



# **POWER ELECTRONIC POWER DISTRIBUTION SYSTEM ARCHITECTURES**

# **Technical Report**

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Submitted by: Carmen E. Araujo, David C. Gross, Michael "Mischa" Steurer, Naqash Ali

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# **1** EXECUTIVE SUMMARY

This report discusses the process, product, and purpose of the PEPDS System Model Version 1.0 which captures diverse stakeholder needs, analyzes black box and white box functions, defines black box and white box context and interfaces, and identifies measures of effectiveness and performance. The foregoing elements distill into a set of system requirements that result in the PEPDS functional architecture. This report is intended to accompany the PEPDS System Model Version 1.0 with the purpose of assisting the reader with navigating and understanding the model.

# **2 NOMENCLATURE**

Nomenclature is defined in the PEPDS System Model Glossary provided in section 11.3, the MagicGrid<sup>®</sup> Book of Knowledge glossary from reference [1], and the No Magic Inc. Glossary of SysML Concepts from reference [2].

# **3** INTRODUCTION

The Power Electronic Power Distribution System (PEPDS) is a new power, energy, and control distribution concept enabled by technology development funded by the Office of Naval Research (ONR). "The goal of the PEPDS program is to achieve revolutionary changes to system design and operation by leveraging recent technological advances and developing both the applications to use them and the control and modeling capabilities needed to employ them" [3]. The PEPDS development program has five (5) main areas of science and technology development:

- 1. Navy Integrated Power Electronics Building Block (NiPEBB),
- 2. Navy Integrated Power and Energy Corridor (NiPEC),
- 3. Model is the Specification,
- 4. Control, and
- 5. System Simulation.

The technical approach for integrating this work is digital engineering grounded in Model-Based System Engineering (MBSE). The product of this MBSE effort is the PEPDS System Model which is a living document that will change and grow throughout the lifetime of the system.

This report discusses the process, product, and purpose of the PEPDS System Model Version 1.0 which captures diverse stakeholder needs, analyzes black box and white box functions, defines black box and white box context and interfaces, and identifies measures of effectiveness and performance. The foregoing elements distill into a set of system requirements that result in the PEPDS functional architecture. This report is intended to accompany the PEPDS System Model Version 1.0 with the purpose of assisting the reader with navigating and understanding the model.

# 4 PROCESS

This section discusses the process used for developing the PEPDS System Model Version 1.0.

# 4.1 Contributors

The authors are chartered to lead the PEPDS functional architecture development. In that role, we established the PEPDS Architecture Team, see Table I, to provide a framework for PEPDS architecture studies and to enable collaborative research. The PEPDS Architecture Team uses the Systems Modeling Language (SysML) to develop the PEPDS System Model with the Cameo

Enterprise Architecture (Version 19) software, explained in detail in section 4.2. Consistent with similar projects at the Naval Sea Systems Command (NAVSEA), the PEPDS System Model follows the MagicGrid<sup>®</sup> Framework, explained in section 4.3.

Organization	Lead Researcher	Main Research Topic	Supporting Team Members
Florida State	Michael "Mischa"	Architectures,	Carmen E. Araujo (Lead MBSE & Team
University	Steurer	Abilities,	Point of Contact), David C. Gross (MBSE),
	(Lead Architect)	System Integration	Naqash Ali, Jodie Bell, Karl Schoder,
			Matthew Bosworth, Sihun Song
Florida State	Juan Ordonez	Thermal Management	
University			
Massachusetts	Julie Chalfant	NiPEC,	Matt Kruse, Drake Platenberg, Avi
Institute of		Naval Architecture	Chatterjee
Technology			
University of	Herbert L. Ginn	Controls	Aaron De La O Perez
South			
Carolina			
University of	David A. Wetz	Energy Storage	Shawn 'Tyler' Scoggin, Hayden Atchison,
Texas at			Alex Johnston
Arlington			
University of	Robert M. Cuzner	Virtual Prototyping	Jacob David Gudex, Joey Authement,
Wisconsin-			William Joseph Koebel, Jose Antonio
Milwaukee			Trujillo Parra, Hamed Shabani, Rounak
X7		N'DEDD	
Virginia Tech	Dong Dong	NIPEBB	Daniel Sathri, Marie Lawson
NSWCPD	Aaron Scherr		
NSWCPD	Nathan Spivey		
NSWCPD	Robert "Bob" Irwin	Stability Design &	
	(PI)	Assessment	
NSWCPD	Shawn Plesnick	Stability Design &	
	(AI)	Assessment	
Previous	n/a		Igor Cvetkovic (VT), Rolando Burgos (VT),
Team			Richard Zhang (VT), Dushan Boroyevich
Members			(VT), Christina DiMarino (VT), Salman
			Hussain (FSU), Ceca Mijatovic (FSU),
			James Narey (UTA)

Table I: PEPDS	Architecture	Team	Members
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# 4.2 Model Based Systems Engineering

MBSE is "the formalized application of modeling to support system requirements, design, analysis, verification, and validation activities beginning in the conceptual design phase and continuing throughout development and later lifecycle phases" [4]. The benefits of using an MBSE approach over a traditional document-based approach are enhanced communications, reduced developmental risk, improved quality, increased productivity, and enhanced knowledge transfer [5].

For the PEPDS System Model, the MBSE tool being used is the Cameo Enterprise Architecture Version 19 software. The Cameo Enterprise Architecture, herein referred to as Cameo, is a product of CATIA No Magic owned by Dassault Systems. The Cameo supported modeling language selected for the PEPDS System Model is SysML. "Modeling languages are

specifications which provide standardized guidelines and structures for expressing system information" [6]. SysML is one of the more frequently used modeling languages for MBSE and is a "graphical language that utilizes diagrams and tables in order to express system information and provides a standard set of nine diagram types which can be used to organize and express system information" [6]. The information expressed via a modeling language is often organized via an architecture framework [6]. The PEPDS System Model follows the MagicGrid<sup>®</sup> Framework which is discussed in section 4.3.

# 4.3 MagicGrid<sup>®</sup> Framework

The PEPDS System Model follows the MagicGrid<sup>®</sup> Framework defined by the first edition of the MagicGrid<sup>®</sup> Book of Knowledge by NoMagic, Inc. The MagicGrid<sup>®</sup> Framework is shown in Fig. 1. The MagicGrid<sup>®</sup> approach "includes the definition of the problem, solution, and implementation domains in the system model. They align with the processes defined by ISO/IEC/IEEE 15288 as follows: problem domain with the Stakeholder Needs Development process, solution domain with the Architecture Definition process, and implementation domain with the Design Definition process" [1]. "Each domain definition includes four different aspects of the system to be considered and captured in the model. These aspects match the four pillars of the SysML, that is, requirements, behavior, structure, and parameters" [1].

	PILLAR						
			Requirements	Behavior	Structure	Parameters	
	Problem	Black Box		B1-W1 Stakeholder Needs	B2 Use Cases	B3 System Context	B4 Measurements of Effectiveness
		White Box		W2 Functional Analysis	W3 Logical Subsystems Communication	W4 MoEs for Subsystems	Specialty Engineering
DOMAIN	Solution		S1 System Requirements	S2 System Behavior	S3 System Structure	S4 System Parameters	Integrated
			SS1 Subsystem Requirements	SS2 Subsystem Behavior	SS3 Subsystem Structure	SS4 Subsystem Parameters	Testing
							Analysis
			C1 Component Requirements	C2 Component Behavior	C3 Component Structure	C4 Component Parameters	
	Implementation		I1 Physical Requirements	Software, Electrical,	Mechanical		

Fig. 1: MagicGrid<sup>®</sup> Framework [1]

The PEPDS System Model Version 1.0 contains content for the entire Problem Domain and S1 System Requirements. Two modifications to the MagicGrid<sup>®</sup> Framework occur in the PEPDS System Model Version 1.0. The first is that some structure diagrams in B3 and W3 are combined into one diagram for convenience. These are the B3.1/W3.1 System Context and Logical Architecture diagram and the B3.3/W3.3 Exchange Items diagram. The second modification is in the W4 MoEs for Subsystems section. Here, the PEPDS System Model Version 1.0 provides the Measures of Performance (MoPs) that make up each of the Measures of Effectiveness (MoEs), defined in B4, for PEPDS at a system level. The MoEs and MoPs for each subsystem are not yet defined but will pull from the MoEs and MoPs defined in the B4 and W4 sections.

The PEPDS System Model contains a MagicGrid<sup>®</sup> Index, shown in Fig. 2, that provides easy access to each section's content. Each section has a package diagram that will contain links to all the diagrams and tables created for that section. A copy of each section's package diagram is provided in section 11.4.





Florida State University – Center for Advanced Power Systems 2000 Levy Ave. Tallahassee, FL 32310



# 4.4 PEPDS System Model Navigation Roadmap

To assist the reader in navigating and understanding the PEPDS System Model, a road map for navigating the model was created. Fig. 3 shows a high-level summarized version of the road map. A copy of the road map is provided in section 11.1. The PEPDS System Model can be explored using the MagicGrid<sup>®</sup> Index or the road map. This report will discuss each diagram in the model in the order suggested by the road map.



Fig. 3: Explanation of PEPDS System Model Road Map

# 5 PRODUCT

This section will walk the reader through the PEPDS System Model Version 1.0. The PEPDS System Model Version 1.0 captures diverse stakeholder needs, defines black box and white box context and interfaces, analyzes black box and white box functions, and identifies measures of effectiveness and performance. The foregoing elements are distilled into a set of system requirements that result in the PEPDS functional architecture.

To view the model in Cameo, follow the instructions in section 10 to download, install, and use the Cameo Enterprise Architecture Reader, herein referred to as Cameo Reader. After opening the PEPDS System Model in the Cameo Reader, there will be a road map illustrating how the model developers suggest the reader should review the model. Sections 5.1, 5.2, and 5.3 of the report explain the PEPDS System Model contents in the order of the road map to enhance reader comprehension. A copy of the road map and each of the diagrams and tables reviewed with the road map are provided in Appendix B: PEPDS System Model Contents.

# 5.1 Black Box Problem Domain

A copy of each of the diagrams and tables reviewed in this section is provided in section 11.2.

