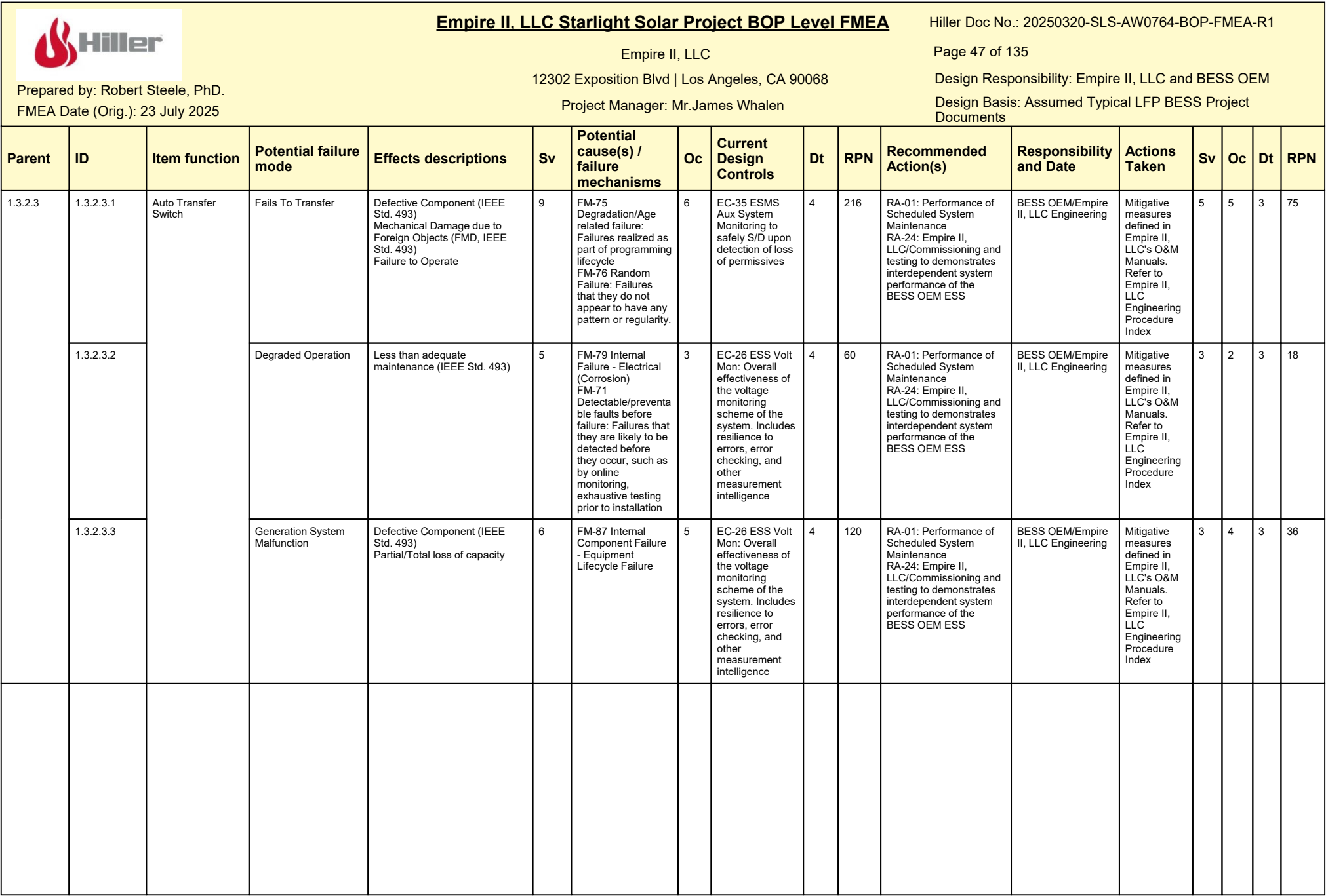
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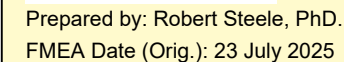
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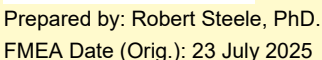


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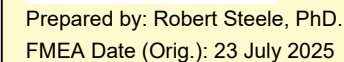


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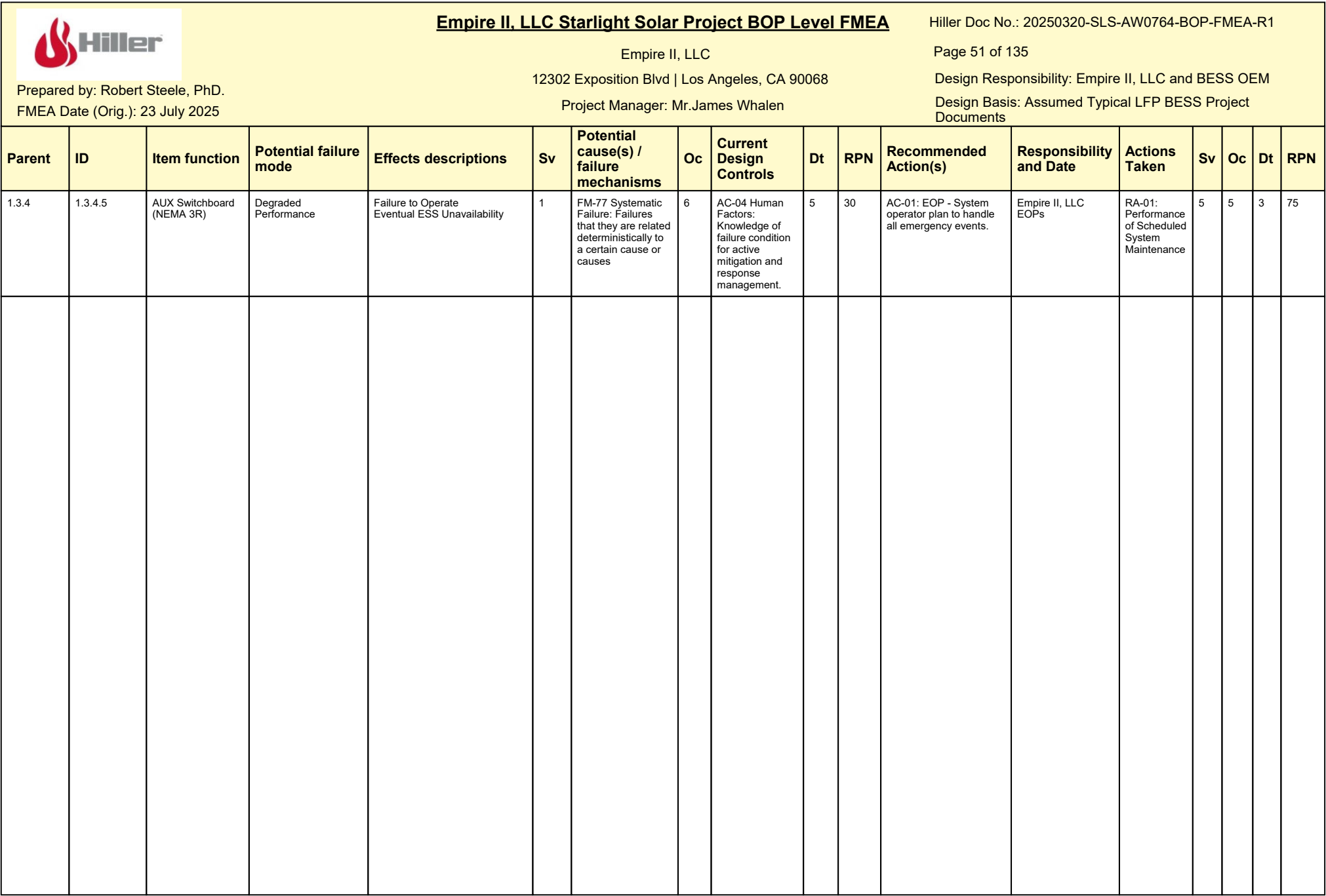
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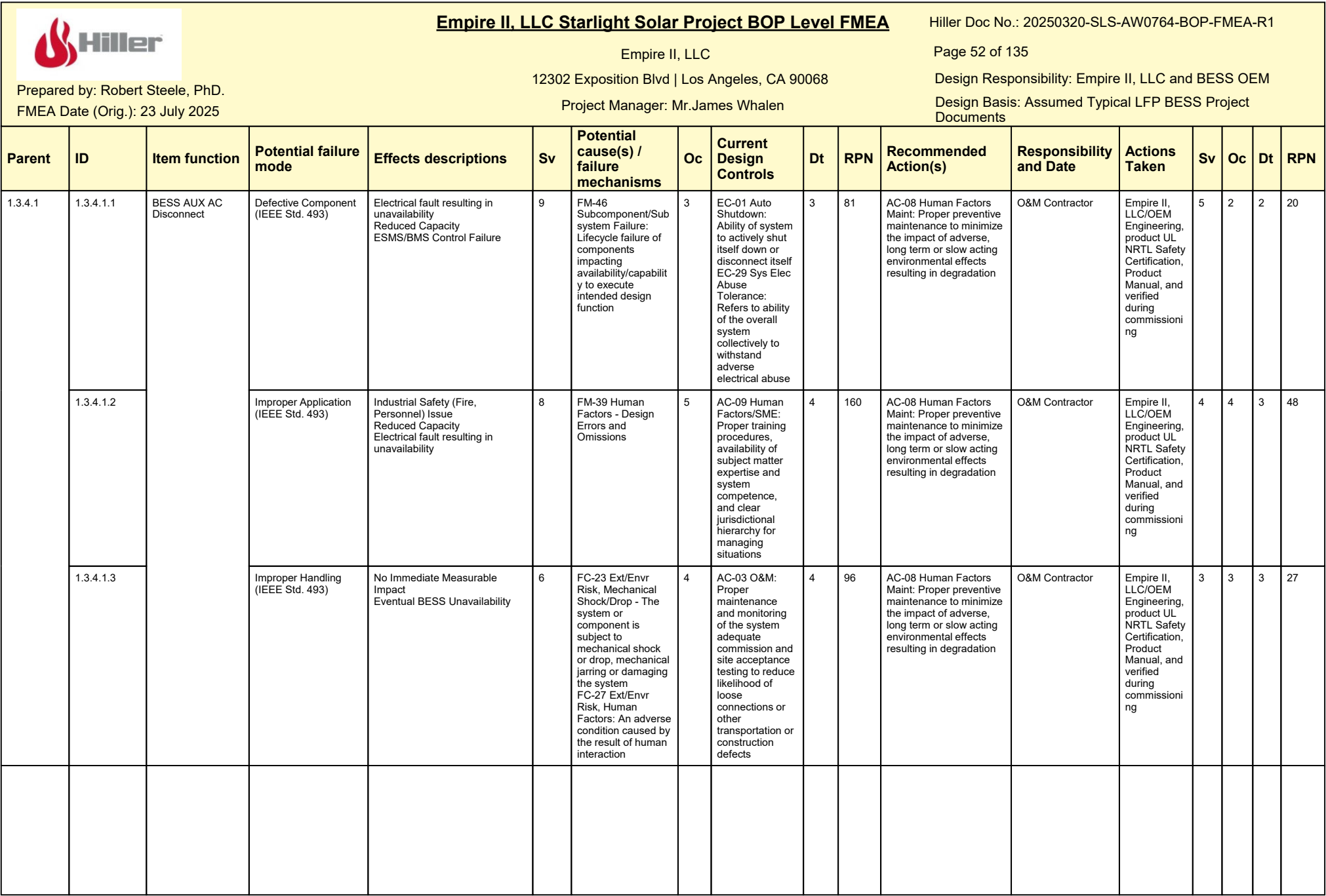
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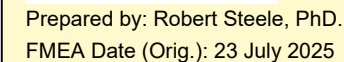
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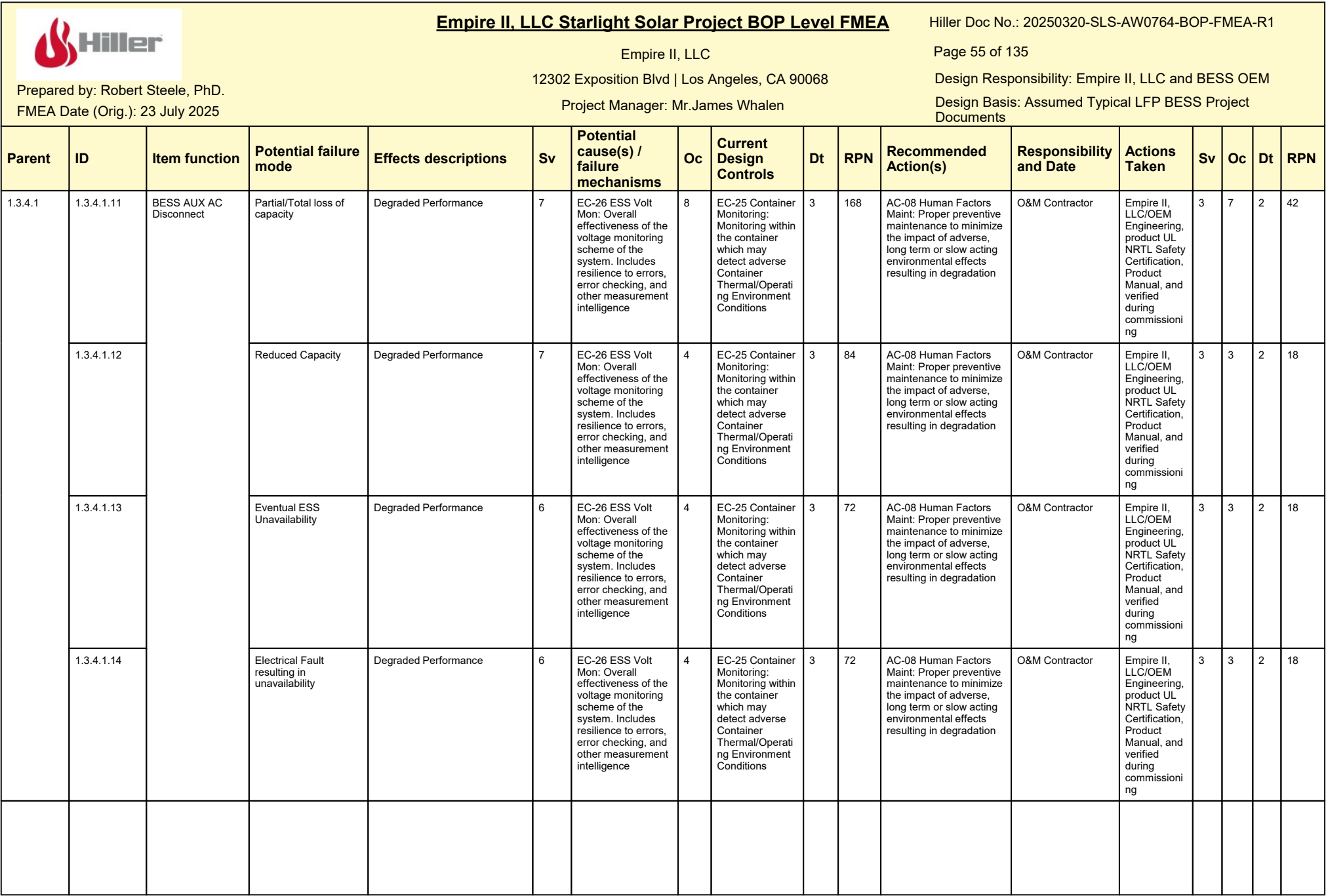
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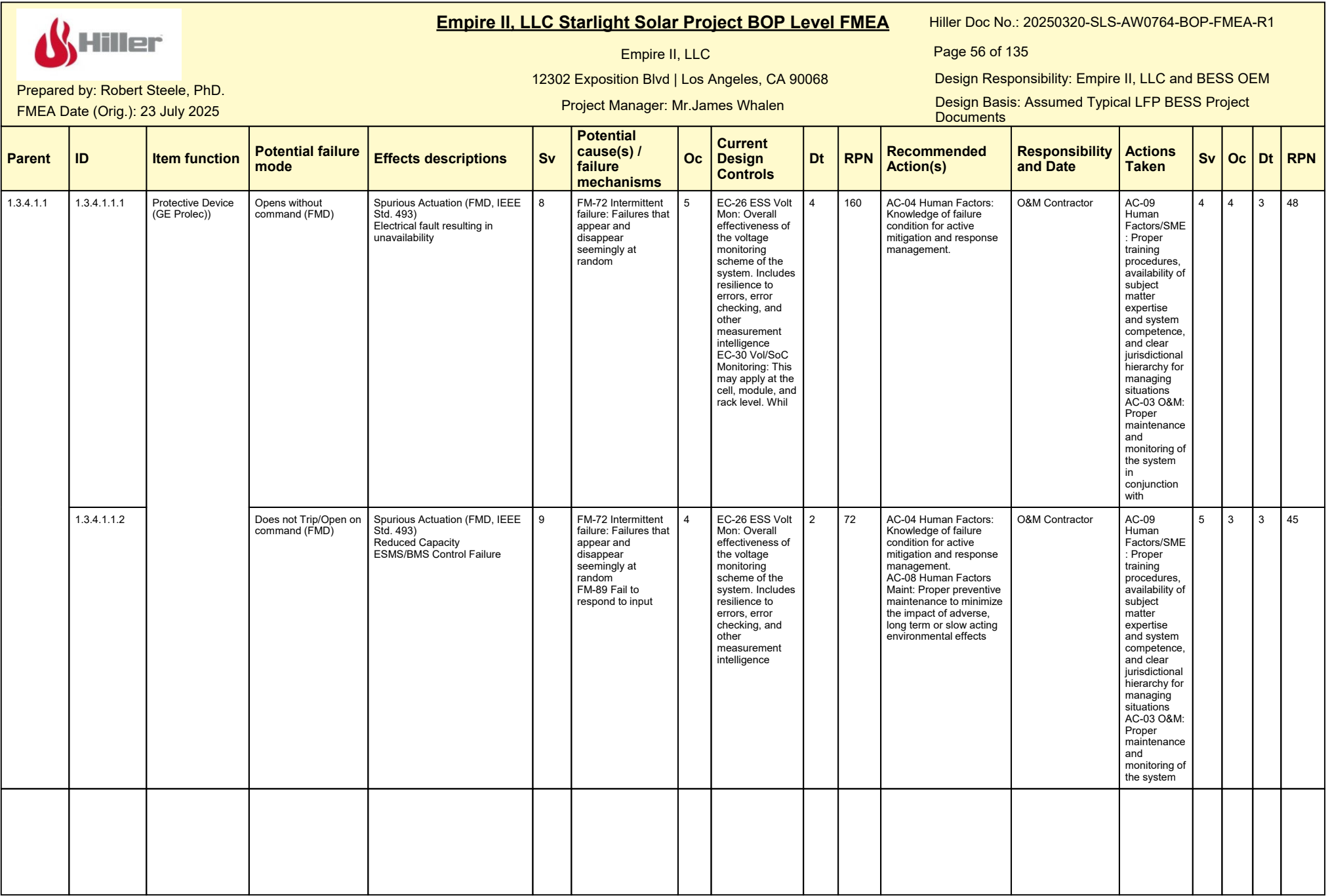
FMEA Date (Orig.): 23 July 2025

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	Oc	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Oc	Dt	RPN
1.3.4.1	1.3.4.1.7	BESS AUX AC 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	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 commissioning	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 commissioning. (*1) Requires validation substantiating 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 commissioning	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 commissioning	4	5	3	60







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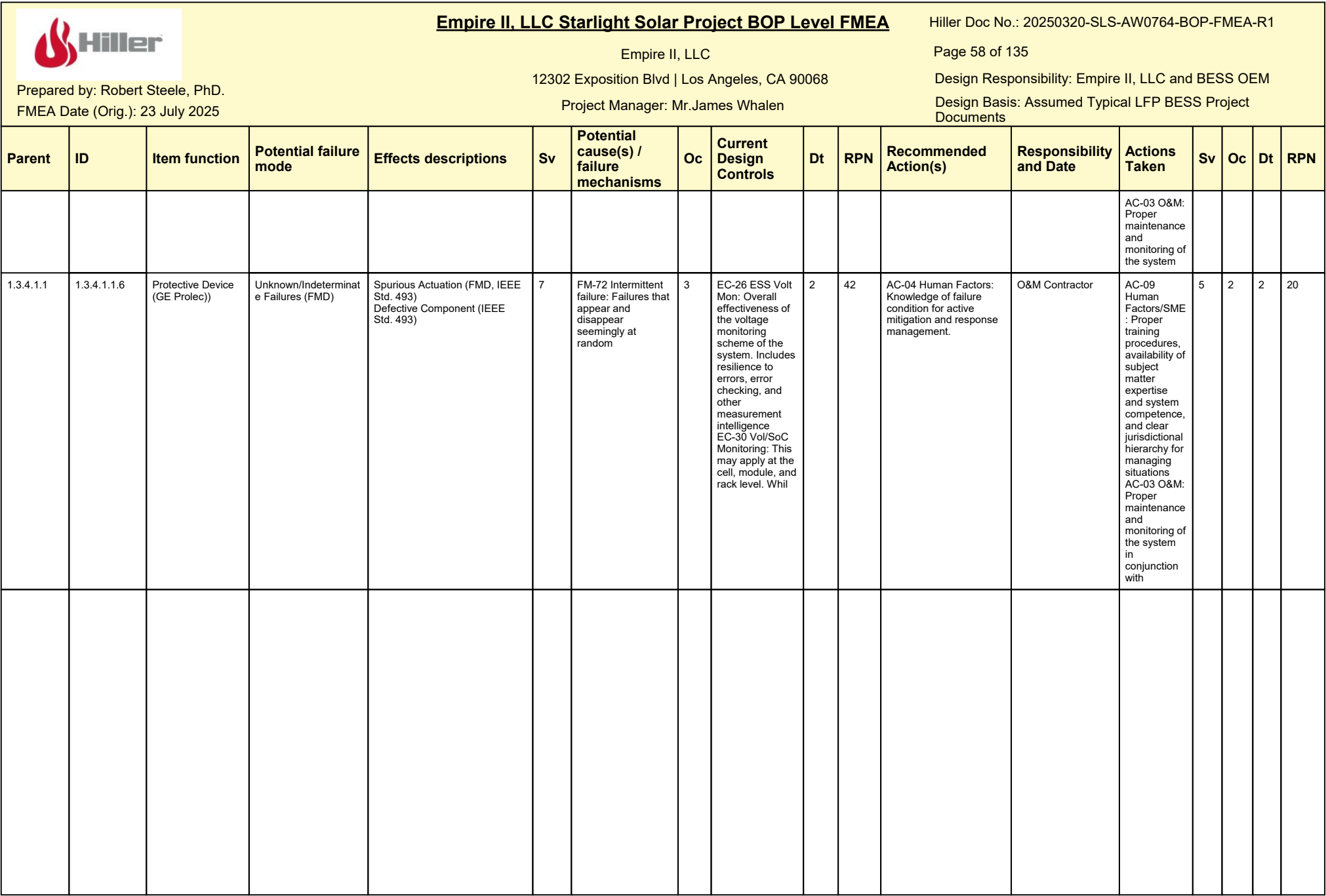
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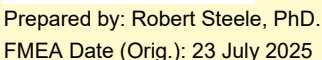
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Project Manager: Mr. James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Oc	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 Protec))	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



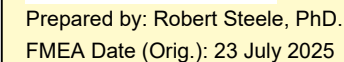


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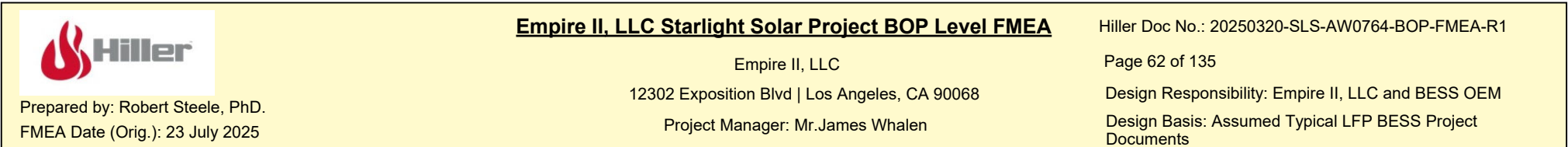
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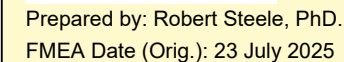
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Design Basis: Assumed Typical LFP BESS Project Documents

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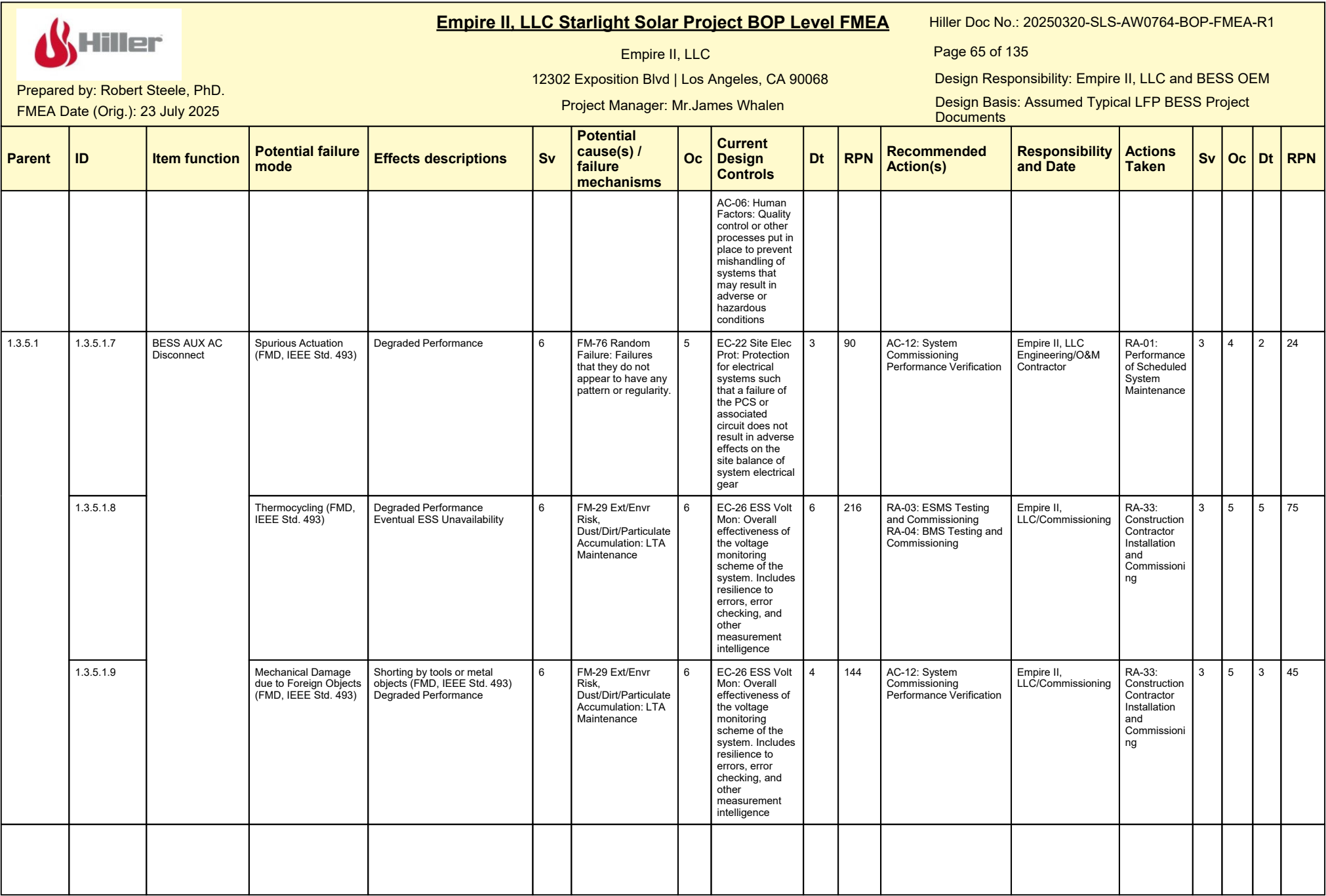
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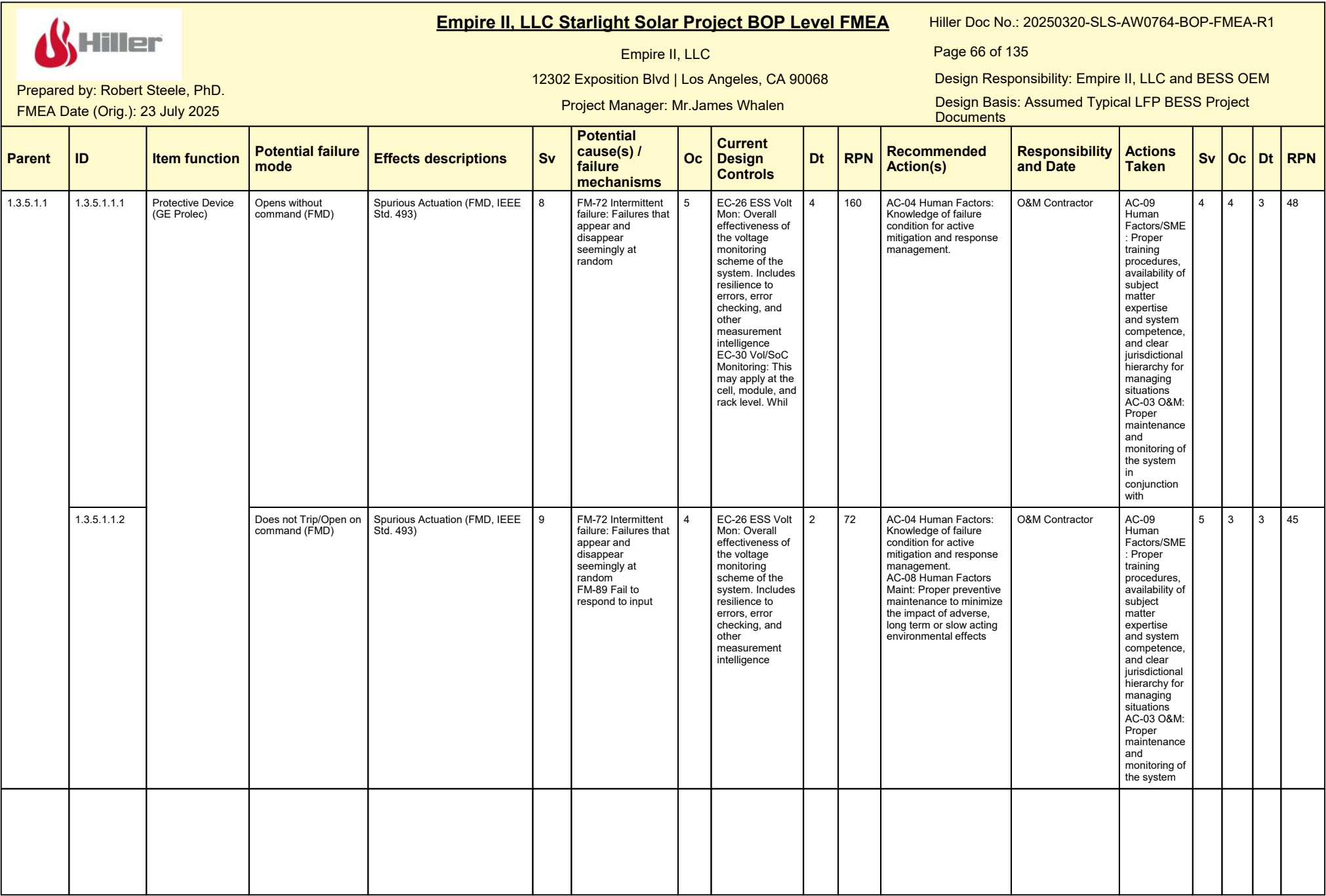
FMEA Date (Orig.): 23 July 2025