# 5.1.1 B1 Stakeholder Needs Table

The B1 Stakeholder Needs Diagram defines what those involved in PEPDS require and desire. Within the model, they are represented as business requirements. Throughout the model, these business requirements are referenced to provide rationale for certain design choices.

### 5.1.2 B3.1/W3.1 System Context Interfaces and Logical Architecture

The top section of the B3.1/W3.1 System Context and Logical Architecture diagram shows how PEPDS exists in its environment. PEPDS is an electric system existing on the electric ship. It interacts with other systems on the electric ship as well as external systems. These interfaces are defined in the B3.2 System Context Interfaces diagram discussed in section 5.1.6. The bottom section of the B3.1/W3.1 System Context and Logical Architecture diagram is part of the White Box Problem Domain and is reviewed in section 5.2.1.

### 5.1.3 B2.1 Use Cases of PEPDS

After gaining an understanding of the system context, proceed to review the PEPDS concept of operations. The PEPDS System Model Version 1.0 defines the concept of operations in three diagrams that express what PEPDS does, but not how PEPDS does it.

The first step is to understand its use cases shown in the B2.1 PEPDS Use Cases diagram. An important requirement of PEPDS is to simplify its operation and maintenance to the point that minimal training on PEPDS is required for the crew. In addition to this, Maintain PEPDS is an included use case within the Operate PEPDS use case. This is because it is required that PEPDS can remain operational while maintenance is performed. The goal is that PEPDS always remains operational while away from the shipyard. This means that PEPDS' ability to operate in nominal and off-nominal conditions is required in addition to its ability to operate during times of maintenance. This concept is further elaborated on in the B2.2 PEPDS States and Modes diagram in section 5.1.4.

PEPDS is also required to have advanced functional control and simple least replaceable unit (LRU) replacement. This is part of the maintenance that must be executable by the crew. The crew is expected to be able to control the component and network functions through programming and reconfiguration as well as replace LRUs that are carriable by a single sailor and require minimal training for installation and removal.

#### 5.1.4 B2.2 PEPDS States and Modes

The B2.2 PEPDS States and Modes diagram shows the states, modes, and transitions that exist for PEPDS. PEPDS states are Off, Operating, and Performing SHIPALT.

The Performing SHIPALT state is needed for the stakeholder need of having PEPDS installable as a unit at the shipyard. This expected PEPDS innovation consists of construction and testing being executable off the ship and avoiding intensive cabling after ship construction.

The operating state reflects the use cases defined in section 5.1.3. The Operating state has the modes of Operating Nominally, Operating Off-Nominally, and Maintaining. The transitions between these modes defined in the diagram reflect multiple stakeholder needs. To minimize the possibilities of failures, condition-based maintenance plus (CBM+) is expected to be fully integrated into the PEPDS design. If a failure does occur, PEPDS is expected to be able to diagnose and prognose failures to autonomously recover when possible. If autonomous recovery is not possible, the crew must perform corrective maintenance. After repairs are completed,

PEPDS is expected to be able to self-adapt to the repairs and upgrades as well as perform a selfcheck to ensure the system has fully recovered.

#### 5.1.5 B2.3 Scenario: Operate PEPDS

The B2.3 Operate PEPDS Scenario diagram elaborates on select activities that occur while PEPDS is in the operating state defined in section 5.1.4. This diagram shows the exchange items that enter and leave PEPDS, where they come from or go to, and what activities they are used for during the Operate PEPDS scenario. The main functions of PEPDS, shown in gold, are Control PEPDS, Protect PEPDS, Distribute Power, and Manage Thermal Load of PEPDS. These functions occur simultaneously in a loop from when PEPDS is turned on to when it is turned off. The functions (depicted as behaviors in the model) define how the system achieves its capabilities (depicted as structures in the model). These behaviors and structures are further defined in the White Box Problem Domain review in section 5.2.

### 5.1.6 B3.2 System Context Interfaces

The B3.2 System Context Interfaces diagram displays the exchange items traveling across the PEPDS external interfaces. It shows all possible exchange items, not just the exchange items for one specific scenario like in the B2.3 Scenario: Operate PEPDS diagram discussed in section 5.1.5. The diagram also shows some of the possible onboard power loads, onboard power sources, and offboard power systems that PEPDS may interact with.

#### 5.1.7 B3.3/W3.3 Exchange Items

The B3.3/W3.3 Exchange Items diagram elaborates on the exchange items that travel in, out, and within PEPDS.

#### 5.1.8 B4 Measurements of Effectiveness

Based on the stakeholder needs defined in the B1 Stakeholder Needs Table discussed in section 5.1.1, three measurements of effectiveness (MoEs) were defined for PEPDS. These are RAM (reliability, availability, maintainability), operability, and safety. The B4 PEPDS MoEs diagram shows these MoEs as well as the measures of performance (MoPs) that are within them. The MoPs are defined further in the White Box Problem Domain review in section 5.2. These MoEs and MoPs measure how well a particular proposed PEPDS solution satisfies stakeholder needs. Review the B4 PEPDS MoEs traced to B1 Stakeholder Needs matrix to see how each MoE and MoP traces back to the stakeholder needs.

# 5.2 White Box Problem Domain

A copy of each of the diagrams and tables reviewed in this section is provided in section 11.2.2.

# 5.2.1 B3.1/W3.1 System Context Interfaces and Logical Architecture Part 2

Returning to the B3.1/W3.1 System Context and Logical Architecture diagram discussed in section 5.1.2, review the second half of the diagram containing the PEPDS Logical Architecture.

PEPDS subsystems are defined as capabilities. These capabilities (depicted as structures in the model) represent what the system of interest can do, as contrasted with the functions (depicted as behaviors in the model) introduced in the B2.3 Scenario: Operate PEPDS diagram discussed in section 5.1.5. The PEPDS capabilities are the Control Capability, Protection Capability, Electrical Distribution Capability, and Thermal Management Capability. The Electrical Distribution Capability is split into three sub-capabilities which are the Energy Storage Capability, Power Transportation Capability, and Power Conversion Capability. The goal of making converters part of distribution is "to reduce cost, achieve control, improve performance, enable cyber security, and further reduce size and weight" [3]. The operational paradigms of future warships depend on energy storage creating a need for "integration of both point and distributed energy storage directly into the power distribution system" [3]. This is why the Energy Storage Capability, Power Transportation Capability, and Power Conversion Capability are defined as parts of the Electrical Distribution Electrical Distribution system" [3].

Each PEPDS Capability is made up of components that are defined as either LRUs or Non-LRUs. This approach to defining the components has the purpose of limiting unnecessary restrictions on the Solution Space while also encouraging PEPDS innovations defined in the B1 Stakeholder Needs Table discussed in section 5.1.1. LRUs are defined in the PEPDS Model as components that are easily installed, removed, and transported by a single sailor, have spares onboard, and that some are reprogrammable. Non-LRUs are defined in the PEPDS Model as components that are not easily installed, removed, and transported by a single sailor.

### 5.2.2 B2.3 Scenario: Operate PEPDS Part 2

Returning to the B2.3 Operate PEPDS Scenario diagram, discussed in section 5.1.5, each of the main functions of PEPDS, shown in gold, are executed by the PEPDS Capabilities defined in the B3.1/W3.1 System Context Interfaces and Logical Architecture diagram, discussed in section 5.2.1. Review the W2.1 Control PEPDS diagram discussed in section 5.2.3, the W2.2 Protect PEPDS diagram discussed in section 5.2.4, the W2.3 Distribute Power diagram discussed in section 5.2.6 to see the behaviors carried out by each of the PEPDS Capabilities to fulfill these PEPDS functions.

#### 5.2.3 W2.1 Control PEPDS

The W2.1 Control PEPDS diagram shows the behaviors of the control capability and the exchange items that are shared with other PEPDS Capabilities and external systems. The Control Capability has two functions. It controls the information within, entering, and exiting PEPDS and controls all PEPDS capabilities. The activities that occur in W2.1.1 Control Information are discussed in section 5.2.3.1 and the activities that occur in W2.1.2 Control PEPDS capabilities are discussed in section 5.2.3.2.

By controlling and processing information, the Control Capability updates the Control Strategy. The Control Strategy controls electrical power by commanding PEPDS Capabilities. Returning to the B3.3/W3.3 Exchange Items diagram discussed in section 5.1.7, the interface block named Control Strategy defines what is included in the Control Strategy which currently consists of the Operation Strategy, Protection Strategy, Maintenance Strategy, Forecasting Consequences, and

Cybersecurity Operations. These individual strategies and activities were combined under the overarching term "Control Strategy" because when one changes, the others must change as well.

# 5.2.3.1 W2.1.1 Control Information

The W2.1.1 Control Information diagram shows the behaviors of the Control Capability and the exchange items that enter and exit the Control Information activity. The commands and feedback entering the Control Information activity are used to consistently monitor PEPDS needs and user needs. If feedback from the Protection Capability requires an immediate response, the Control Capability will override other planned activities as needed and proceed to determine a course of action based on the Protection Capability feedback. If the Protection Capability feedback does not show a need for an immediate response, one of three paths will occur based on the Control Strategy. As shown in the B2.3 Scenario: Operate PEPDS diagram discussed in 5.1.5, the PEPDS functions occur in a loop. So, if one Control Information path is dependent on a different one, they will occur in the order needed. Just because one path is chosen does not mean a different one will never occur. They will just proceed in the order necessary for the task at hand.

The Capability Control Path determines a course of action based on the analysis of power load demands, power source supply, and capability needs. After determining a course of action, the Control Strategy is updated. The Functional Control Path programs communication networks, power networks, and PEPDS components. Once the programming is completed, it performs an automated self-check to assess the effects of the changes. The CBM+ Path initiates the CBM+ process. Data is captured and stored locally for internal CBM+ analysis. Select captured data is transmitted to Ship Control which relays it to an external database to support external CBM+ processes. Raw data and externally analyzed data are used to perform an internal CBM+ analysis. If this analysis produces evidence of need for maintenance, the Control Capability will determine a course of action to address this in a future iteration of the looped process. This evidence of need for maintenance can be a system health change or a PEPDS failure. All paths end with the track and improve activity which represents PEPDS' ability to self-learn by tracking performance and CBM+ data and analyzing control and protection activities. At the end of the Control Information Activity, feedback is provided to the Crew and Ship Control.