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	Oc	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Oc	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







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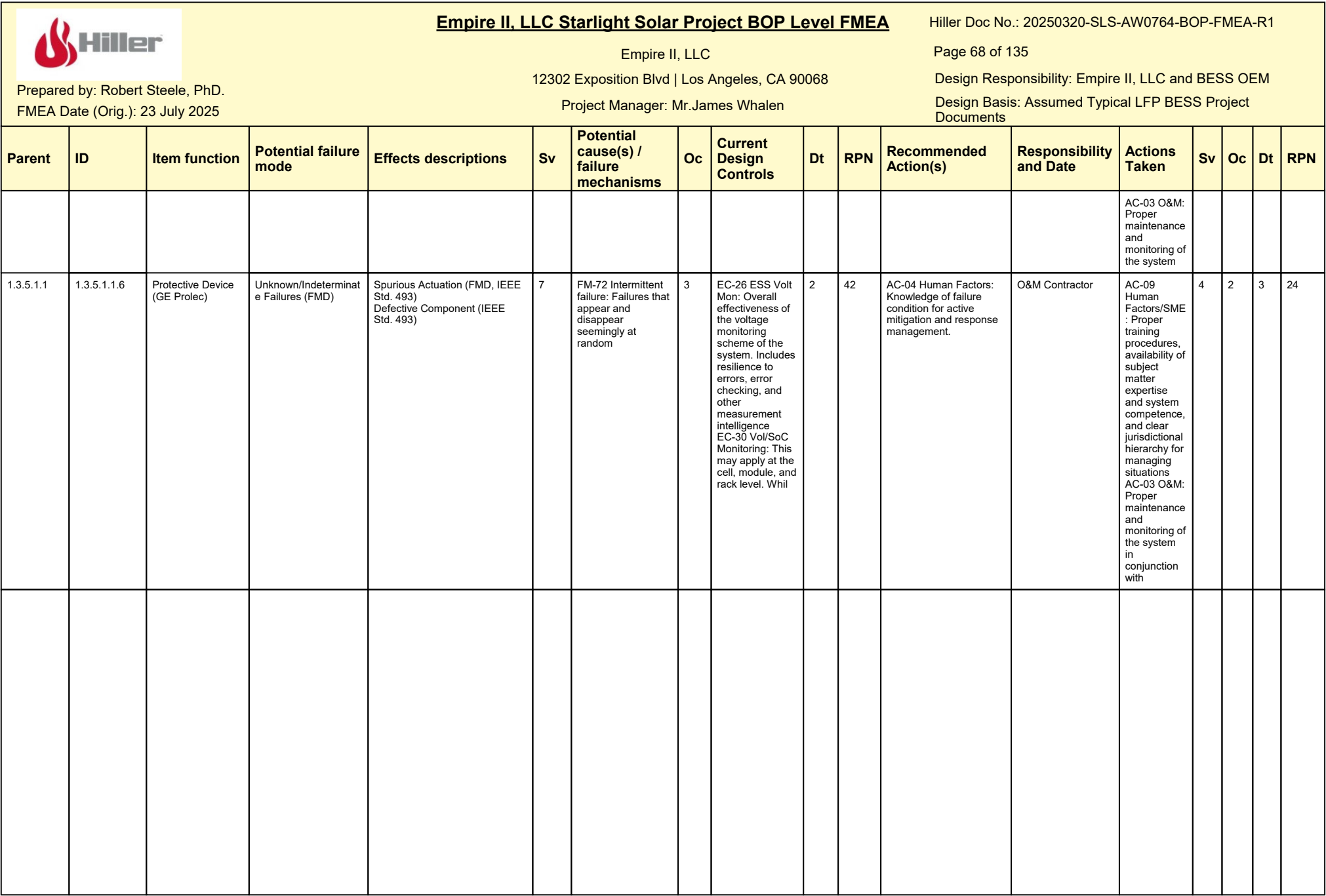
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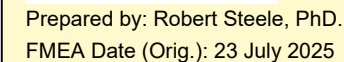
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Project Manager: Mr. James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Oc	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Oc	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





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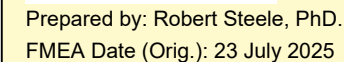
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Design Responsibility: Empire II, LLC and BESS OEM

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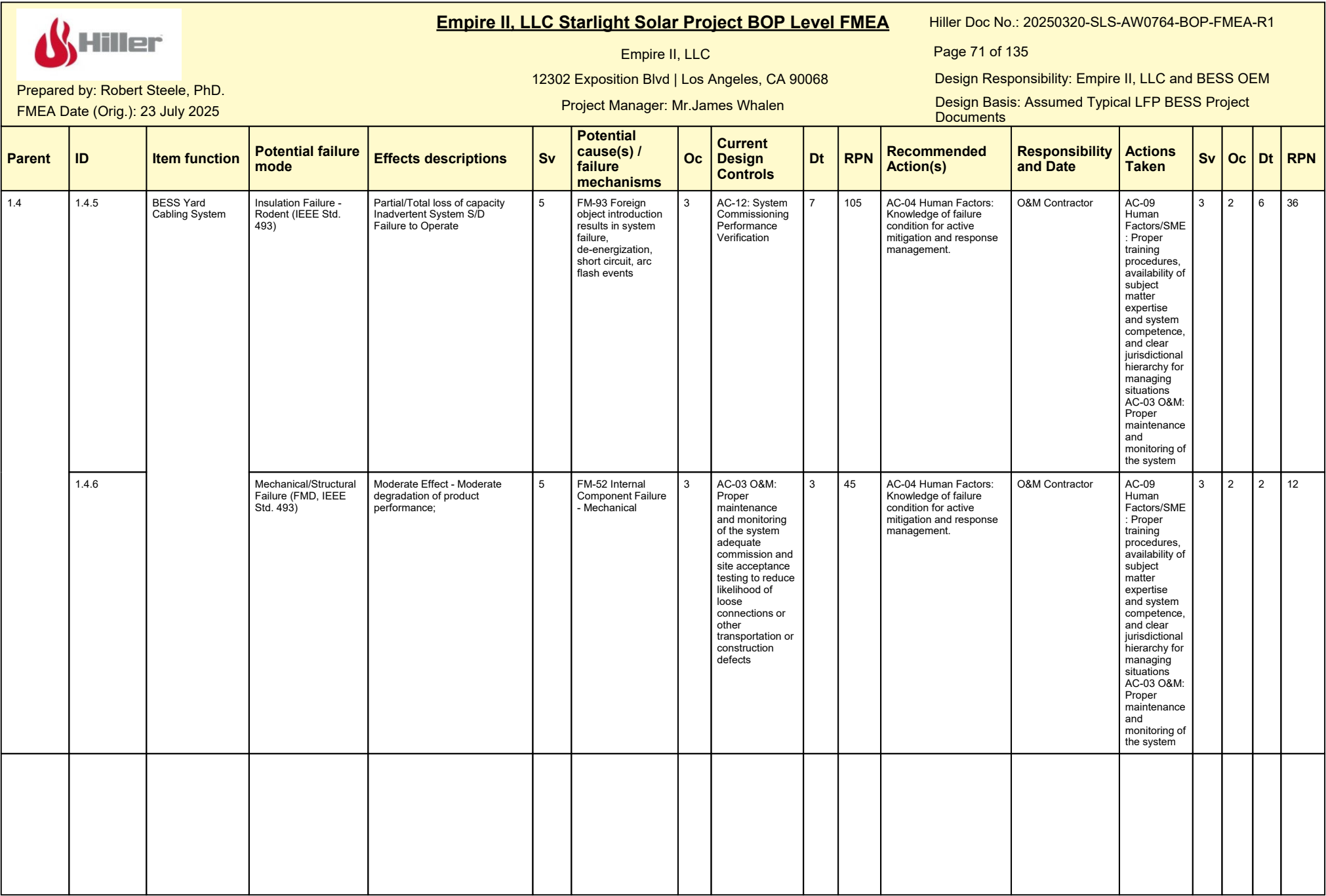
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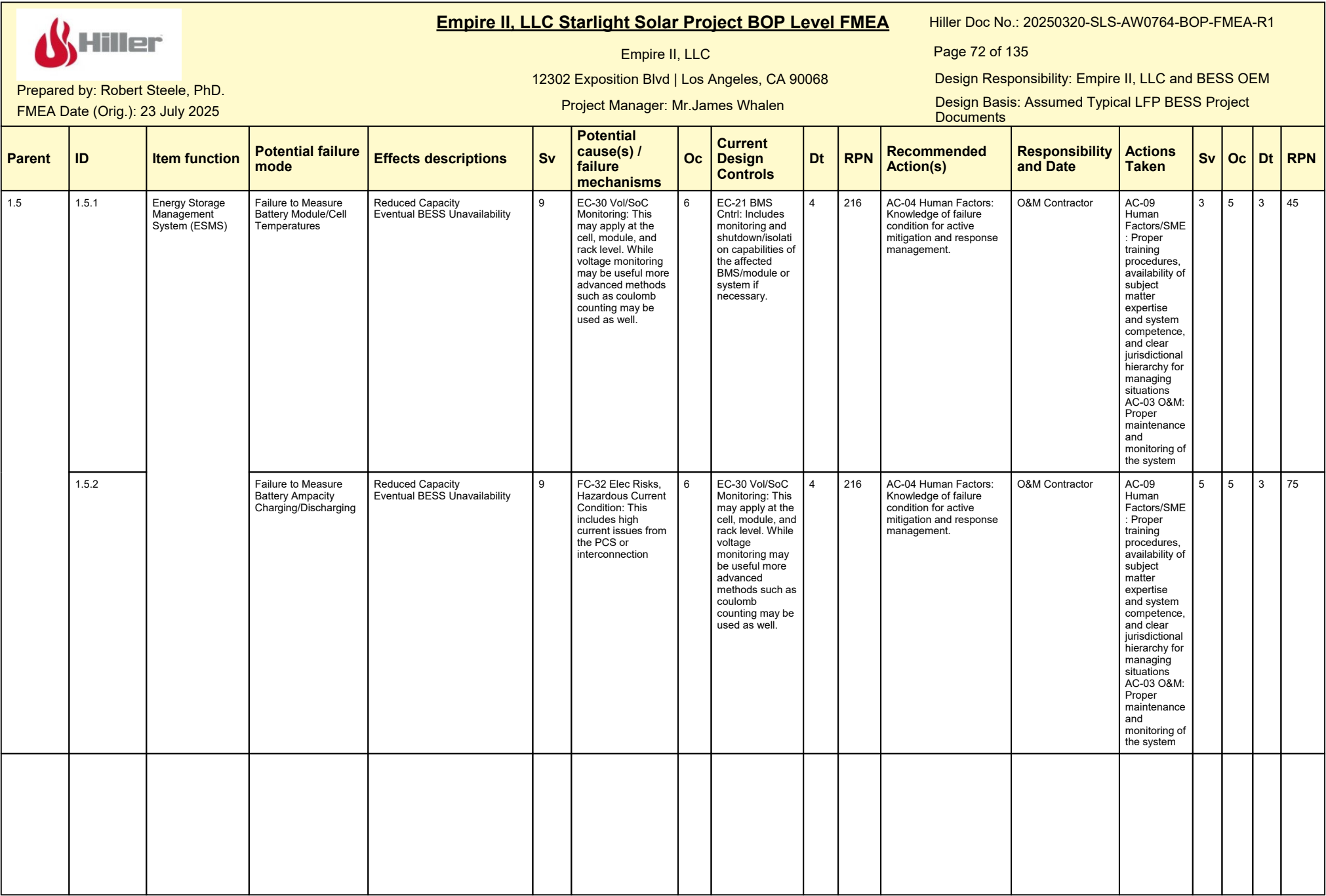
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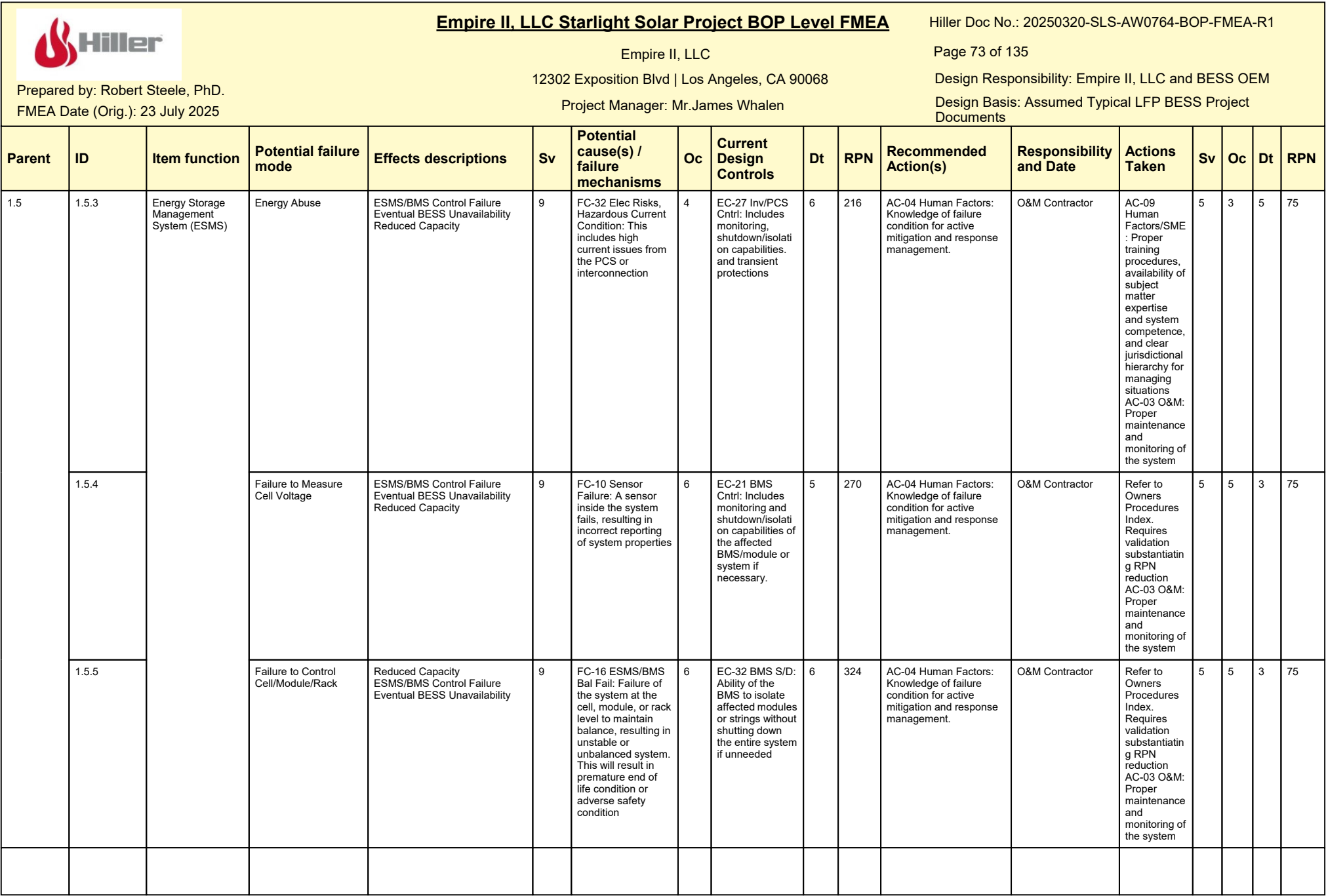
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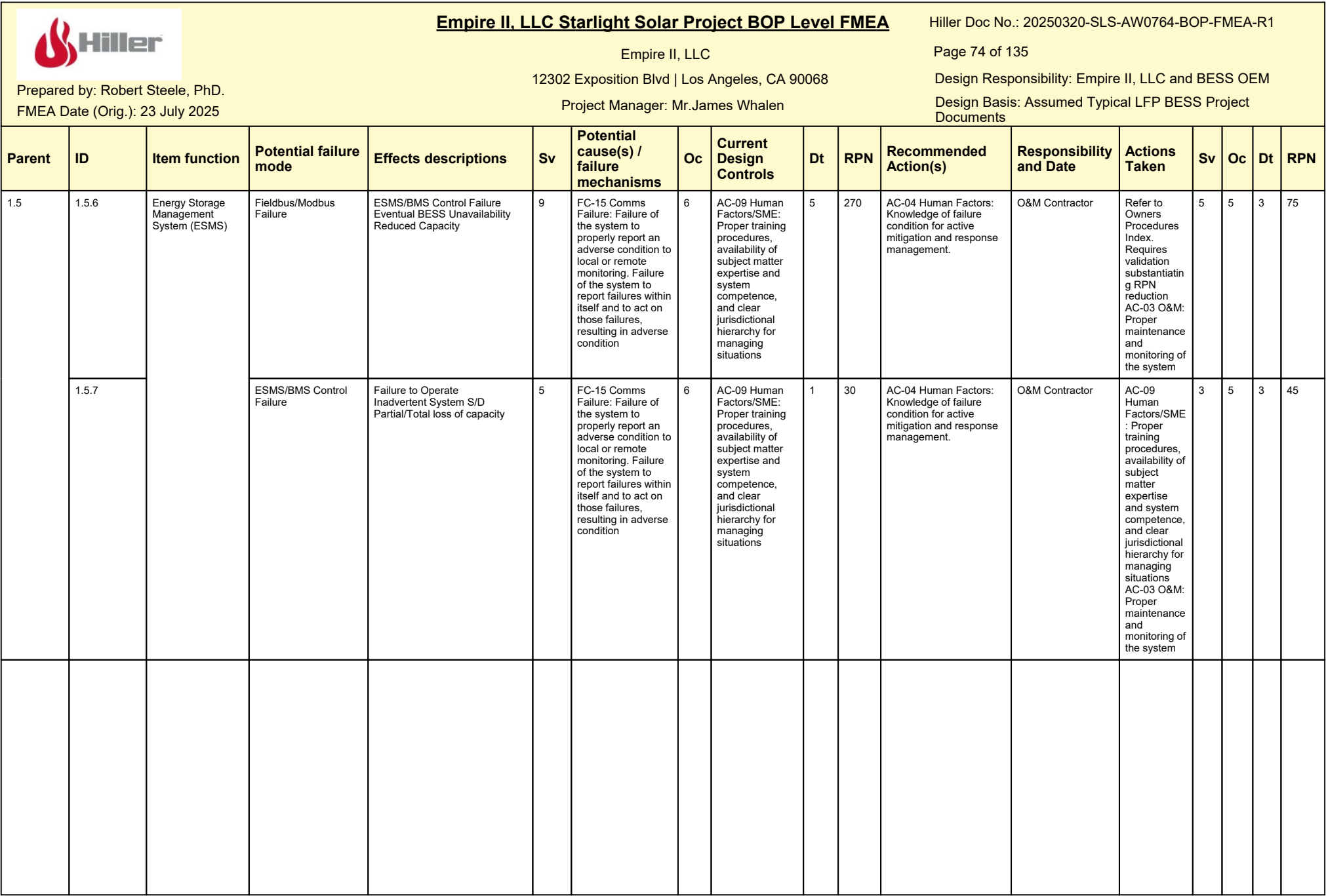
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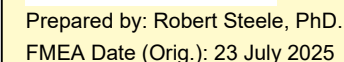
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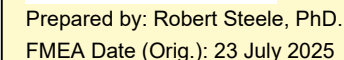
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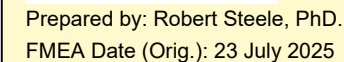


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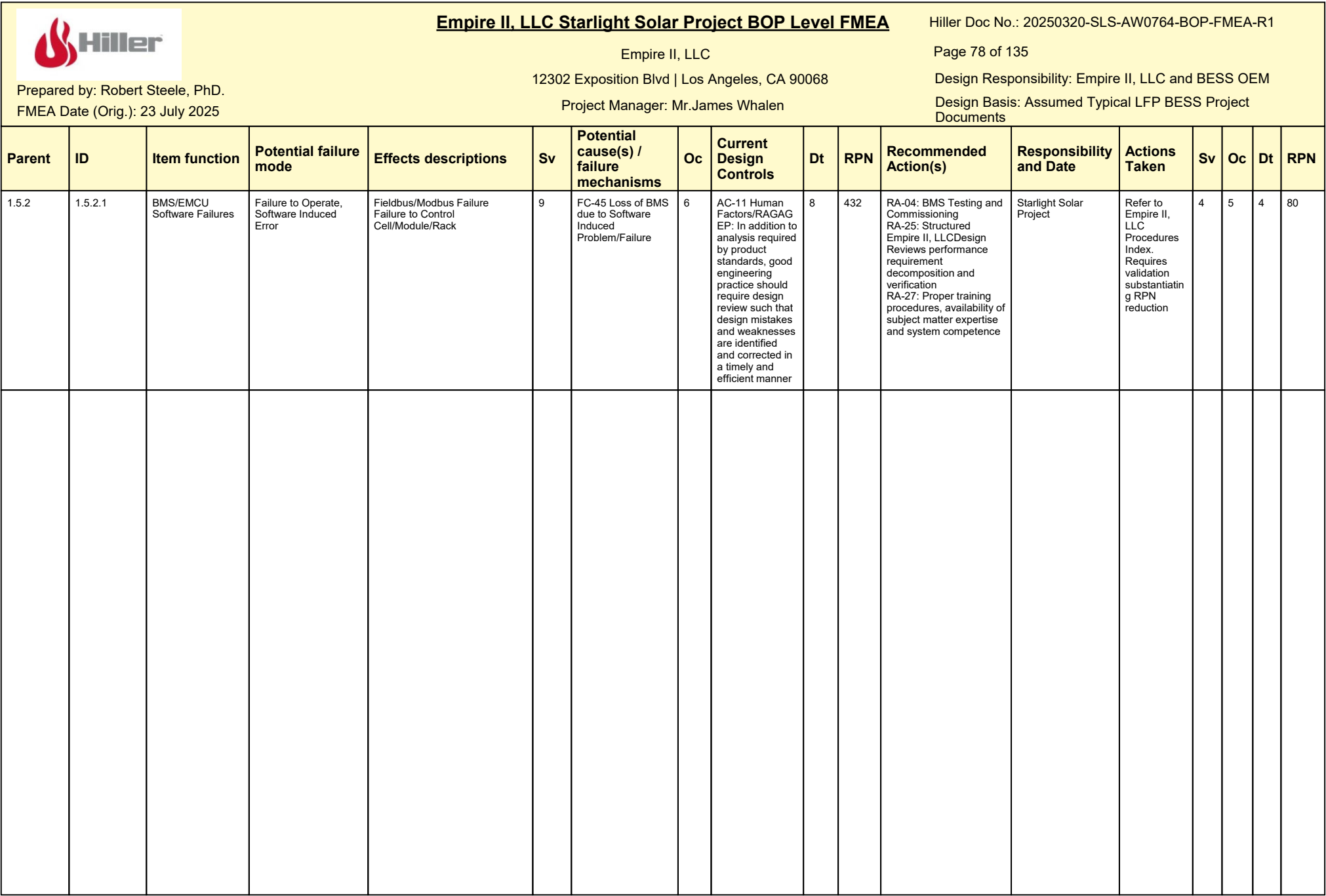