# 5.2.3.2 W2.1.2 Control PEPDS Capabilities

The W2.1.2 Control PEPDS Capabilities diagram shows how the Control Capability executes the Control Strategy. As shown in the diagram, the Control Capability controls interfaces between PEPDS and external power systems, configures PEPDS networks and components, commands how power should be tailored, and addresses all other possible PEPDS Capability needs. It issues prioritized commands to PEPDS Capabilities as directed by the Control Strategy.

# 5.2.4 W2.2 Protect PEPDS

The W2.2 Protect PEPDS diagram shows the activities that occur for executing continuous protection and handling failures. The Protection Capability determines needs for safety, performance, and resilience based on the analysis of power source and load interfaces, analysis of PEPDS performance, commands by the Control Capability, and protection strategy in the Control Strategy. Based on the former, the Protection Capability will select a protection

response. If a failure occurs, diagnosis and prognosis are performed before selecting a protection response to address the failure. Selected protection responses are sent to the Control Capability for execution. The protection feedback may recommend immediate response of the system because of imminent danger to personnel, PEPDS, or an external system, may require an eventual response, or may require no response.

#### 5.2.5 W2.3 Distribute Power

The W2.3 Distribute Power diagram shows how the Electrical Distribution Capability transports, converts, and stores power. The Electrical Distribution Capability consists of the Power Transportation Capability, Power Conversion Capability, and Energy Storage all of which are commanded by the control capability. Electrical power is transported from the source to the load and undergoes conversion when needed. After going through all necessary power conversions, the electrical power can either be stored or transported. The diagram shows that electrical power must go through the Power Conversion Capability before entering the Energy Storage Capability. This does not mean electrical power will always undergo conversion. If it is in the correct form, then it will be transported directly to the Energy Storage Capability.

# 5.2.6 W2.4 Manage Thermal Load of PEPDS

PEPDS Capabilities will create environmental loads as an unintended side effect of their functions. The Thermal Management Capability manages these loads and since they are unintended side effects, they are only modeled in the W2.4 Manage Thermal Load of PEPDS diagram. This diagram shows that the Thermal Management Capability regulates PEPDS internal thermal load to facilitate PEPDS continuing operations. One of the stakeholder needs requires that a universal thermal interface is proposed. System designers will create a PEPDS solution that regulates its internal thermal load using the resources available on the ship. A solution should be able to access and use the already existing environmental management services on the ship. The possible environmental management services are defined in the B3.3/W3.3 Exchange Items diagram discussed in section 5.1.7. The currently defined environmental management services are chilled water and forced air.

#### 5.2.7 W3.2 PEPDS Interface Diagram

The W3.2 PEPDS Interface Diagram shows the interfaces and exchange items between PEPDS Capabilities as well as between PEPDS Capabilities and external systems. These are the same exchange items and interfaces defined in the white box behavior diagrams shown in a different view. This view shows the networks needed for PEPDS to execute its functions. These networks are a communication network, electrical power network, and environmental load management network.

#### 5.2.8 B4 Measurements of Effectiveness Part 2

Returning to the B4 Measurements of Effectiveness diagram, discussed in section 5.1.8, each MoE is broken down into its MoPs that are defined in the W4.1 RAM MoEs diagram discussed in section 5.2.9, the W4.2 Operability MoEs diagram discussed in section 5.2.10, and the W4.3

Safety MoEs diagram discussed in section 5.2.11. The MoEs and MoPs for each PEPDS Capability are not yet defined but will pull from the MoEs and MoPs in the W4 diagrams.

#### 5.2.9 W4.1 RAM MoEs

The W4.1 RAM MoEs diagram identifies constraint calculations, thresholds, and goals for each MoP for the RAM MoE.

#### 5.2.10 W4.2 Operability MoEs

The W4.2 Operability MoEs diagram identifies constraint calculations, thresholds, and goals for each MoP for the Operability MoE.

#### 5.2.11 W4.3 Safety MoEs

The W4.3 Safety MoEs diagram identifies constraint calculations, thresholds, and goals for each MoP for the Safety MoE.

### 5.3 System Level Solution Domain

A copy of each of the diagrams and tables reviewed in this section is provided in section 11.2.3.

#### 5.3.1 S1 PEPDS Requirements

The problem domain elements were distilled into a set of system requirements that result in the PEPDS functional architecture. These system requirements are available in the tables and diagrams contained in the S1 System Requirements package diagram, provided in section 11.2.3.1. The S1 System Requirements diagrams, provided in section 11.2.3.2, show the S1 PEPDS Requirements organized in their respective packages and are traced to stakeholder needs. The tracing between S1 and the Problem Domain is shown in the S1 System Requirements Traceability Matrices, provided in section 11.2.3.3. The S1 System Requirements Table, provided in section 11.2.3.4, shows all of the S1 system requirements along with their tracing, source, verification method, risk level, and revision date.

The PEPDS System Model Version 1.0 ends at the S1 System Requirements.

#### 5.4 PEPDS System Model Future Improvements

The PEPDS System Model is a living document that will change and grow throughout the lifetime of the system. It will continue to support system requirements, design, analysis, verification, and validation activities throughout development and later lifecycle phases [4].

Some aspects lacking in Version 1.0 that will be addressed in Version 2.0 are dynamic behavior, the ability to integrate with focus area models, and the modeling and analysis of the design trade space.

# 6 **PURPOSE**

Using an MBSE approach for the PEPDS development process will enhance communication, reduce developmental risk, improve quality, increase productivity, and enhance knowledge transfer [5]. System designers will use the PEPDS System Model to understand the PEPDS functional architecture, propose alternative designs, select a preferred design, and build and qualify implementations. The PEPDS System Model will provide a framework for PEPDS architecture studies and enable collaborative research.

# 7 CONCLUSION AND RECOMMENDATIONS

The PEPDS Architecture Team has successfully baselined a functional architecture described in terms of needs, functions, structures, and measures transformed into a baselined set of functional requirements. The functional architecture baseline enables initial exploration of the solution space. The system model will transition from its role in framing the problem to enabling exchange of technology research, data, and information and exploration of the PEPDS design trade space.

Forthcoming work includes adding dynamic behavior to the system model, acquiring tools, enabling integration of the system model with focus area models, and exploring the PEPDS design trade space.

### 8 ACKNOWLEDGEMENTS

The authors gratefully acknowledge the contributions of the Architecture Team shown in Table I.

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# **10** APPENDIX A: HOW TO INSTALL AND USE CAMEO ENTERPRISE ARCHITECTURE READER

Cameo Enterprise Architecture Reader is made for reading and previewing models created with Cameo Enterprise Architecture and is free of charge.

# 10.1 Instructions on Installing Cameo Enterprise Architecture Reader

Follow the instructions to install the Cameo Enterprise Architecture Reader:

- 1. Go to: <u>https://www.magicdraw.com/main.php</u>
- 2. Register as a User and Login.
- 3. Select **Download Reader** from the column on the left near the end.
- 4. Select Cameo Enterprise Architecture product and 19.0 SP1 LTR version.
- 5. Select the download file link based on your operating system.
- 6. Download the file from the mirror site nearest you.
- 7. Open the file and follow the installation prompts.
  - a. If you selected no\_install.zip, extract the .zip file and follow the instructions in the **readme** HTML document under section "**Using no-install package**".

The Cameo Enterprise Architecture Reader is now ready for use. Proceed to section 10.2.

# **10.2** How to use Cameo Enterprise Architecture Reader

Open Cameo Enterprise Architecture Reader then, under file, select "open project" and open the ".mdzip" file of the model you would like to view.

Navigate the model in a fashion similar to a webpage. You can open diagrams/tables by double clicking the diagram/table or by right clicking the diagram/table and selecting "Open in New Tab". The diagrams/tables can be opened from a linked icon/element on a diagram or from the containment tree. To see two diagrams/tables side by side, right click the tab and select "new horizontal/vertical group". You can close diagrams/tables by clicking the back arrow (when applicable) or by clicking the X on the tab.

Utilize the zooming and the vertical and horizontal scrolling in order to increase readability.

You can print diagrams/tables by selecting file  $\rightarrow$  print.

User manuals are available under "help". Resources to help you understand the SysML diagrams are the MagicGrid<sup>®</sup> Book of Knowledge from reference [1] and the No Magic Inc. Glossary of SysML Concepts from reference [2].

# **11 APPENDIX B: PEPDS SYSTEM MODEL CONTENTS**

The following list provides the sections of Appendix B and defines their content's purpose:

- Section 11.1 Navigation Road Map begins on page 19. The road map, discussed in section 4.4, is used for the product review in section 5 of the technical report.
- Section 11.2 PEPDS System Model Review Contents begins on page 20. The diagrams in this section accompany the product review in section 5 of the technical report.
  - Section 11.2.1 Problem Domain Black Box Review begins on page 20. The diagrams in this section accompany the Black Box Problem Domain review in section 5.1 of the technical report.
  - Section 11.2.2 Problem Domain White Box Review begins on page 30. The diagrams in this section accompany the White Box Problem Domain review in section 5.2 of the technical report.
  - Section 11.2.3 Solution Domain S1 System Requirements Review begins on page 45. The diagrams in this section accompany the System Level Solution Domain review in section 5.3 of the technical report.
    - Section 11.2.3.1 S1 System Requirements on page 45 shows all of the tables, diagrams, and matrices used to define the S1 system requirements.
    - Section 11.2.3.2 S1 System Requirements Diagrams begins on page 46. These diagrams show the S1 system requirements organized in their respective packages and are traced to stakeholder needs.
    - Section 11.2.3.3 S1 System Requirements Traceability Matrices begins on page 59. These matrices show the tracing between S1 and the Problem Domain.
    - Section 11.2.3.4 S1 System Requirements Table begins on page 63. This table provides all of the S1 system requirements along with their tracing, source, verification method, risk level, and revision date.
- Section 11.3 System Model Appendix begins on page 88. The diagrams in this section are not reviewed in the product review in section 5 of the technical report. They are supplementary material that provide information that will enhance the understanding of the PEPDS System Model product, discussed in section 5, and the PEPDS Functional Architecture development process, discussed in section 4.
- Section 11.4 MagicGrid<sup>®</sup> Index Package Diagrams begins on page 104. The diagrams in this section are the package diagrams from the MagicGrid<sup>®</sup> Index discussed in section 4.3.