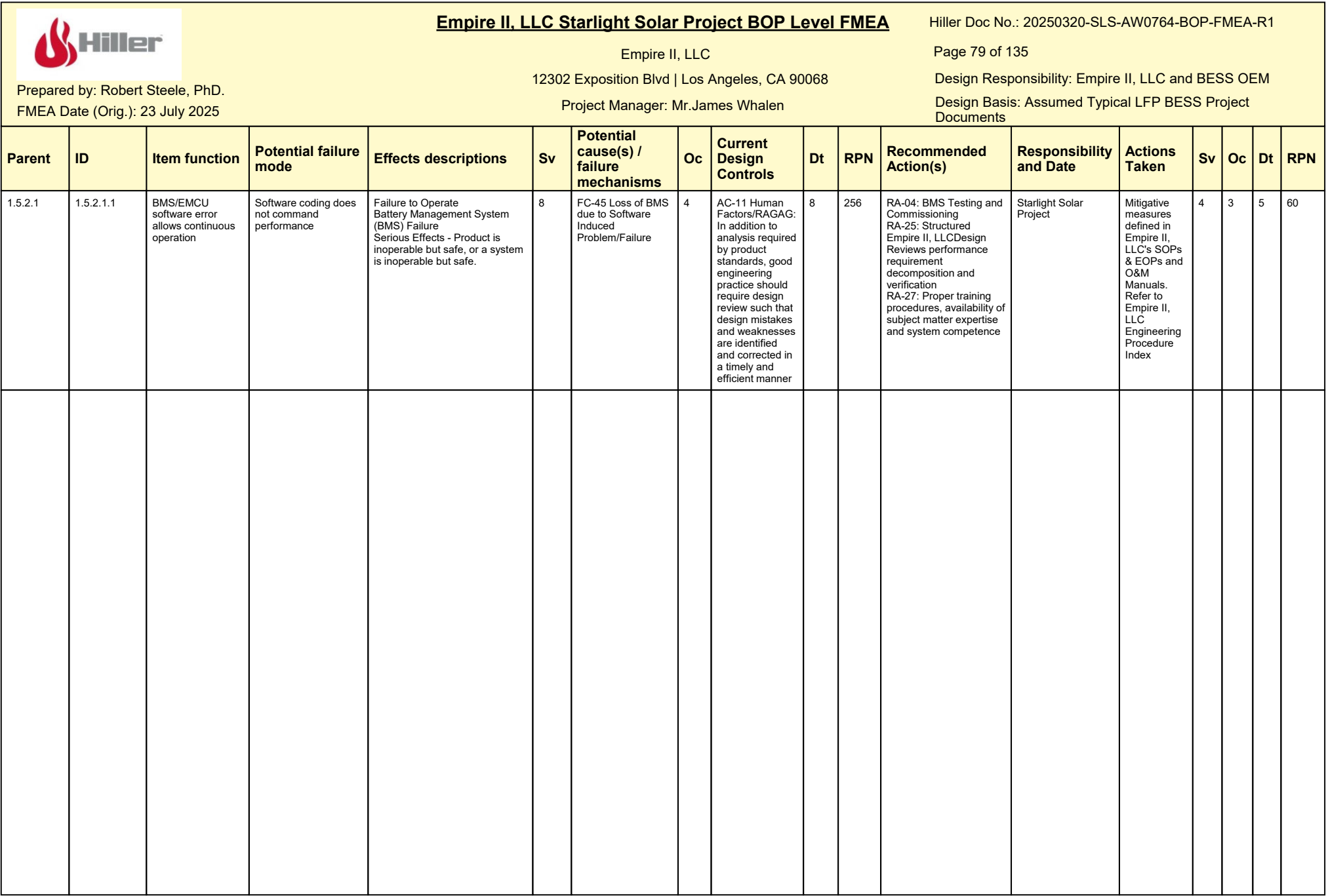
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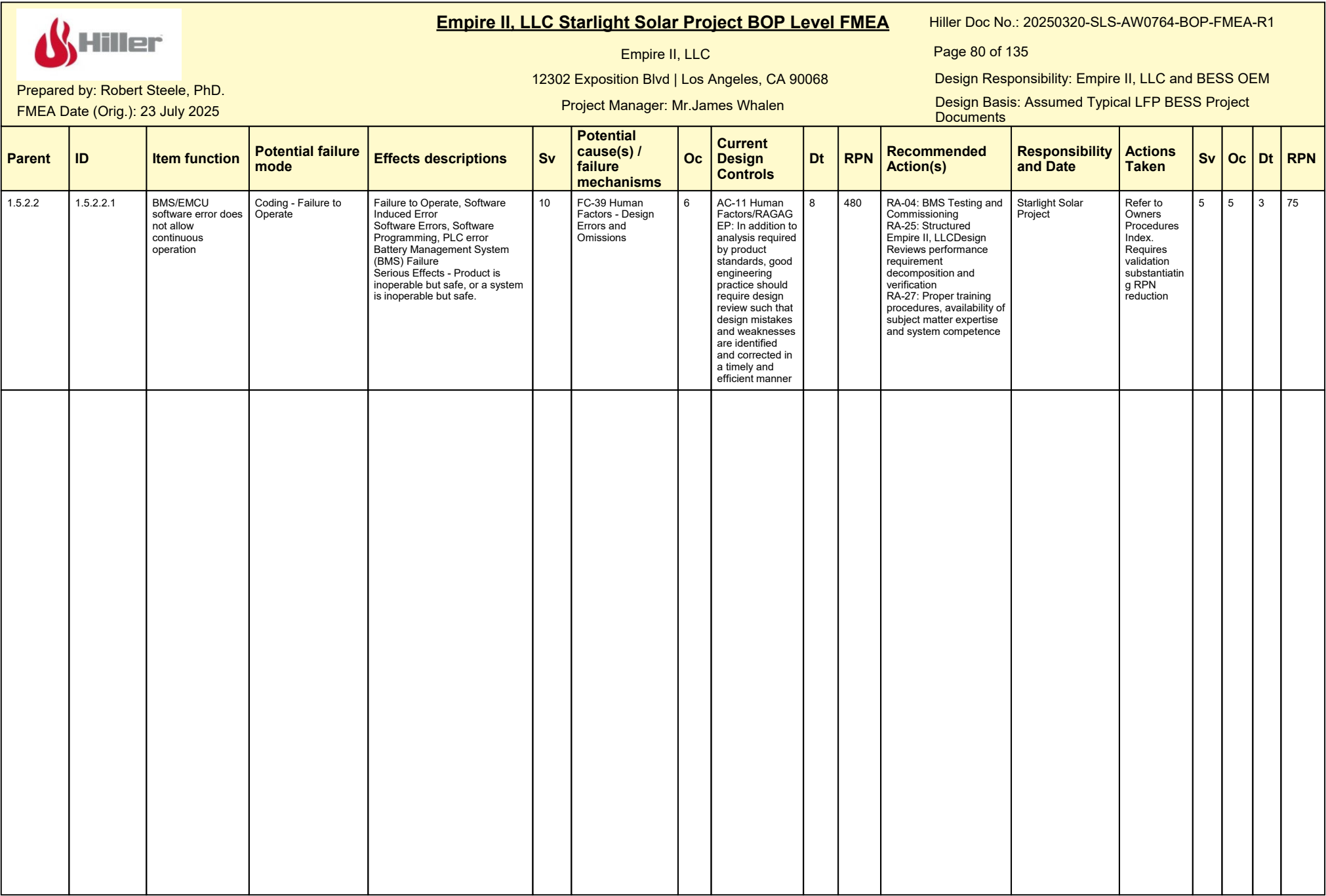
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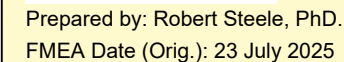
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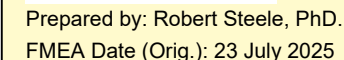


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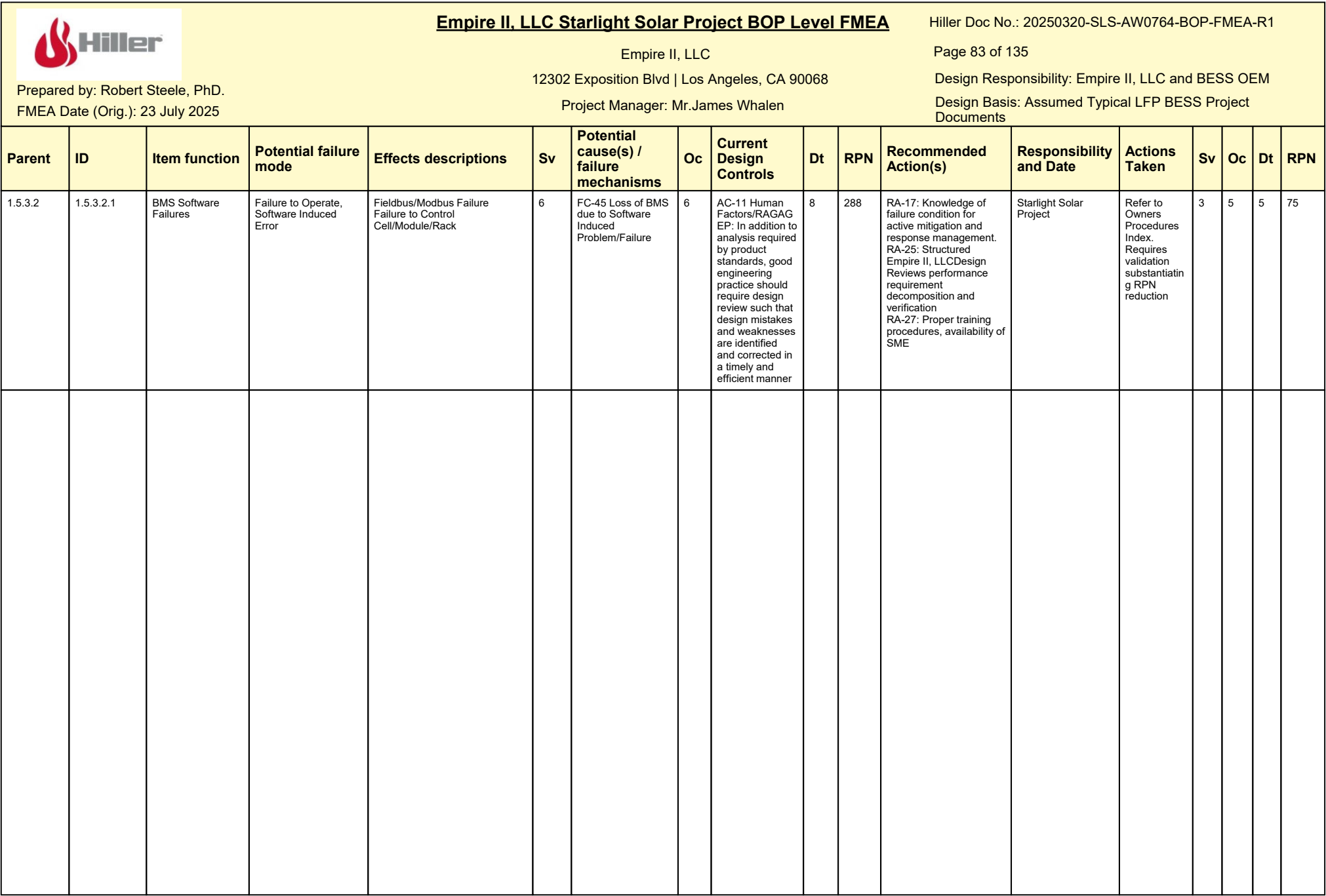


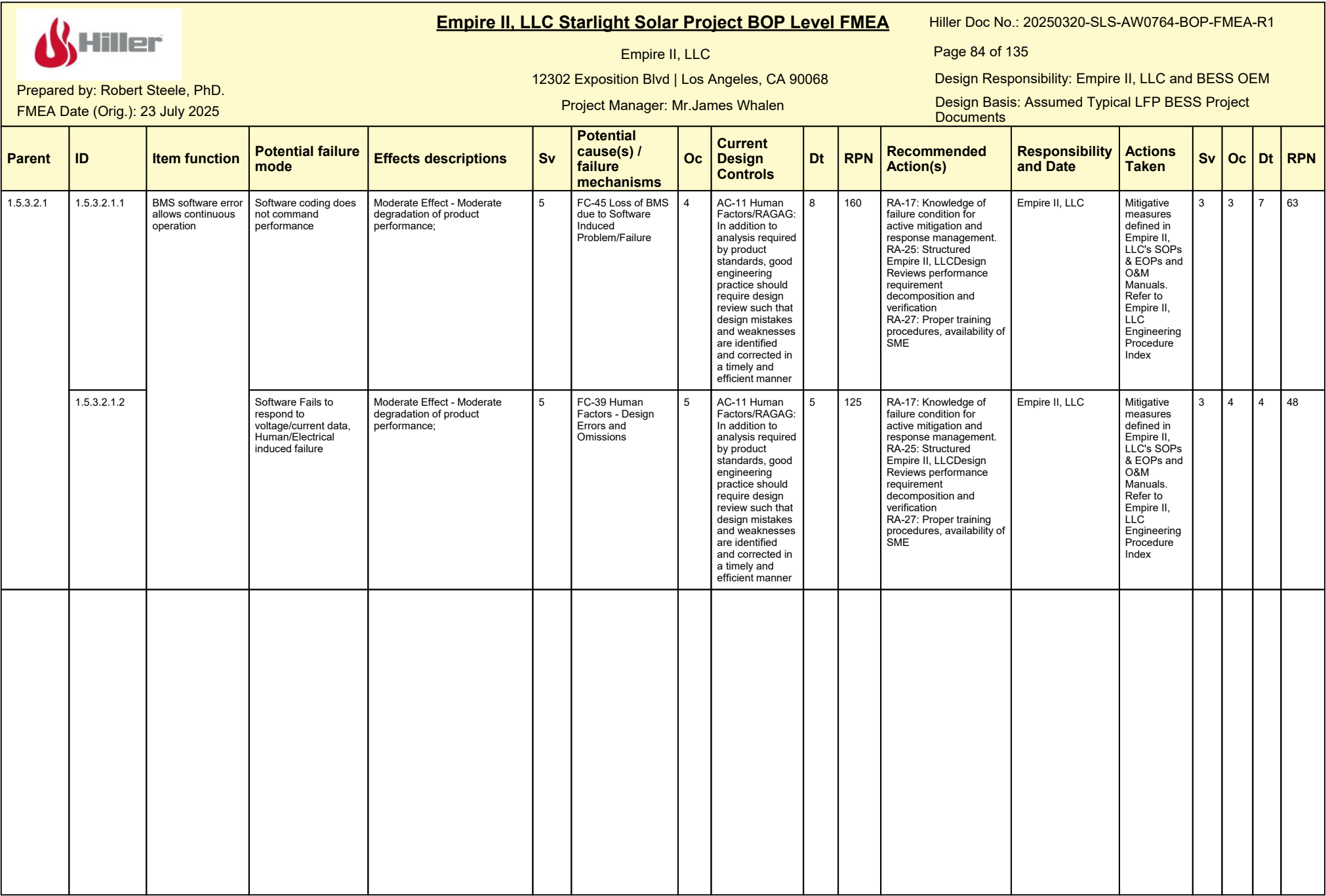
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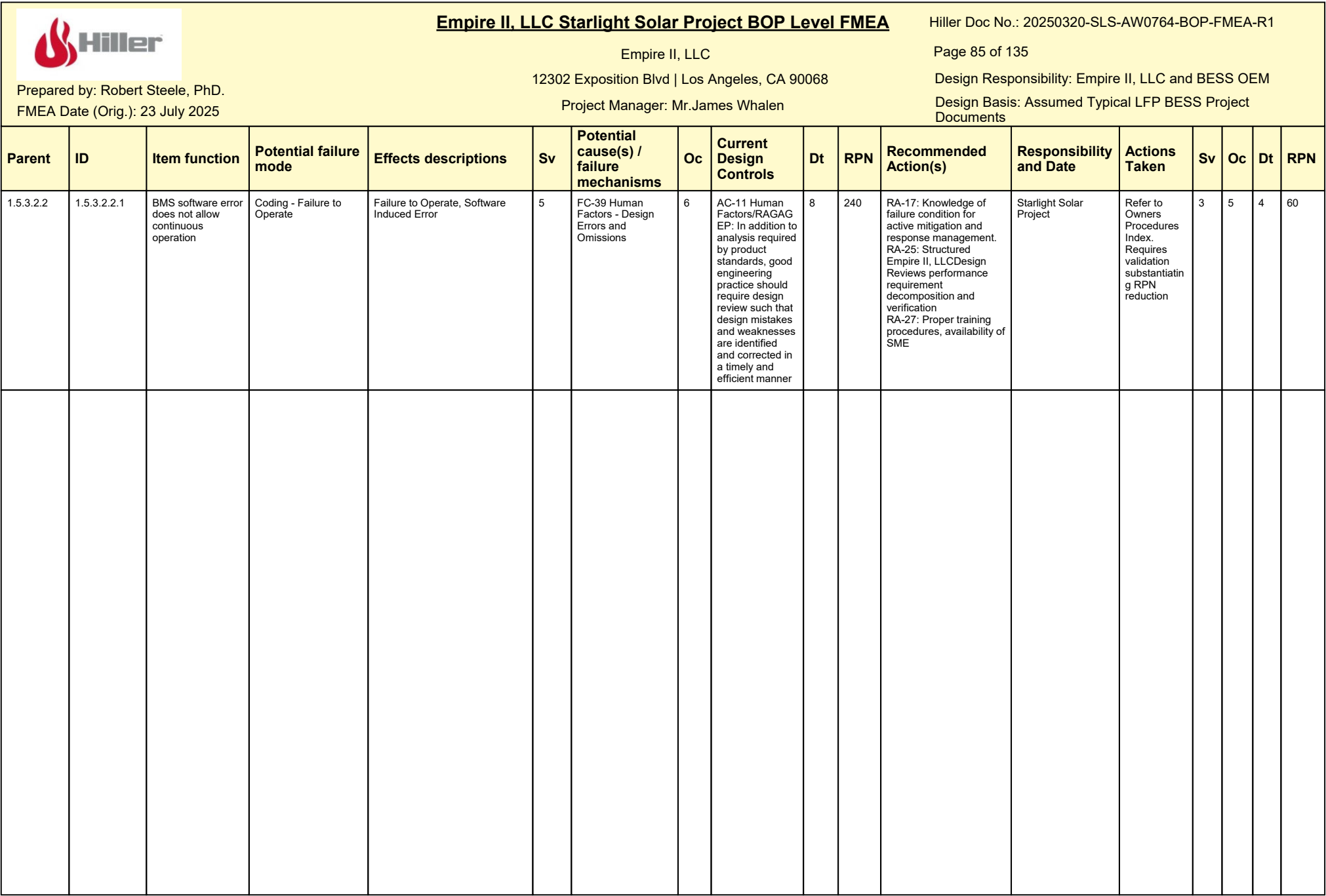
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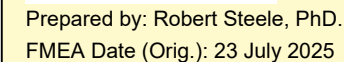
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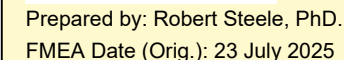
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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Oc	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Oc	Dt	RPN
1.5.5	1.5.5.5	ESMS/EMCU - General	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 substantiating 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, LLCDesign 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 substantiating 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, LLCDesign Reviews performance requirement decomposition and verification	Starlight Solar Project	Refer to Empire II, LLC Procedures Index	4	3	4	48



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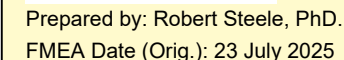
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Project Manager: Mr.James Whalen

Design Basis: Assumed Typical LFP BESS Project Documents

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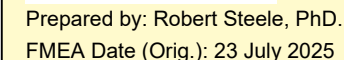


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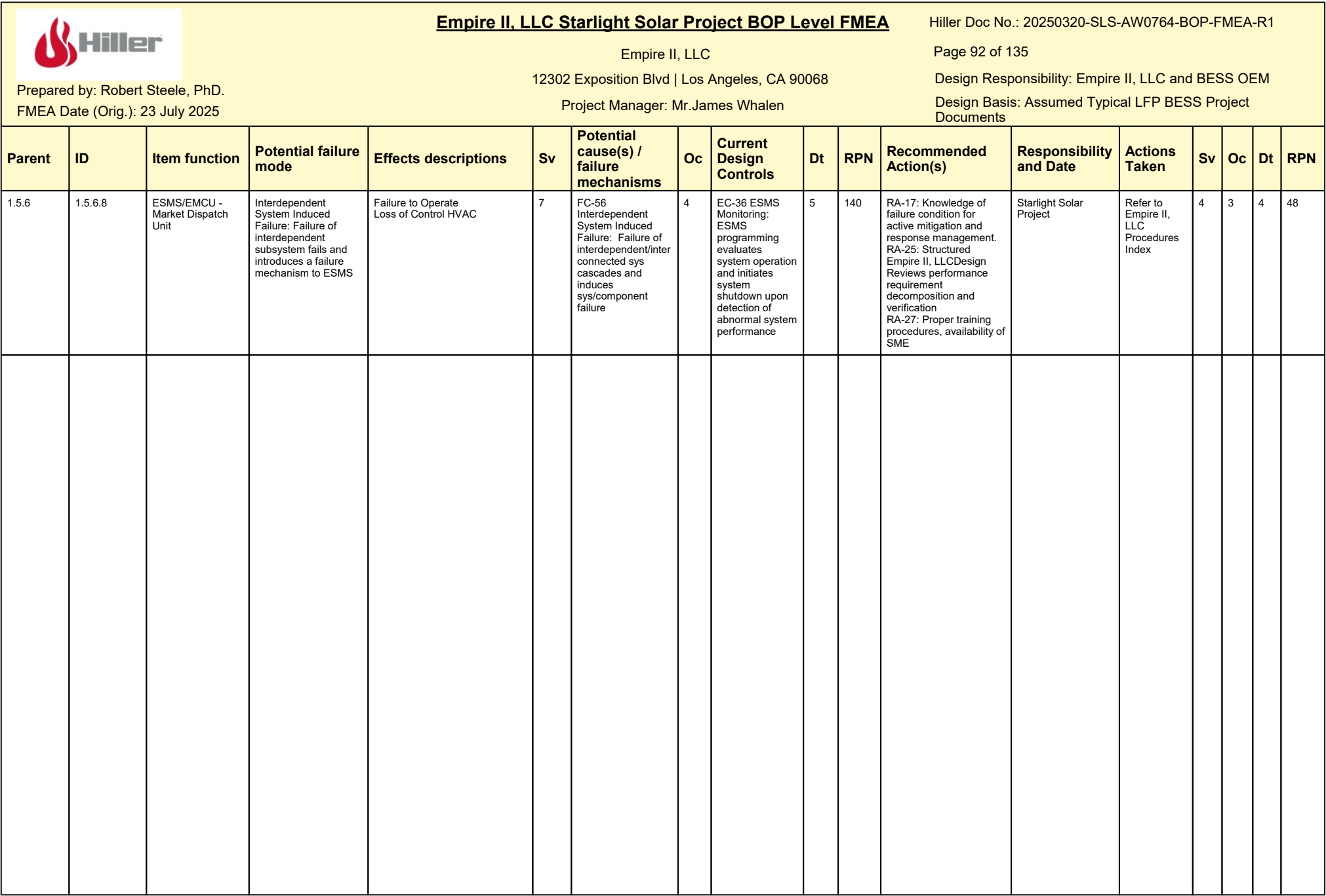


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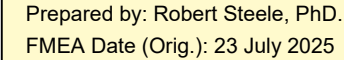
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1.5.7	1.5.7.1	ESMS/EMCU - BESS OEM Array Controller	Loss of Communication	Failure to Operate Battery Management System (BMS) Failure	7	FC-62 Programming Error: A failure resulting from an error in the system software or firmware.	4	AC-11 Human Factors/RAGAG 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, LLC Design 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, LLC Design 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-sequence-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, LLC Design 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, LLC Design 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



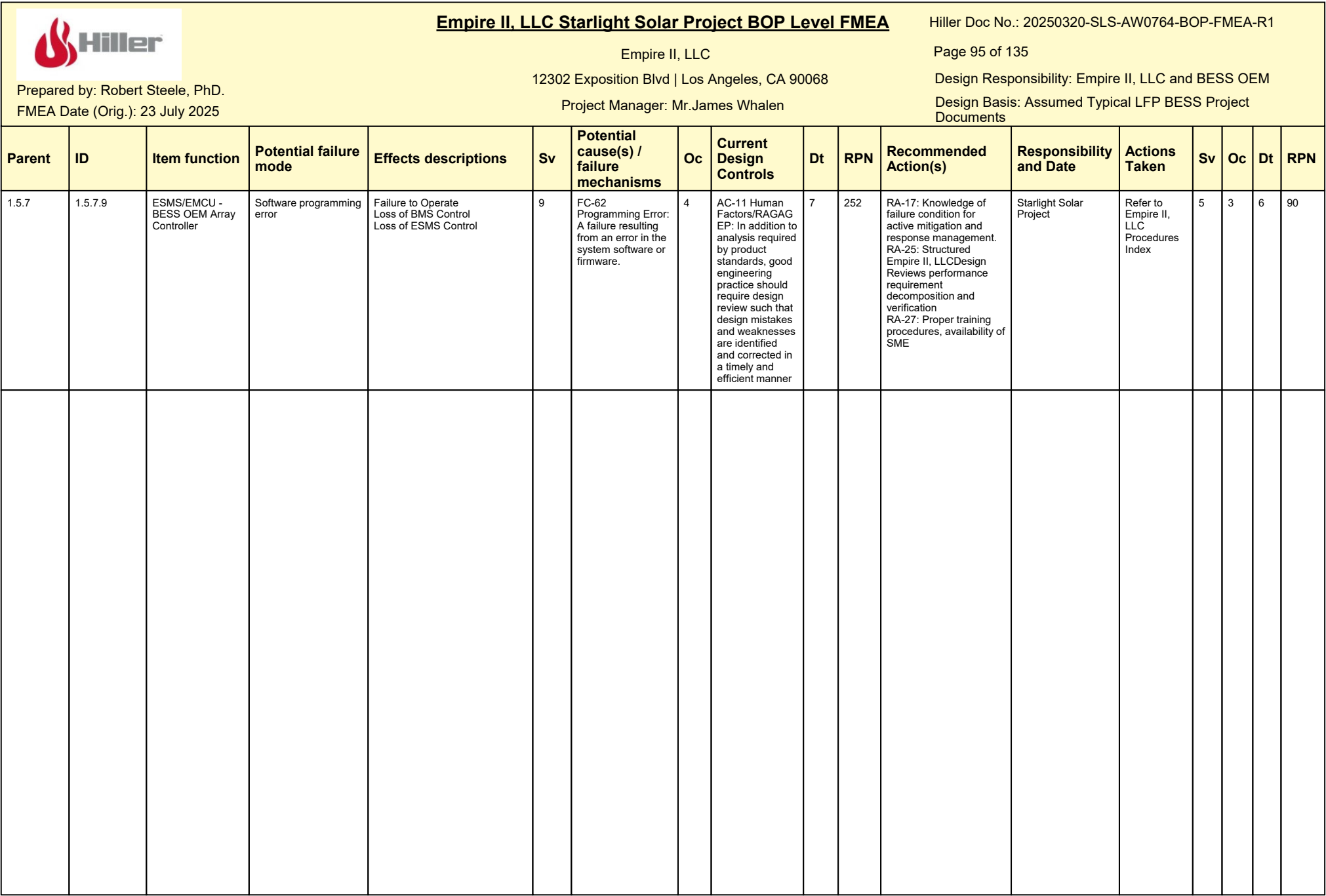
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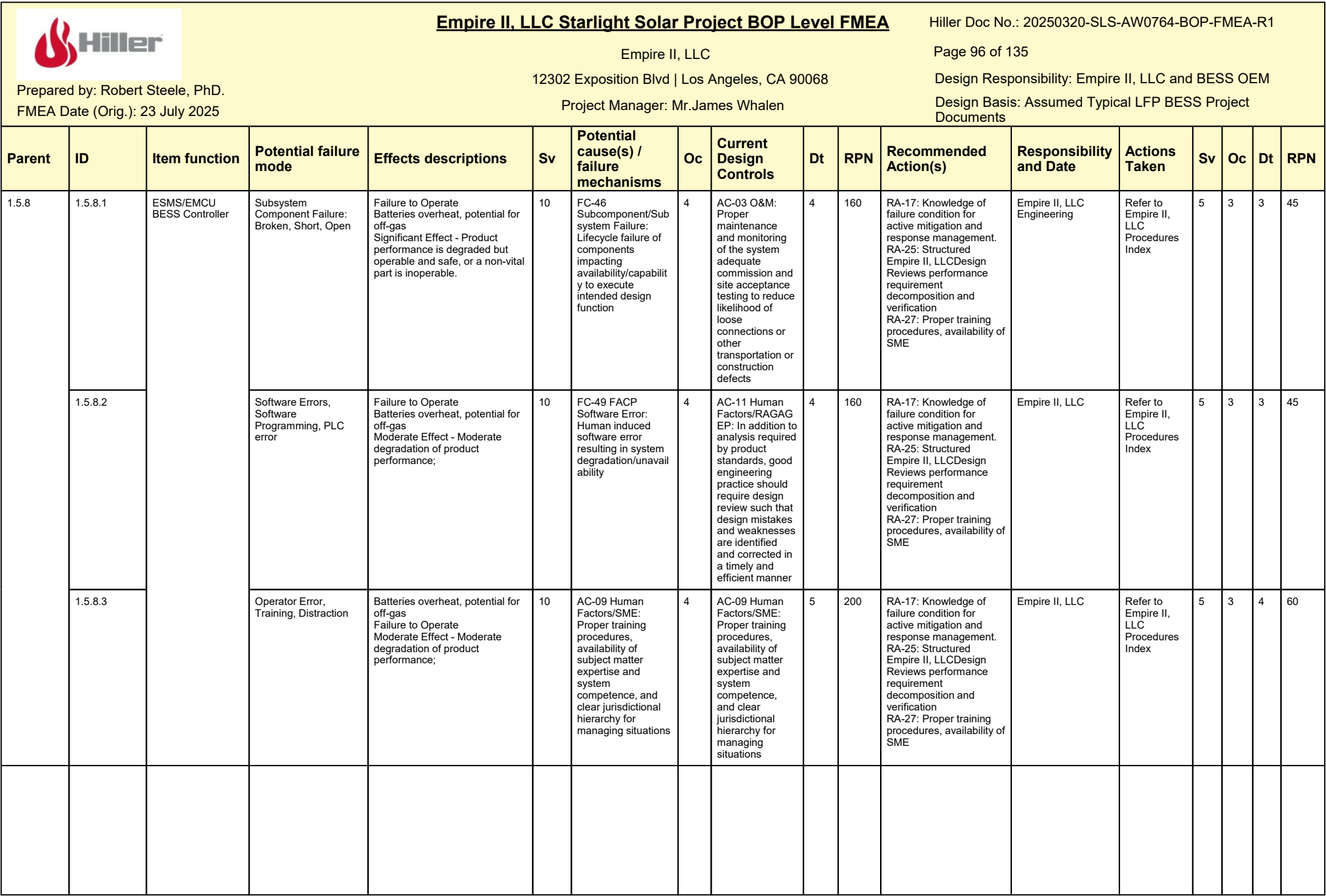
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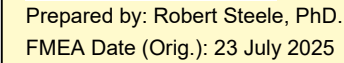
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1.6	1.6.1	BESS Yard Fiber Network	Fiber Network to respond to input data, Human/Electrical induced failure	Failure to Operate Partial/Total loss of capacity	6	FC-39 Human Factors - Design Errors and Omissions	5	AC-11 Human Factors/RAGAG: In addition 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, LLC Design 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, LLC Design 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/Operating Environment Conditions	2	48	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 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, LLC Design 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