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# 11.1 Navigation Road Map



Fig. 4: Navigation Road Map

# **11.2 PEPDS System Model Review Contents**

#### 11.2.1 Problem Domain Black Box Review

#	Id	Source	△ Name	Text
1	1	Navy	E B 1 Power Delivery	Transfers power from power source to power load
2	1.1	Navy	E B 1.1 Power Efficiency	Limit power loss during transmission and conversion
3	1.1.1	Navy	1.1.1 Fuel Efficiency	Reduce amount of fuel consumption
4	1.2	Navy	B 1.2 Power Density	High power rating relative to volume
5	1.3	Navy	B 1.3 Reliability	Long online time when measured by MTBF
6	1.4	Navy	B 1.4 Robustness	Compatible with various operating conditions and set points
7	1.5	Navy	B 1.5 Resiliency	Tolerant to critical scenarios such as faults and failure of device(s)
8	1.6	Navy	B 1.6 UPS	If demand is greater than supply (delta power), then provide provisional power for x time
9	2	Navy	E 🖪 2 Operability	System operation accomplished with reduced manning and logistics effort
10	2.1	Navy	B 2.1 Maintainability	Maintenance with reduced down time
11	2.2	Navy	2.2 Operator Trainability	Low training requirements in regards to time and technical skills
12	2.3	Operator	E B 2.3 Safety	Safe handling conditions
13	2.3.1	Operator	B 2.3.1 Thermally Touchable	External environment at reasonable handling temperatures
14	2.3.2	Operator	B 2.3.2 Liftable	Weight and volume at a reasonable range for handling
15	2.3.3	Operator	B 2.3.3 Electrically Insulated	Insulation to limit current through operator
16	2.4	Navy	B 2.4 Long Life Expectancy	Long operable lifespan
17	3	Navy	E B 3 Scalability	Greater power requirement met through serial and/or parallel connections
18	3.1	Navy	3.1 Serial Thermal Management	Universal thermal interface should be proposed
19	3.2	Navy	3.2 Parallel Redundancy	Parallel operation to provide continuous power to mission critical loads
20	3.3	Navy	E B 3.3 Controllable	Coordination should allow for extension/addition of devices
21	3.3.1	Navy	B 3.3.1 Software Reliability	Continuous high performance operation even in disruptive processes
22	3.3.2	Navy	B 3.3.2 Cyber Security	Resistant to malicious attacks against software and offers security observation
23	3.3.3	Navy	B 3.3.3 Dynamic response	Can ramp up power in a short time; can provide x time over power in a short time slot
24	3.4	Navy	B 3.4 Standardizable	Fits in many classes of ship
25	3.5	Navy	B 3.5 Affordability	Reduce implementation and operation cost for life cycle
26	3.6	Navy	B 3.6 Hotswappable	Hotswappable "Plug-and-Play" applications
27	4	CAPS Power Systems	4 Model Objectives	PEPDS Model key objectives
28	4.1	CAPS Power Systems	4.1 Program Communication	To become a vehicle to communicate PEPDS work progress and accomplishments
29	4.2	CAPS Power System	4.2 Single Source of Truth	This model is formal representation of PEPDS system in order to make clear: (1) Its structure, interfaces, and internal and external relationships (2) The behaviors exhibited by the entity and its elements, both internally and externally (3) The global rules to which the entity and its elements must conform in order to meet the requirements allocated to them, initially and over the entity's operational lifetime
30	4.3	CAPS Power System	4.3 Program Guideline	To guide and support solutioning of PEPDS modular architecture
31	5	Navy	E B 5 PEPDS Innovations	PEPDS innovations are dependent on using power electronics in an innovative way and utilizing advancements in technology and control capabilities
32	5.1	Navy	B 5.1 Ease of Installation as a Unit	Reduce installation time and cost by having construction and testing executable off ship and avoiding intensive cabling after ship construction
33	5.2	Navy	B 5.2 Load Interface Design	Common interface solution for all loads with increased possibilities of load interface spatial arrangement in the ship
34	5.3	Navy	B 5.3 Power Electronic Interfaces	All source and load interfaces are power electronics based and as such provide the required adaptability, reconfigurability, and fault current limitation
35	5.4	Navy	B 5.4 Self Learning	Ability to self learn by tracking performance and CBM+ data and analyzing control and protection activities
36	5.5	Navy	5.5 Integrated Control	Integrated electrical, thermal, and mechanical control
37	5.6	Navy	5.6 Functional Control	Control component and network functions through programming and reconfiguration
38	5.7	Navy	B 5.7 Adaptive Controls	Control algorithms self-adapt to changes in mission requirements, load performance, and system upgrades
39	5.8	Navy	5.8 Automated Self-check	Have self diagnosis or automated self-check after controls upgrades which would be an advanced concept of CHL with regression tests embedded in PEPDS (integrated "digital twin") – including cybersecurity aspects
40	5.9	Navy	B 5.9 Integrated CBM+	Condition based maintenance + fully integrated into design. Diagnosis, prognosis, and health prediction capabilities - down to the device level.
41	5.10	Navy	5.10 Comprehensive Application of the LRU Approach to the Entire System Design	Maximize the dependence on LRUs while minimizing the different types of LRUs
42	5.11	Navy	B 5.11 Simplified LRU Replacement	Utilize LRUs that are a size and weight carriable by a single sailor, that can fit through hatches, that requires minimal training for installation and removal, and has plug & play capabilities
43	5.12	Navy	B 5.12 Minimal Redundant Elements	Provide power quality to loads using fewer components by using distributed resources and integrated functionality such as advanced power electronic control across many converters, active filtering across many converters, and distributed storage
44	5.13	Navy	5.13 Integrated Power and Energy Power Distribution System	PEPDS is an integrated power and energy power distribution system which should have integrated power, propulsion, optimization, protection, filtering, storage, and control
45	5.14	Navy	B 5.14 Distributed Power Conversion	Distributed power conversion provides protection, filtering, and energy storage. It creates an interface for every load meaning there will be no single interface standard for all loads and that as or dc, frequency, voltage, power, etc. are tailored to meet individual load requirements
46	5.15	Navy	5.15 Reduce Conventional Switchgear	Integrate functionality of switchgear within the power electronics framework in order to reduce or eliminate use of conventional external switchgear and provide current limiting function - thereby reducing risk from high fault currents and hence improving reliability

Fig. 5: B1 Stakeholder Needs Table



Fig. 6: B1 Stakeholder Needs Diagram



Fig. 7: B3.1/W3.1 System Context and Logical Architecture (Review Part 1)



Fig. 8: B2.1 PEPDS Use Cases



Fig. 9: B2.2 PEPDS States and Modes



Fig. 10: B2.3 Operate PEPDS Scenario (Review Part 1)



#### Fig. 11: B3.2 System Context Interfaces



Fig. 12: B3.3/W3.3 Exchange Items



Fig. 13: B4 PEPDS MoEs (Review Part 1)

Legend		B4 Measurements of Effectiveness															
		🗄 📋 1 RAM MoE 📩 🛅 2 Operability MoE 🛛										Ē.					
			ġ.			ning.		ġ.					any.	SES	Ē-		
			Щ	Mot	All	<sup>10</sup>		Mot	/ Mc	Ϋ́	De	įbų.	erv-	YM	ЯÜ	afe	et/ F
			MN	lity	ider	ty N		₩	oility	dilic	MG	)istr	of S	afet	Σ	lel S	Safe
			RA	<u>de</u>	Itair	llide		rabi	ptat	rdat	stic	طر ال	lity.	35	afet	onr	Em
				Ava	Vair	Relie		Ope	Ada	Affo	ogi	Pow	Sua		S C	Pers	Syst
🖃 🛅 B1 Stakeholder Needs			7	2	2	5		18	6	2	4	7			8	6	3
🖹 🔳 1 Power Delivery	2						2	7				7					
E I.1 Power Efficiency	2	4					2	7				7					_
- 🖪 1.2 Power Density	2						2	7				7					
🖪 1.3 Reliability	3	3	7	7		7											
🖪 1.4 Robustness	2						2	7	7								
🖪 1.5 Resiliency	2	2	7			7											
	2	2	7			7											
🖹 🔳 2 Operability	2						2	7			7						
🖪 2.1 Maintainability	3	3	7	~	~												
🖪 2.2 Operator Trainability	2						2	7			~						
🔁 🖪 2.3 Safety	2													2	7	~	
🖪 2.3.1 Thermally Touchable	2													2	7	7	
🖪 2.3.2 Liftable	2													2	7	~	
2.3.3 Electrically Insulated	2													2	7	7	
- 3 2.4 Long Life Expectancy	2	2	7			7											
🛱 🖪 3 Scalability	2						2	~	~								
- 🖪 3.1 Serial Thermal Management	3													3	7	~	7
🖪 3.2 Parallel Redundancy	2	2	7			7											
🔁 🔳 3.3 Controllable																	
🖪 3.3.1 Software Reliability																	
🖪 3.3.2 Cyber Security	2													2	7		7
🔄 🖪 3.3.3 Dynamic response	2						2	7	-			~					
🖪 3.4 Standardizable	2						2	~	~	1000							
🖪 3.5 Affordability	2						2	7		7							
L B 3.6 Hotswappable	2						2	7	~								
E S PEPDS Innovations	2.0						-	_		Case 1	-						
5.1 Ease of Installation as a Unit	3						3	1		1	~						
🖪 5.2 Load Interface Design		6					1	-				7					
5.3 Power Electronic Interfaces	2						2	1				/					
🖪 5.4 Self Learning		. I															
- 8 5.5 Integrated Control	2						-										
5.6 Functional Control	2	а — 91					2	1	~								
5.7 Adaptive Controls	2						2	1	~						78		7
B 5.8 Automated Self-check	2	-	78		7									2	/		1
5.9 Integrated CBM+	2	2	1		/												
5.10 Comprehensive Application of t								7			7				7	7	_
5.11 Simplified LRU Replacement	4						2	7			/	7		2	1	1	_
5.12 Minimal Redundant Elements	2	1					2	1				/					
- U 5.13 Integrated Power and Energy P																	
5.14 Distributed Power Conversion	2						-	7				7					
🕒 5.15 Reduce Conventional Switchgea	2						2	1				1					-

#### Fig. 14: B4 PEPDS MoEs traced to B1 Stakeholder Needs
### 11.2.2 Problem Domain White Box Review



Fig. 15: B3.1/W3.1 System Context and Logical Architecture (Review Part 2)



Fig. 16: B2.3 Operate PEPDS Scenario (Review Part 2)



Fig. 17: W2.1 Control PEPDS



Fig. 18: W2.1.1 Control Information



Fig. 19: W2.1.2 Control PEPDS Capabilities



Fig. 20: W2.2 Protect PEPDS

ltern	Function	Potential Failure Mode	Potential Effects of Failure	Severity	Potential Causes of Failure	Occurance	Current Controls for Prevention/Detection	Detection	RPN
		PEPDS fail to de-energize specific section of system PEPDS fails to analyze capability needs							<b>—</b>
		PEPDS fails to analyze power load demands							
		PEPDS fails to assess impact of programming							
		PEPDS fails to command servicing and shedding of the loads PEPDS fails to configure power networks and components							$\vdash$
		PEPDS fails to control source power							
		PEPOS fails to betermine the correct course or action PEPOS fails to issue prioritized commands							
		PEPDS fails to map control strategy onto PEPDS actions PEPDS fails to perform CBM+							
		PEPDS fails to program communication networks							
		PEPDs fails to program components PEPDS fails to program power networks							
		PEPDS fails to send feedback to crew and ship control PEPDS fails to tailor power based on need							
		PEPDS fails to track and improve control strategy							
		PEPDs fails to track and improve need for maintenance PEPDS fails to update control strategy							
		The control capability fails to control PEPDS capabilities							$\vdash$
Constant Consubility	Control	The control capability fails to establish an interface with the crew							
control capaciticy	Control	energy storage capability							
		The control capability fails to establish an interface with the onboard and offboard power sources and loads							
		The control capability fails to establish an interface with the power conversion capability							
		The control capability fails to establish an interface with the							
		power transportation capability The control capability fails to establish an interface with the							
		protection capability The control ranability fails to establish an interface with the shin							<b>—</b>
		control							
		control capability tails to interface control strategy in the control activity							
		The control capability fails to monitor PEPDS The control capability fails to receive feedback from all other							
		capabilities The control canability fails to send commands to all other							
		capabilities							
		PEPDS fails to take counter measures to control abnormality in operations							
		PEPDS fails to address electrical power needs PEPDS fails to address ship control commands							
		PEPDS fails to address crew commands							
		Degradation of energy storage devices Energy storage charge rate exceeds acceptable range							
		Energy storage discharge rate exceeds acceptable range Energy Storage Overcharges							
		Energy Storage Overdischarges							
		PEPDS fails to store energy							
Energy Storage Capability	Store Energy	The energy storage capability fails to address commands from the control capability							
		The energy storage capability fails to address electrical power							
		The energy storage capability fails to deliver electrical power to							
		power conversion capability The energy storage capability fails to update energy storage							
		status to the protection capability							
	Allow Maintenance	Removal of LRU fails							
		PEPOS fails to perform device level maintenance URU fails to establish an interface with PEPOS							
		PEPDS fails to establish an interface with the shipyard PEPDS fails to establish an interface with the solvated							
	Establish Interface with External System	systems							
		PEPUs rais to establish an interface with the crew PEPUS fails to establish an interface with the electric ship							
		PEPDS fails to establish an interface with the offboard power systems							
		PEPDS detects a failure but does not go to off-nominal state from							
PEPDS		nominal state PEPDS fails to go to maintaining state from operating nominally							
		state REPOS fails to an to maintaining state from operating off-							
		nominally state							
	Transition States	PEPUS fails to go to off state after maintenance PEPUS fails to go to off state after performing SHIPALT							
		PEPDS fails to operate nominally after maintenance is completed							L
		PEPUs tails to operate omnominally after a repair is performed PEPDS fails to recover autonomously from operating off-							
		nominally PEPDS fails to shutdown							
		PEPDS fail to convert power for problems other than voltage,							
		Power conversion fails to meet current specification							
		Power conversion fails to meet frequency specification Power conversion fails to meet phase specification							
		Power conversion fails to meet voltage specification							
Power Conversion Capability	Convert Power	the control capability							
		The power conversion capability fails to address electrical power from the energy storage capability							L
		The power conversion capability fails to address electrical power							
		The power conversion capability fails to establish an interface							
		with the energy storage capability The power conversion capability fails to update power conversion							
		status to the protection capability Ark flashing							
		Conductor to ground short							
		Fault currents							
		Internal electrical short detected Line to ground short							
		Line to line short PEPDS fail to deliver power to loads							
		PEPDS fail to distribute power							
		PEPUS fail to receive power from off-board power sources PEPDS fail to receive power from on-board power sources							
		The power transportation capability fails to accommodate electrical power from the power conversion capability							L
Rouse Transportation Capability	Transport Rowar	The power transportation capability fails to deliver electrical power to loads							
a sourceparently		The power transportation capability fails to establish an interface							
		The power transportation capability fails to establish an interface		-					
		with the offboard power systems The power transportation capability fails to establish an interface							
		with the onboard power systems The power transportation ranability fails to establish as in-							$ \rightarrow $
		with the power conversion capability							
		from the control capability							
		The power transportation capability fails to receive electrical power from sources							
		The power transportation capability fails to update power transportation status to the protection cavability							
		Change in System Functions							
		control capability							
		ine protection capability fails to analyze PEPDS performance based on feedback from other capabilities							
		The protection capability fails to analyze power and source interface characteristics							
		ne protection capability fails to determine need for safety, performance and resilience based on protection strategy							
		The protection capability fails to diagnose or prognose the fails re-							
Protection Capability	Provide Protection	The protection capability fails to establish an interface with the energy storage capability							
		The protection capability fails to establish an interface with the							
		power conversion capability The protection capability fails to establish an interface with the							
		power transportation capability						-	
		detection of a fault							
		the protection capability fails to send the the protection status to the control capability							
		Uncontained cybersecurity intrusion Undetected cybersecurity intrusion		-					
		Unresolved cybersecurity intrusion							
		Insuequate capability to drain used coolant Leakage in coolant system							
		PEPDS fails to maintain thermal situation during continuous operations							
		PEPDS fails to manage external environmental services							
		PEPDS fails to regulate environmental load from capabilities							
		The thermal management capability fails to address commands from the control capability							1
		The thermal management capability fails to dissipate thermal Inad automation PEPDS							
		The thermal management capability fails to establish an interface							
		with the control capability The thermal management capability fails to establish an interface							
		with the electric ship. The thermal management canability fails		-					
Thermal Management Capability	Manage Thermal Load	with the energy storage capability							
		The thermal management capability fails to establish an interface with the power conversion capability							
		The thermal management capability fails to establish an interface with the power transportation canability							
		The thermal management capability fails to establish an interface							
		The thermal management capability fails to regulate PEPDS							
		Internal thermia load The thermal management capability fails to update thermal							
		management status to the control capability The thermal monagement capability							
		management to the protection strategy							
		Inernal degradation Used coolant exposed to oxygen							

### Fig. 21: W2.2.1 PEPDS FMECA



Fig. 22: W2.3 Distribute Power



Fig. 23: W2.4 Manage Thermal Load of PEPDS



Fig. 24: W3.2 PEPDS Interface Diagram



Fig. 25: B4 PEPDS MoEs (Review Part 2)

#	Owner	Name	MoPs
1	Operability MoEs	Adaptability MoPs	Application Adaptability Scalability Robustness Survivability Applicable Ship Classes
2	Dperability MoEs	Affordability MoPs	Removal Cost     Installation Cost     Operation Cost     Implementation Cost
3	Operability MoEs	Logistics MoPs	LMS Manning     LMS Training     Operation Manning     Operator Manning     Operator Training     Effectiveness of Support Capability     Removal Time     Installation Time
4	Dperability MoEs	Power Distribution MoPs	Specific Energy Power Density Response Time Power Electronic Utilization Transmission Efficiency Recharge C Rate Conversion Efficiency Discharge C Rate
5	Operability MoEs	Quality of Service MoPs	Mean Time to Resolve Service Interruption of Un-Interruptible Load Mean Time to Resolve Service Interruption of Short Term Interrupt Load Survival Service Time for Un-Interruptible Load Survival Service Time for Short Term Interrupt Load Mean Time to Resolve Service Interruption Survival Service Time Mean Time to Resolve Service Interruption of Long Term Interrupt Load Survival Service Time for Long Term Interrupt Load
6	RAM MoEs	Availability MoPs	Inherent Availability Operational Availability Achieved Availability
7	RAM MoEs	🔲 Maintainability MoPs	Mean Operating Hours between False Alarm Percent BIT Fault Detection Percent BIT Fault Isolation Mean Down Time Maintenance Burden
8	RAM MoEs	Reliability MoPs	Mean Time Between Repairs Mean Time Between Maintenance Resiliency Quality of Service MoPs Power Delivery Reliability Life Expectancy Mean Time Between Failure
9	Safety MoEs	🥃 Personnel Safety MoPs	LRU s Transportability LRU s Liftability Electrical Safety Thermal Safety
10	Safety MoEs	🥃 System Safety MoPs	Tolerance to Environmental Loads Mean Time to Contain Cybersecurity Intrusion Mean Time to Resolve Cybersecurity Intrusion Mean Time to Detect Cybersecurity Intrusion