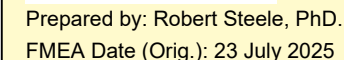
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Design Basis: Assumed Typical LFP BESS Project Documents

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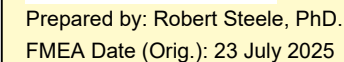


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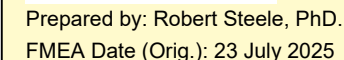
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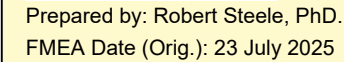


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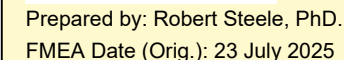
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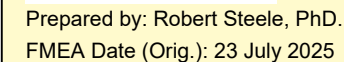


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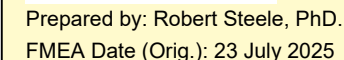


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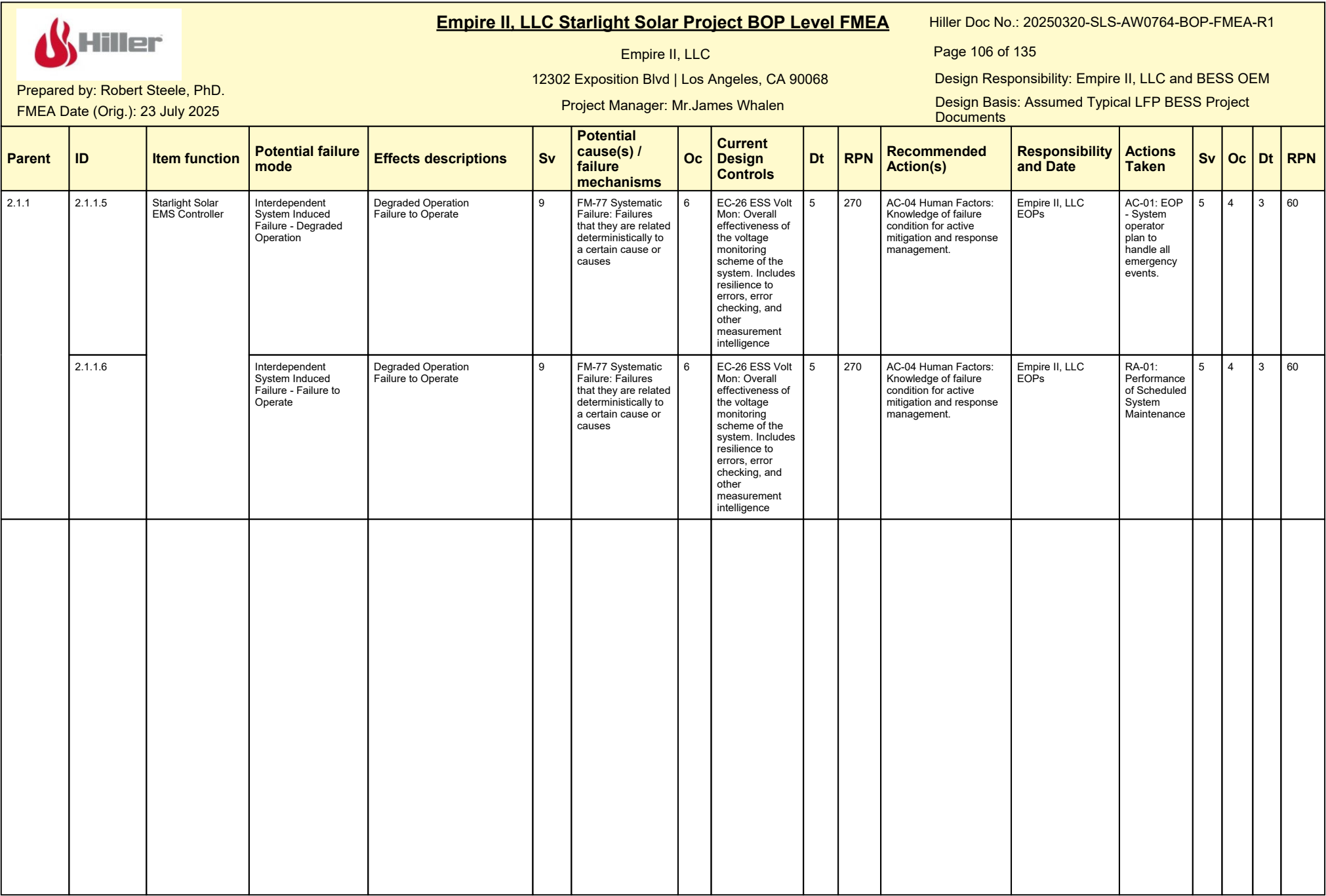


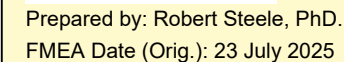
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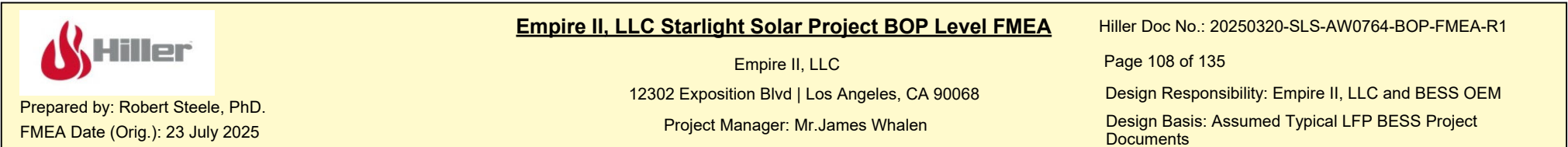
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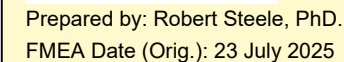
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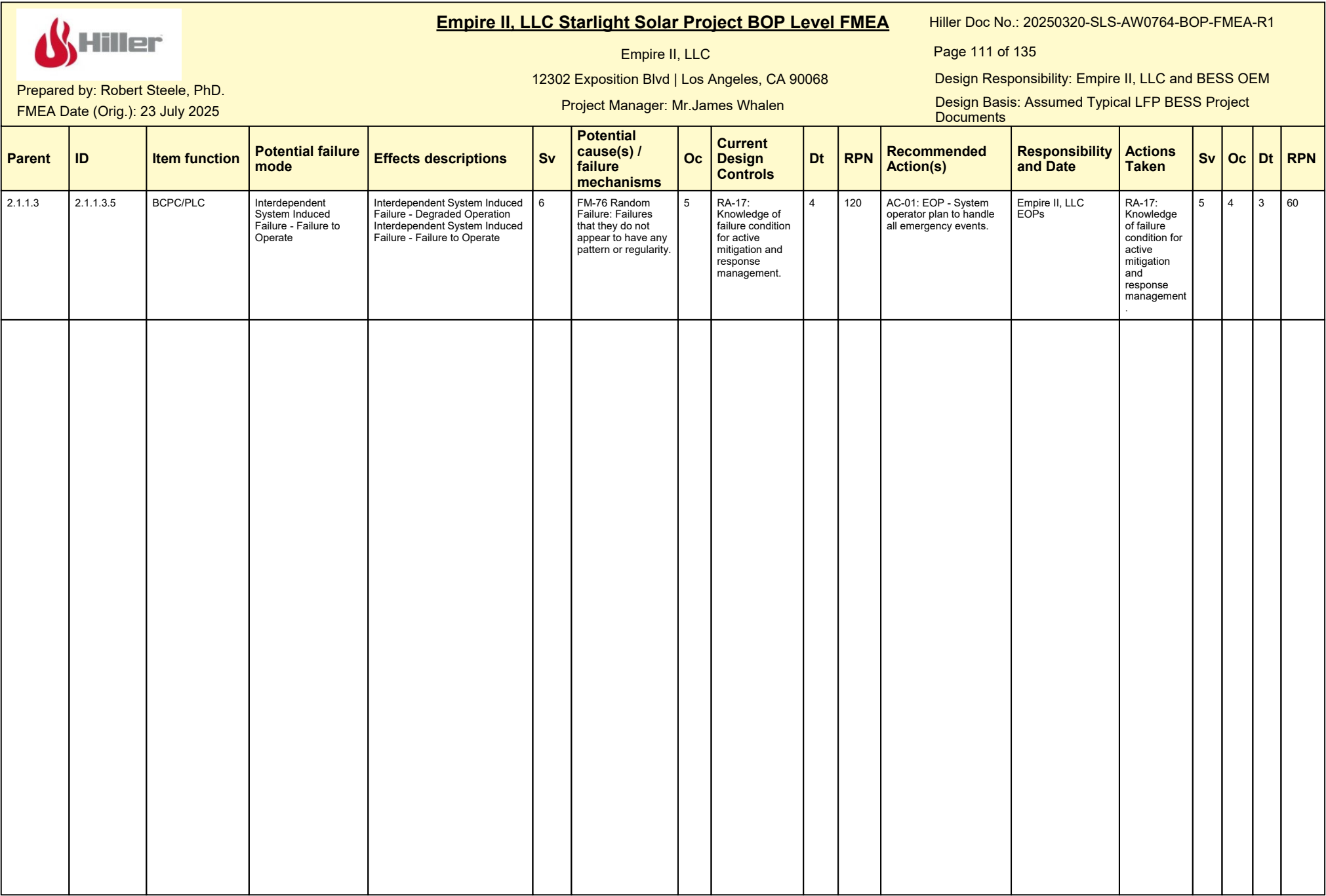
Design Responsibility: Empire II, LLC and BESS OEM

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Project Manager: Mr. James Whalen

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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	Oc	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/capability 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 Commissioning 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/unavailability	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 Commissioning 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 Commissioning 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





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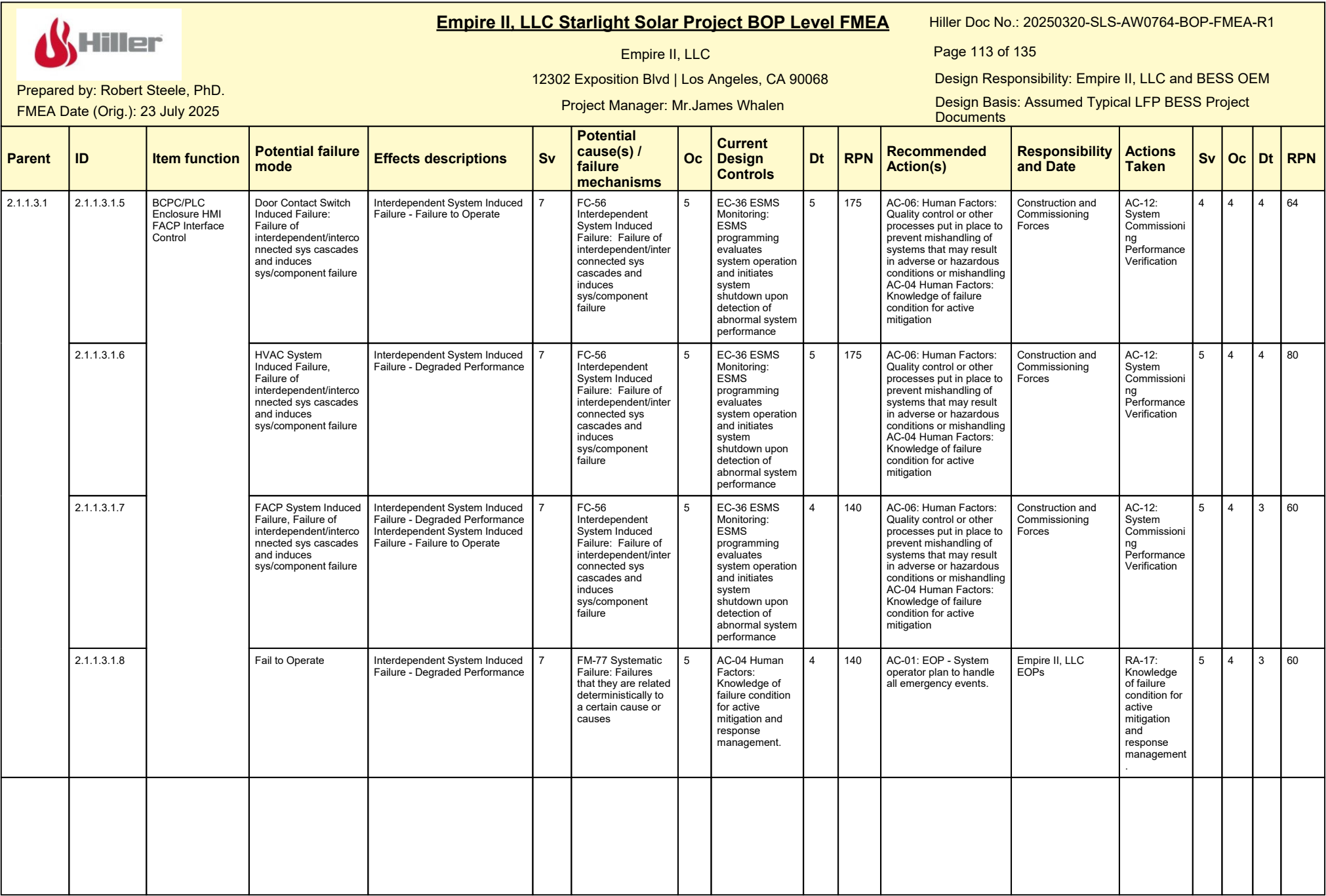
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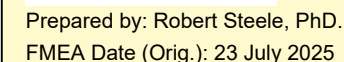
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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Oc	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Oc	Dt	RPN
2.1.1.3.1	2.1.1.3.1.1	BCPC/PLC Enclosure HMI FACP Interface Control	RS485 TO DC METER (X4): Failure of interdependent/interconnected sys cascades and induces sys/component failure	Subsystem Component Failure: Broken, Short, Open	9	FC-46 Subcomponent/Subsystem Failure: Lifecycle failure of components impacting availability/capability 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 substantiating 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 substantiating RPN reduction	5	4	4	80
	2.1.1.3.1.3		Temperature Probes: Failure of interdependent/interconnected sys cascades and induces sys/component failure	Interdependent System Induced Failure - Degraded Performance	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/interconnected 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 substantiating RPN reduction	5	4	4	80
	2.1.1.3.1.4		Humidity/Temp Sensor Failure: Failure of interdependent/interconnected 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 Commissioning Performance Verification	2	2	5	20





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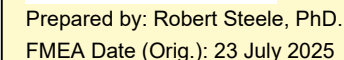
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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Oc	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Oc	Dt	RPN
2.1.1.3.1.1	2.1.1.3.1.1.1	BCPC/EMCU/BMS Temp Sensors FACP Interface Control	RS485 TO DC METER (X4): Failure of interdependent/interconnected sys cascades and induces sys/component failure	Interdependent System Induced Failure - Degraded Performance	1	FC-46 Subcomponent/Subsystem Failure: Lifecycle failure of components impacting availability/capability 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 substantiating 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 substantiating RPN reduction	5	4	4	80
	2.1.1.3.1.1.3		Temperature Probes: Failure of interdependent/interconnected sys cascades and induces sys/component failure	Interdependent System Induced Failure - Degraded Performance	1	FC-56 Interdependent System Induced Failure: Failure of interdependent/interconnected 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 substantiating RPN reduction	5	4	4	80
	2.1.1.3.1.1.4		Humidity/Temp Sensor Failure: Failure of interdependent/interconnected 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 Commissioning Performance Verification	2	2	5	20



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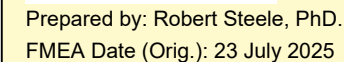
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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Oc	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Oc	Dt	RPN
2.1.1.3.1.2	2.1.1.3.1.2.1	BMS/EMCU E-Stop FACP Interface Control	RS485 TO DC METER (X4): Failure of interdependent/interconnected 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/capability 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 substantiating 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 substantiating RPN reduction	5	4	4	80
	2.1.1.3.1.2.3		Temperature Probes: Failure of interdependent/interconnected sys cascades and induces sys/component failure	Degraded Performance	8	FC-56 Interdependent System Induced Failure: Failure of interdependent/interconnected 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 substantiating RPN reduction	5	4	4	80
	2.1.1.3.1.2.4		Humidity/Temp Sensor Failure: Failure of interdependent/interconnected 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 Commissioning Performance Verification	2	2	5	20



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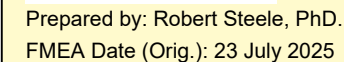
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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Oc	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Oc	Dt	RPN
2.1.1.3.1.3	2.1.1.3.1.3.1	BMS/EMCU Door Alarms FACP Interface Control	RS485 TO DC METER (X4): Failure of interdependent/interconnected 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/capability 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 substantiating 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 substantiating RPN reduction	5	4	4	80
	2.1.1.3.1.3.3		Temperature Probes: Failure of interdependent/interconnected sys cascades and induces sys/component failure	Interdependent System Induced Failure - Failure to Operate	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/interconnected 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 substantiating RPN reduction	5	4	4	80
	2.1.1.3.1.3.4		Humidity/Temp Sensor Failure: Failure of interdependent/interconnected 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 Commissioning Performance Verification	2	4	5	40



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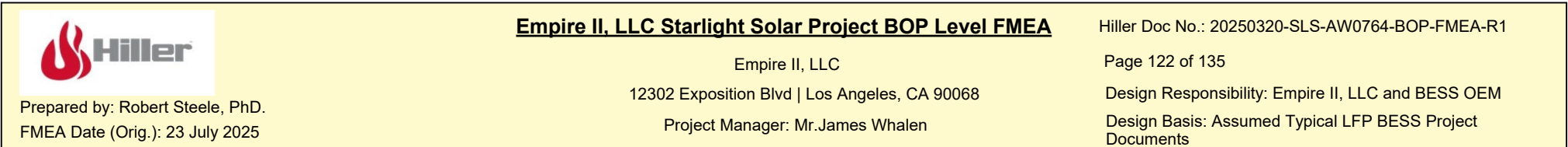
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2.1.1.3.1.4	2.1.1.3.1.4.1	BMS/EMCU Flammable Gas Detection FACP Interface Control	RS485 TO DC METER (X4): Failure of interdependent/interconnected sys cascades and induces sys/component failure	Interdependent System Induced Failure - Degraded Performance	6	FC-46 Subcomponent/Sub system Failure: Lifecycle failure of components impacting availability/capability 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 substantiating 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 substantiating RPN reduction	5	4	4	80
	2.1.1.3.1.4.3		Temperature Probes: Failure of interdependent/interconnected sys cascades and induces sys/component failure	Interdependent System Induced Failure - Degraded Performance	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/interconnected 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 substantiating RPN reduction	5	4	4	80
	2.1.1.3.1.4.4		Humidity/Temp Sensor Failure: Failure of interdependent/interconnected 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 Commissioning Performance Verification	2	4	5	40



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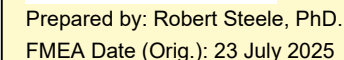
Design Responsibility: Empire II, LLC and BESS OEM

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Parent	ID	Item function	Potential failure mode	Effects descriptions	Sv	Potential cause(s) / failure mechanisms	Oc	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Oc	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/interconnected sys cascades and induces sys/component failure	Interdependent System Induced Failure - Degraded Performance Interdependent System Induced Failure - Failure to Operate	7	FC-46 Subcomponent/Subsystem Failure: Lifecycle failure of components impacting availability/capability 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 substantiating 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 substantiating RPN reduction	5	4	4	80
	2.1.1.3.2.3		Temperature Probes: Failure of interdependent/interconnected sys cascades and induces sys/component failure	Interdependent System Induced Failure - Degraded Performance	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/interconnected 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 substantiating RPN reduction	5	4	4	80
	2.1.1.3.2.4		Humidity/Temp Sensor Failure: Failure of interdependent/interconnected 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 Commissioning Performance Verification	2	3	5	30

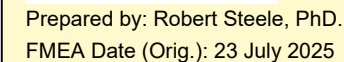


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2.1.1.3.2.1.1	1	Smoke Detection FACP Interface Control	RS485 TO DC METER (X4): Failure of interdependent/interconnected sys cascades and induces sys/component failure	Failure to Operate Degraded Performance	5	FC-46 Subcomponent/Subsystem Failure: Lifecycle failure of components impacting availability/capability 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 Engineering Commissioning and Engineering	RA-23: BESS OEM ESMS Software controls interdependent system to safely detect system degradation and initiate S/D protocols	3	5	6	90
	2		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 substantiating RPN reduction	5	5	3	75
	3		Temperature Probes: 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/interconnected 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 substantiating RPN reduction	5	4	3	60
	4		Humidity/Temp Sensor Failure: Failure of interdependent/interconnected 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: Environmental Temperature Monitoring and Alarms	2	3	5	30



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													RA-21: BESS OEM ESMS Software controls monitors interdependent system to safely detect system degradation and initiate S/D protocols				
2.1.1.3.2.1.1	2.1.1.3.2.1.1.5	Smoke Detection FACP Interface Control	Door Contact Switch Induced Failure: Failure of interdependent/interconnected sys cascades and induces sys/component failure	Degraded Performance Failure to Operate	1	FC-56 Interdependent System Induced Failure: Failure of interdependent/interconnected 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 interdependent system to safely detect system degradation and initiate S/D protocols	4	4	4	64
	2.1.1.3.2.1.1.6		HVAC 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/interconnected 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 interdependent system to safely detect system degradation and initiate S/D protocols	5	4	4	80
	2.1.1.3.2.1.1.7		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/interconnected 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 interdependent system to safely detect system degradation and initiate S/D protocols	5	4	3	60

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2.1.1.3.2.1.2	1	IEC CGI FACP Interface Control	RS485 TO DC METER (X4): Failure of interdependent/interconnected 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/capability 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 substantiating RPN reduction	5	5	3	75
	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 substantiating RPN reduction	5	5	3	75
	3		Temperature Probes: Failure of interdependent/interconnected sys cascades and induces sys/component failure	Interdependent System Failure - Degraded Performance	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/interconnected 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 substantiating RPN reduction	5	4	3	60
	4		Humidity/Temp Sensor Failure: Failure of interdependent/interconnected 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: Environmental Temperature Monitoring and Alarms	2	3	5	30



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													RA-21: BESS OEM ESMS Software controls monitors interdependent system to safely detect system degradation and initiate S/D protocols				
2.1.1.3.2.1.2	2.1.1.3.2.1.2.5	IEC CGI FACP Interface Control	Door Contact Switch Induced Failure: Failure of interdependent/interconnected sys cascades and induces sys/component failure	Interdependent System Failure - Degraded Performance	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/interconnected 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 interdependent system to safely detect system degradation and initiate S/D protocols	4	4	4	64
	2.1.1.3.2.1.2.6		HVAC System Induced Failure, Failure of interdependent/interconnected sys cascades and induces sys/component failure	Interdependent System Failure - Failure to Operate	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/interconnected 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 interdependent system to safely detect system degradation and initiate S/D protocols	5	4	4	80
	2.1.1.3.2.1.2.7		FACP System Induced Failure, Failure of interdependent/interconnected sys cascades and induces sys/component failure	Interdependent System Failure - Degraded Performance	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/interconnected 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 interdependent system to safely detect system degradation and initiate S/D protocols	5	4	3	60



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2.1.1.3.2.1.3	2.1.1.3.2.1.3.1	Humidity Monitoring FACP Interface Control	RS485 TO DC METER (X4): Failure of interdependent/interconnected 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/capability 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 substantiating RPN reduction	5	5	4	100
	2.1.1.3.2.1.3.2		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 substantiating RPN reduction	5	5	3	75
	2.1.1.3.2.1.3.3		Temperature Probes: Failure of interdependent/interconnected sys cascades and induces sys/component failure	Interdependent System Failure - Degraded Performance	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/interconnected 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 substantiating RPN reduction	5	4	3	60
	2.1.1.3.2.1.3.4		Humidity/Temp Sensor Failure: Failure of interdependent/interconnected 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: Environmental Temperature Monitoring and Alarms	2	3	5	30



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													RA-21: BESS OEM ESMS Software controls monitors interdependent system to safely detect system degradation and initiate S/D protocols				
2.1.1.3.2.1.3	2.1.1.3.2.1.3.5	Humidity Monitoring FACP Interface Control	Door Contact Switch Induced Failure: Failure of interdependent/interconnected sys cascades and induces sys/component failure	Interdependent System Failure - Degraded Performance	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/interconnected 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 interdependent system to safely detect system degradation and initiate S/D protocols	4	4	4	64
	2.1.1.3.2.1.3.6		HVAC System Induced Failure, Failure of interdependent/interconnected sys cascades and induces sys/component failure	Interdependent System Failure - Degraded Performance	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/interconnected 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 interdependent system to safely detect system degradation and initiate S/D protocols	5	4	4	80
	2.1.1.3.2.1.3.7		FACP System Induced Failure, Failure of interdependent/interconnected sys cascades and induces sys/component failure	Interdependent System Failure - Degraded Performance	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/interconnected 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 interdependent system to safely detect system degradation and initiate S/D protocols	5	4	3	60



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2.1.1.3.2.1.4	2.1.1.3.2.1.4.1	Exhaust Fan Control FACP Interface Control	RS485 TO DC METER (X4): Failure of interdependent/interconnected 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/capability 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 substantiating RPN reduction	5	5	3	75
	2.1.1.3.2.1.4.2		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 substantiating RPN reduction	5	5	3	75
	2.1.1.3.2.1.4.3		Temperature Probes: Failure of interdependent/interconnected sys cascades and induces sys/component failure	Interdependent System Failure - Degraded Performance	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/interconnected 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 substantiating RPN reduction	5	4	3	60
	2.1.1.3.2.1.4.4		Humidity/Temp Sensor Failure: Failure of interdependent/interconnected 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: Environmental Temperature Monitoring and Alarms	2	4	5	40



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12302 Exposition Blvd | Los Angeles, CA 90068

Design Responsibility: Empire II, LLC and BESS OEM

FMEA Date (Orig.): 23 July 2025

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	Oc	Current Design Controls	Dt	RPN	Recommended Action(s)	Responsibility and Date	Actions Taken	Sv	Oc	Dt	RPN
													RA-21: BESS OEM ESMS Software controls monitors interdependent system to safely detect system degradation and initiate S/D protocols				
2.1.1.3.2.1.4	2.1.1.3.2.1.4.5	Exhaust Fan Control FACP Interface Control	Door Contact Switch Induced Failure: Failure of interdependent/interconnected sys cascades and induces sys/component failure	Interdependent System Failure - Degraded Performance	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/interconnected 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 interdependent system to safely detect system degradation and initiate S/D protocols	4	4	4	64
	2.1.1.3.2.1.4.6		HVAC System Induced Failure, Failure of interdependent/interconnected sys cascades and induces sys/component failure	Interdependent System Failure - Degraded Performance	8	FC-56 Interdependent System Induced Failure: Failure of interdependent/interconnected 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 interdependent system to safely detect system degradation and initiate S/D protocols	5	4	4	80
	2.1.1.3.2.1.4.7		FACP System Induced Failure, Failure of interdependent/interconnected sys cascades and induces sys/component failure	Interdependent System Failure - Degraded Performance	7	FC-56 Interdependent System Induced Failure: Failure of interdependent/interconnected 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 interdependent system to safely detect system degradation and initiate S/D protocols	5	4	3	60



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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	Oc	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 Annunciation: Ability of the FAA to detect component failure and alarm/annunciate 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 failure and alarm/annunciate 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/annunciate 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 Annunciation: Ability of the FAA to detect component failure and alarm/annunciate 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