Fig. 26: W4 Measurements of Performance



Fig. 27: W4.1 RAM MoEs



Fig. 28: W4.2 Operability MoEs



Fig. 29: W4.3 Safety MoEs

## **11.2.3 Solution Domain S1 System Requirements Review**

# 11.2.3.1 S1 System Requirements



#### Fig. 30: S1 PEPDS Requirements

## 11.2.3.2 S1 System Requirements Diagrams



Fig. 31: S1.1 PEPDS Requirements Part 1.1



Fig. 32: S1.1 PEPDS Requirements Part 1.2

PEPDS	Operations
FLFDS	Operations



#### Fig. 33: S1.1 PEPDS Requirements Part 2.1





#### Fig. 34: S1.1 PEPDS Requirements Part 2.2



#### Fig. 35: S1.1 PEPDS Requirements Part 2.3



**PEPDS Performance Metrics** 

#### PEPDS Components, Structure, and Interfaces

Fig. 36: S1.1 PEPDS Requirements Part 3.1



Fig. 37: S1.1 PEPDS Requirements Part 3.2



Fig. 38: S1.2.1 Control Capability Requirement Part 1



Fig. 39: S1.2.1 Control Capability Requirement Part 2



Fig. 40: S1.2.1 Control Capability Requirement Part 3



Fig. 41: S1.2.2. Protection Capability Requirements



Fig. 42: S1.2.3 Electrical Distribution Capability Requirements



Fig. 43: S1.2.4 Thermal Management Capability Requirements

## 11.2.3.3 S1 System Requirements Traceability Matrices



Fig. 44: S1-B1 PEPDS Requirements and Stakeholder Needs Traceability Matrix



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Fig. 46: S1-B3-W3 PEPDS Requirements and PEPDS Structure Traceability Matrix



Fig. 47: S1.1.3-B4-W4 PEPDS Requirements and PEPDS Parameters Traceability Matrix

# 11.2.3.4 S1 System Requirements Table

#	△ Name	Text	Traced To	Source	Verify Method	Risk	Revision Date
1	S1.1 PEPDS Requirements						
2	S1.1.1 PEPDS Generic Power System Requirem	r					
3	S1.1.1.1 PEPDS States and Modes						
4	F S1.1.1.1	PEPDS shall have an Operating state in which it is electrically active and functions are available.	PEPDS (***) Operating	[ref 45]	Analysis		2022.11.15
5	<b>F</b> S1.1.1.12	PEPDS shall fulfil mission requirements to the maximum extent possible in all modes of the Operating state.	Operating     1.4 Robustness     1.5 Resiliency     PEPDS	[ref 36]	Analysis		2022.11.15
6	F S1.1.1.1.3	PEPDS shall have an Off state in which it is electrically inert and non-functional.	PEPDS Off	[ref 45]	Analysis		2022.11.15
7	F 51.1.1.14	PEPDS shall transition to the Off state from any other state upon command or complete failure via controlled, graceful, and failsafe shutdown.	PEPDS Controlled Shutdown Forced   Controlled Shutdown Off Complete Install   Remove Complete Install   Remove Commands Failure	[ref 45]	Analysis		2022.11.15
8	E S1.1.1.2 PEPDS Operations						
34	E S1.1.1.3 PEPDS Components and Structure	e					
44	S1.1.2 PEPDS Innovative Requirements						
80	E S1.1.3 PEPDS Performance Metrics						
204	E S1.2 Capability Requirements						

Fig. 48: S1.1.1.1 PEPDS States and Modes

#	△ Name	Text	Traced To	Source	Verify Method	Risk	Revision Date
1	S1.1 PEPDS Requirements						
2	S1.1.1 PEPDS Generic Power System Requiren     S1.1.1.1 PEPDS States and Modes					-	
8	<ul> <li>\$1.1.1.2 PEPOS Operations</li> <li>\$1.1.1.2.1</li> </ul>	PEPDS shall startup on Commands (e.g. blackstart, coldstart).	PEPDS Startup	[ref 54]	Analysis		2022.11.15
		PEPDS shall meet general human engineering design criteria	Commands		-	-	2022.11.15
10	S1.1.1.2.2	specified by MIL-STD-1472H including tagout of components for maintenance or repair, physical access, liftability. PEPDS shall transfer Environmental Load to Ship Body.	2.3 Safety     Crew     Ship Body	[ref 43]	Analysis		2022.11.15
11	<b>S1.1.1.2.3</b>		Environmental Load     EPDS     W2.4 Manage Thermal Load of PEPDS	[ref 40]	Analysis		
12	III S1.1.1.2.4	PEPDS shall accommodate Environmental Load naturally transferred from the Electric Ship.	PEPDS     Environmental Load     Electric Ship     W2.4 Manage Thermal Load of PEPDS	[ref 40]	Analysis		2022.11.15
13	🖬 SI.1.1.2.5	PEPDS shall execute Crew Commands according to priorities established by 1) the Crew 2) Ship Control, or 3) autonomous operations in descending order of priority.	PEPDS Crew Ship Control Commands W W2.1 Control PEPDS	(ref 54)	Analysis		2022.11.15
14	II S1.1.1.2.6	PEPDS shall execute Crew Commands overriding Ship Control Commands and PEPDS autonomous operations.	PEPDS Crew Commands Ship Control W.2.1 Control PEPDS	[ref 54]	Analysis		2022.11.15
15	■ S1.1.1.2.7	PEPDS shall execute Ship Control Commands overriding PEPDS autonomous operations.	PEPDS Commands Ship Control W2.1 Control PEPDS	[ref 40]	Analysis		2022.11.15
16	I S1.1.1.2.8	PEPDS shall send Feedback (e.g. operational status, health status, falure dagnosis, falure prognosis, control strategy, cybersecurity status) to Crew.	PEPDS Feedback Crew Control Strategy W2.1 Control PEPDS	[ref 54]	Analysis		2022.11.15
17	<b>F</b> S1.1.1.2.9	PEPOS shall send Feedback (e.g. operational status, health status, falure dagnous; falure prognosis, control strategy, cybersecurity status) to Ship Control.	Ship Control Feedback Feedback Control Strategy W2.1 Control PEPDS	[ref 40]	Analysis		2022.11.15
18	I SI.1.1.2.10	PPD's shall be able to bathoute Bectrical Power from any available source to served loads based on priorities.	PPDS     Bechical Power     Criboard Power Sources     Onboard Power Loads     Power Delivery     W2.3 Distribute Power     Offboard Power Systems	[ref 50] [ref 52]	Analysis		2022.11.15
19	■ \$1.1.1.2.11	PEPDS shall receive Electrical Power from Onboard Power Sources including generators, regenerators, and energy storage.	Onboard Power Sources     Electrical Power     PEPDS     Power Delivery     W2.3 Distribute Power	[ref 40]	Analysis		2022.11.15
20	☑ \$1.1.1.2.12	PEPDS shall accommodate receiving Electrical Power from Onboard Power Loads.	PEPDS     Ectrical Power     Onboard Power Loads     I Power Delivery     W2.3 Distribute Power	[ref 40]	Analysis		2022.11.15
21	☑ S1.1.1.2.13	PEPDS shall receive Electrical Power from Offboard Power Systems when appropriately connected.	Offboard Power Systems Electrical Power PPDS I POwer Delivery W2.3 Distribute Power	[ref 40]	Analysis		2022.11.15
22	S1.1.1.2.14	PEPDS shall deliver Electrical Power to Orboard Power Loads.	Onboard Power Loads  Electrical Power  PPDS  1 Power Delivery  W2.3 Distribute Power	[ref 40]	Analysis		2022.11.15
23	☑ S1.1.1.2.15	PEPDS shall accommodate delivering Electrical Power to Onboard Power Sources.	PEPDS  Extract Power  Coboard Power  Coboard Power Sources  I Power Delivery  W2.3 Distribute Power	[ref 40]	Analysis		2022.11.15
24	☑ S1.1.1.2.16	PEPDS shall deliver Electrical Power to Offboard Power Systems when appropriately connected.	Offboard Power Systems Ectrical Power PEPDS I Power Delivery W2.3 Distribute Power	[ref 40]	Analysis		2022.11.15
25	SI.1.1.2.17	PEPDS should maximize alternative electrical paths to service Onboard Power Loads.	PEPDS Onboard Power Loads O W2.3 Distribute Power	[ref 44]	Analysis		2022.11.15
26	S1.1.1.2.18	PEPDS shall provide at least two electrical paths to service mission critical loads.	PEPDS W2.3 Distribute Power Onboard Power Loads	[ref 44]	Analysis		2022.11.15
27	S1.1.1.2.19	PEPDS should maximize alternative electrical paths from each Onboard Power Source.	PEPDS Onboard Power Sources U 2.3 Distribute Power	[ref 44]	Analysis		2022.11.15
28	S1.1.1.2.20	PEPDS shall have at least two electrical paths from every Onboard Power Source.	PEPDS Onboard Power Sources ON 2.3 Distribute Power	[ref 44]	Analysis		2022.11.15
29	I \$1.1.1.2.21	PEPDS shall maximize separation between alternative electrical paths.	PEPDS     W2.3 Distribute Power     Offboard Power Systems     Onboard Power Loads     Onboard Power Sources	[ref 44]	Analysis		2022.11.15
30	51.1.1.2.22	PEPDS shall receive Onboard Power Source Characterization from the Electric Ship.	PEPOS     Characterization     Onboard Power Sources     Electric Ship     W2.1 Control PEPDS	[ref 44]	Analysis		2022.11.15
31	<b>51.1.1.2.23</b>	IPEPOS shall receive Onboard Power Load Characterization from the Electric Ship.	PEPDS     Characterization     Onboard Power Loads     Electric Ship     W2.1 Control PEPDS	[ref 40]	Analysis		2022.11.15
32	I \$1.1.1.2.24	PEPDS shall receive Offboard Power Source Characterization from the Electric Systems.	PEPDS     Offboard Power Systems     Characterization     Electric Systems     W2.1 Control PEPDS	[ref 44]	Analysis		2022.11.15
33	S1.1.1.2.25	PEPDS shall receive Offboard Power Load Characterization from the Electric Systems.	PEPDS     Characterization     Offboard Power Systems     Electric Systems     W2.1 Control PEPDS	[ref 44]	Analysis		2022.11.15
34 44	S1.1.1.3 PEPDS Components and Structure     S1.1.2 PEPDS Innovative Permittement						
80	S1.1.3 PEPDS Performance Metrics						
204	E 🛅 S1.2 Capability Requirements						

# Fig. 49: S1.1.1.2 PEPDS Operations

#	△ Name	Text	Traced To	Source	Verify Method	Risk	Revision Date
1	S1.1 PEPDS Requirements						
2	S1.1.1 PEPDS Generic Power System Requirem	n					
3	E S1.1.1.1 PEPDS States and Modes						
8	E S1.1.1.2 PEPDS Operations						
34	S1.1.1.3 PEPDS Components and Structure						
35	<b>F</b> 51.1.1.3.1	PEPDS is a part of the Electric Systems on the Electric Ship.	Electric Systems Electric Ship	[ref 40]	Analysis		2022.11.15
36	F S1.1.1.3.2	PEPDS shall be installable by standard US Navy SHIPALT processes.	PEPDS Performing SHIPALT	[ref 59]	Analysis		2022.11.15
37	F S1.1.1.3.3	PEPDS shall be removable by standard US Navy SHIPALT processes.	PEPDS Performing SHIPALT	[ref 59]	Analysis		2022.11.15
38	F S1.1.1.3.4	PEPDS components shall be LRUs or Non-LRUs.	PEPDS LRUs Non-LRUs	[ref 46]	Analysis		2022.11.15
39	F S1.1.1.3.5	PEPDS shall have LRUs installed, removed, and replaced by the Crew.	PEPDS LRUs Crew Replace LRUs 2.2 Operator Trainability	[ref 7]	Analysis		2022.11.15
40	F S1.1.1.3.6	PEPDS LRUs shall have spares in Electric Ship stores which are stocked by the U.S. Navy Supply System.	LRUs	[ref 60]	Analysis		2022.11.15
41	F S1.1.1.3.7	PEPDS shall comply with applicable EMI/EMC standards (i.e. not adversely affect external equipment)	PEPDS	[ref 49]	Analysis		2022.11.15
42	S1.1.1.3.8	PEPDS shall provide means to isolate common mode paths between Onboard Power Sources and Onboard Power Loads to the extent required so that PEPDS can provide the appropriate Quality of Service to the Onboard Power Loads while minimizing damage or disruption of PEPDS external equipment.	PEPDS Quality of Service Onboard Power Loads Onboard Power Sources	[ref 39]	Analysis		2022.11.15
43	S1.1.1.3.9	PEPDS shall provide means to isolate common mode paths between Onboard Power Loads to the extent required so that PEPDS can provide the appropriate Quality of Service to the Onboard Power Loads while minimizing damage or disruption of PEPDS external equipment.	PEPDS Quality of Service Onboard Power Loads	[ref 39] [ref 44]	Analysis		2022.11.15
44	S1.1.2 PEPDS Innovative Requirements						
80	S1.1.3 PEPDS Performance Metrics						
204	S1.2 Capability Requirements						

Fig. 50: S1.1.1.3 PEPDS	<b>Components and</b>	Structure					
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#	△ Name	Text	Traced To	Source	Verify Method	Risk	Revision Date
-----	--	--	---	---------------------------------	------------------	------	---------------
1	S1.1 PEPDS Requirements					_	
2	E S1.1.1 PEPDS Generic Power System Requirem						
44	S1.1.2 PEPDS Innovative Requirements						
45	S1.1.2.1 Innovative PEPDS States, Modes,						
46	B S1.1.2.1.1	The PEPDS Operating state shall function in one of the following states: 1) Operating Nominally state, 2) Operating Off-Nominally state, or 3) Maintaining state.	PEPDS     POParating     Operating Nominally     Operating Off-Nominally     Maintaining     1.4 Robustness	[ref 7]	Analysis		2022.11.15
47	S1.1.2.1.2	PEPDS in all states of its Operating state shall utilize power sources to service power loads in accordance with its Control Strategy, Ship Control Commands, and Crew Commands.	PEPDS  Control Strategy  Control Strategy  Offboard Power Systems  I Power Delivery  Onboard Power Sources  Onboard Power Loads  Commands  Crew Ship Control	[ref 45] [ref 50] [ref 52] [ref	Analysis		2022.11.15
48	F S1.1.2.1.3	PEPDS in its Operating Off-Nominally state shall attempt to autonomously resolve failures by rerouting, reconfiguring, and reprogramming.	PEPDS  Peptos  Autonomously Recovered  5.7 Adaptive Controls  5.8 Automated Self-check  Fallure	[ref 50]	Analysis		2022.11.15
49	<b>S</b> 1.1.2.1.4	PEPDS in its Maintaining state shall enable Crew reprogramming, reconfiguring, and replacement of LRUs.	PEPDS PepDS Paintaining Preve RUs S.9 Integrated CBM+ S.5 Integrated CBM+ S.5 Pintegrated CBM+ S.5 Pintenal Control S.5 Functional Control S.5 Pintenal Control Replace LNUs PepDS Maintain PEPDS	[ref 7] [ref 50]	Analysis		2022.11.15
50	F S1.1.2.1.5	PEPDS shall transition from Operating Nominally state to Operating Off-Nominally state when PEPDS has detected a Failure.	PEPDS     Operating Nominally     Operating Off-Nominally     Failure     1.5 Resiliency     Failure	[ref 7]	Analysis		2022.11.15
51	F S1.1.2.1.6	PEPDS shall transition from Operating Off-Nominally state to Operating Nominally state upon autonomous recovery of all detected Failures.	PEPDS Operating Nominally Operating Off-Nominally autonomously Recovered Failure Failure Sature Sature	[ref 50] [ref 58]	Analysis		2022.11.15
52	<b>S</b> 1.1.2.1.7	PEPDS shall transition from Operating Nominally state to Maintaining state when there is an Evidence of Need for Maintenance.	FePDS     Maintaining     Evidence of Need for Maintenance     Operating Nominally     S.9 Integrated CBM+	[ref 50] [ref 58]	Analysis		2022.11.15
53	F S1.1.2.1.8	PEPDS shall transition from the Maintaining state to the Operating Nominally state when Maintenance Completed.	PEPDS     Maintaining     Operating Nominally     Maintenance Completed     5.9 Integrated CBM+	[ref 7]	Analysis		2022.11.15
54	I S1.1.2.1.9	PEPDS shall transition from Maintaining state to Operating Off- Nominally state after getting Repaired.	PEPDS     Maintaining     Operating Off-Nominally     Repaired     5.9 Integrated CBM+	[ref 50]	Analysis		2022.11.15
55	S1.1.2.1.10	PEPDS shall transition from Operating Off-Nominally state to Maintaining state when there is an Evidence of Need for Repair.	PEPDS     Operating Off-Nominally     Maintaining     Evidence of Need for Repair     5.9 Integrated CBM+	[ref 7]	Analysis		2022.11.15
56	S1.1.2.1.11	PEPDS shall have a Performing SHIPALT state for the purpose of installation or removal of PEPDS.	Performing SHIPALT     PEPDS     Complete Install   Remove     5.1 Ease of Installation as a Unit	[ref 45] [ref 7] [ref 50]	Analysis		2022.11.15
57	S1.1.2.1.12	PEPDS shall transition to Performing SHITPALT state to Initiate Install   Remove of PEPDS only if in a Shipyard.	PEPDS     Performing SHIPALT     Initiate Install   Remove     Shipyard     5.1 Ease of Installation as a Unit	[ref 7]	Analysis		2022.11.15
58	S1.1.2.2 Innovative PEPDS Operations	•					
80	S1.1.2.3 PEPDS Innovative Components, S	۶ 					
204	S1 2 Canability Requirements						
-97	orrecopoonty requirements	1	1	I			

### Fig. 51: S1.1.2.1 Innovative PEPDS States, Modes, and Transitions

#	△ Name	Text	Traced To	Source	Verify Method	Risk	Revision Date
1	S1.1 PEPDS Requirements						
2	S1.1.1 PEPDS Generic Power System Requirem						
44	S1.1.2 PEPDS Innovative Requirements						
45	E S1.1.2.1 Innovative PEPDS States, Modes	,					
58	S1.1.2.2 Innovative PEPDS Operations						
59	■ S1.1.2.2.1	PEPDS shall execute control, carry out protection, distribute power, and manage thermals functions simultaneously.	PEPDS UP V2.1 Control PEPDS UP V2.2 Protect PEPDS UP V2.3 Distribute Power UP V2.4 Manage Thermal Load of PEPDS UP 5.13 Integrated Power and Energy Pc UP 5.13 Integrated Pow	[ref 50] [ref 52] [ref 58]	Analysis		2022.11.15
60	I S1.1.2.2.2	Shutdown of PEPDS should only be necessary while docked for extensive maintenance or SHIPALT.	Controlled Shutdown Performing SHIPALT PFDS Shutdown I.1. Maintainability I.3. Reliability I.5. Ease of Installation as a Unit	[ref 7] [ref 45] [ref 50]	Analysis		2022.11.15
61	F S1.1.2.2.3	PEPDS shall be capable of receiving Electrical Power from all power sources simultaneously.	PEPDS Onboard Power Sources Offboard Power Systems 5.14 Distributed Power Conversion W. W2.3 Distribute Power Electrical Power	[ref 52] [ref 58]	Analysis		2022.11.15
62	I S1.1.2.2.4	PEPDS shall be capable of receiving Electrical Power in any form from any power source.	PEPDS     Electrical Power     Orboard Power Sources     Ofboard Power Systems     5.14 Distributed Power Conversion     W2.3 Distribute Power	[ref 52] [ref 58]	Analysis		2022.11.15
63	I S1.1.2.2.5	PEPDS shall be capable of distributing Electrical Power to all Onboard Power Loads simultaneously.	PEPDS     Onboard Power Loads     5.14 Distributed Power Conversion     Electrical Power     @ W2.3 Distribute Power	[ref 52] [ref 58]	Analysis		2022.11.16
64	I S1.1.2.2.6	PEPDS shall be capable of distributing Electrical Power conditioned for each individual Onboard Power Load.	PEPDS     5.14 Distributed Power Conversion     W2.3 Distribute Power     Onboard Power Loads     Electrical Power	[ref 52] [ref 58]	Analysis		2022.11.16
65	I S1.1.2.2.7	PEPDS shall receive services from the Electric Ship in order to manage its Environmental Load such as Chilled Water and Forced Air as appropriate for the design.	Electric Ship PEPDS Finite Content of the second s	[ref 40]	Analysis		2022.11.15
66	🗄 📋 S1.1.2.3 PEPDS Innovative Components, S						
80	S1.1.3 PEPDS Performance Metrics						
204	S1.2 Capability Requirements						

Fig. 52: S1.1.2.2 Innovative PEPDS Operation	ons
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#	△ Name	Text	Traced To	Source	Verify Method	Risk	Revision Date
1	S1.1 PEPDS Requirements						
2	🗄 📋 S1.1.1 PEPDS Generic Power System Requiren						
44	S1.1.2 PEPDS Innovative Requirements						
45	E S1.1.2.1 Innovative PEPDS States, Modes	,					
58	E S1.1.2.2 Innovative PEPDS Operations						
66	S1.1.2.3 PEPDS Innovative Components, S						
		PEPDS shall be a Navy shipboard power and energy distribution	Electric Ship				2022.11.15
67	F S1.1.2.3.1	system.	PEPDS	[ref 52] [ref 58]	Analysis		
			5.13 Integrated Power and Energy Power				
		PEPDS shall minimize the number of unique LRU types.	PEPDS				2022.11.15
68	F S1.1.2.3.2		LRUs L	[ref 50] [ref 58]	Analysis		
			5.10 Comprehensive Application of th				
		PEPDS LRUs shall be replaceable onboard, underway, by ship's	Replace LRUs				2022.11.15
		Crew.	PEPDS PEPDS				
69	F S1.1.2.3.3		Crew Crew	[ref 7]	Analysis		
			LRUs LRUs		,,		
			5.11 Simplified LRU Replacement				
			C Maintain PEPDS				
70	F S1.1.2.3.4	LRUs should be hot swappable (i.e. able to be safely exchanged	LRUs L	[ref 50]	Analysis		2022.11.15
		by personner while the sun ounding equipment is energized)	B 3.6 Hotswappable				
		PEPDS Non-LRUs shall be verifiable as an assembly prior to	PEPDS				2022.11.15
71	F S1.1.2.3.5	instaliation and post instaliation.	Non-LRUs	[ref 50]	Analysis		
			5.1 Ease of Installation as a Unit				
72		PEPDS Non-LRUs shall be removable as an assembly.	PEPDS				2022.11.15
	F S1.1.2.3.6		Non-LRUs	[ref 50]	Analysis		
			5.1 Ease of Installation as a Unit				
		PEPDS Non-LRUs shall be installable as an assembly.	PEPDS				2022.11.15
73	F S1.1.2.3.7		Non-LRUs	[ref 50]	Analysis		
			5.1 Ease of Installation as a Unit				
		PEPDS Non-LRUs shall be assemblable prior to installation.	PEPDS				2022.11.15
74	F S1.1.2.3.8		Non-LRUs	[ref 50]	Analysis		
			5.1 Ease of Installation as a Unit				
		PEPDS components shall provide maximum reconfigurability so as	PEPDS				2022.11.15
75	F S1.1.2.3.9	a part.	Non-LRUs	[ref 50]	Analysis		
			5.6 Functional Control				
		property shall accord any income an annual state	LKUS				2022 11 15
		order to permit changing their individual functionality	PEPDS				2022.11.15
70		,		[	Amelini		
/0	F 51.1.2.3.10		Non-LRUS	[rer b0]	Analysis		
			5.6 Functional Control				
		PERDS shall maximize the tappable locations for Opheard Rewer	Program				2022 11 15
77	<b>6</b> 51 1 2 3 11	Loads.	Coheard Bewer Leads	[ref 44] [ref 50] [ref 52]	Analysis		2022.11.13
//	<b>1</b> 31,1,2,3,11		5 21 and Interface Design	per +4 (rei soj (rei 52)	Andrysis		
		PEPDS shall maximize the tannable locations for Onboard Power	S peope				2022 11 15
78	E S1 1 2 3 12	Sources.	Coheard Bawer Sources	[ref 50] [ref 52]	Analysis		
/0	<b>1</b> 31, 1, 2, 3, 12		5 21 and Interface Design	per soj per szj	Andrysis		
		PEPDS load interfaces shall maximize possible costial arrangements	S people				2022 11 15
70	E \$1 1 7 3 13	while maximizing likelihood of correct connection.	F 21 and Interface Design	[ref 50] [ref 52]	Analysis		2022.11.13
/9	F \$1.1.2.3.13	-	D. 2 Load Interface Design     Opheand Device Loads	[rer bo] [rer b2]	Analysis		
80	E C1 1 2 DEDDS Derformance Matrice		Choodru Power Loaus				
204	S1 2 Canability Requirements						
201	B S12 Capability Requirements						

Fig. 53: S1.1.2.3 PEPDS Innovative Components, Structure, and Interfaces

#	△ Name	Text	Traced To	Source	Verify Method	Risk	Revision Date
1	S1.1 PEPDS Requirements						
2	① S1.1.1 PEPDS Generic Power System Requirem	n					
44	S1.1.2 PEPDS Innovative Requirements						
80	S1.1.3 PEPDS Performance Metrics						
81	S1.1.3.1 PEPDS RAM						
82	S1.1.3.1.1 Availability	proposited and the operation of the definition of the sector of the sect					2022 44 45
83	P S1.1.3.1.1.1	PEPUS shall maximize operational Availability achieving a minimum threshold of 0.995.	PPDS     Coperational Availability     Threshold = 0,995     Operational Availability     RAM MoEs     Availability MoPs     B4 MoEs	[ref 33] [ref 35]	Analysis		2022.11.15
84	P 51.1.3.1.1.2	PEPDS should maximize Operational Availability achieving a minimum goal of 1.0.	PEPDS Portional Availability Goal = 1.0 Portional Availability Availability Availability Availability Availability PoPs PHMCEs	[ref 33] [ref 35]	Analysis		2022.11.15
85	₽ S1.1.3.1.1.3	PEPDS shall maximize Inherent Availability achieving a minimum threshold of TBD.	PEPDS     Inherent Availability     Inherent Availability     Treshold = TBD     RAM MoEs     Availability MoPs     B4 MoEs	[ref 33] [ref 35]	Analysis		2022.11.15
86	P S1.1.3.1.1.4	PEPDS should maximize Inherent Availability achieving a minimum goal of TBD.	PEPDS Dependent Availability Goal = TBD Inherent Availability RAM MoEs Availability MoPs B4 MoEs	[ref 33] [ref 35]	Analysis		2022.11.15
87	I S1.1.3.1.1.5	PEPDS shall maximize Achieved Availability achieving a minimum threshold of TBD.	PEPDS     Arailability     Threshold = 180     Arhived Availability     Arhived Availability     Arhived Availability     Availability     Availability MoPs     Availability MoPs     B4 MoEs	[ref 33] [ref 35]	Analysis		2022.11.15
88	₽ S1.1.3.1.1.6	PEPDS should maximize Achieved Availability achieving a minimum goal of TBD.	PEPDS     Arhived Availability     Goal = TED     Arhived Availability     Adhived Availability     Adhived Availability     Adhived Availability     Availability MoPs     Availability MoPs     B4 MoEs	[ref 33] [ref 35]	Analysis		2022.11.15
89	🗄 📋 S1.1.3.1.2 Maintainability						
100	🗄 📋 S1.1.3.1.3 Reliability						
113	🗄 📋 S1.1.3.2 PEPDS Operability						
185	🗄 🛅 S1.1.3.3 PEPDS Safety						
204	🗉 📋 S1.2 Capability Requirements						

Fig. 54: S1.1.3.1.1 Availability

#	△ Name	Text	Traced To	Source	Verify Method	Risk	Revision Date
1	S1.1 PEPDS Requirements      S1.1 1 PEPDS Constric Power System Page iron						
44	S1.1.2 PEPDS Generic Power System Requirements						
80	S1.1.3 PEPDS Performance Metrics						
81	S1.1.3.1 PEPDS RAM						
82	🗄 🛅 S1.1.3.1.1 Availability						
89 90	<ul> <li>S1.1.3.1.2 Maintainability</li> <li>S1.1.3.1.2.1</li> </ul>	PEPDS shall minimize Maintenance Burden achieving a maximum threshold of TBD.	Maintenance Burden PEPDS Maintenance Burden Threshold = TBD C. Maintanability RAM MoEs Maintanability MoPs	[ref 23] [ref 33]	Analysis		2022.11.15
91	P S1.1.3.1.2.2	PEPDS should minimize Maintenance Burden achieving a maximum goal of TED.	H4 MoEs     Maintenance Burden     PEPDS     Maintenance Burden     Goal = TBD     1.1 Maintainability     RAM MoEs     Maintainability MoPs     H4 MoEs	[ref 23] [ref 33]	Analysis		2022.11.15
92	P S1.1.3.1.2.3	PEPDS shall minimize Mean Down Time achieving a maximum threshold of TBD.	PEPDS     Mean Down Time     Mean Down Time     Timeshold = TBD     2.1 Maintainability     AM MoEs     Maintainability MoPs     64 MoEs	[ref 33] [ref 35]	Analysis		2022.11.15
93	I S1.1.3.1.2.4	PEPDS should minimize Mean Down Time adhieving a maximum goal of TBD.	PEPDS     Mean Down Time     Gal = TBD     2.1 Maintainability     RaM MoEs     Maintainability MoPs     94 MoEs	[ref 33] [ref 35]	Analysis		2022.11.15
94	I S1.1.3.1.2.5	PEPDS shall maximize Percent Fault Detection achieving a minimum threshold of TBD.	PEPDS     Pro     Prot     Prot     Procent BIT Fault Detection     U Threshold = TBD     2.1 Maintainability     RAM MoEs     Maintainability MoPs     94 MoEs	[ref 33]	Analysis		2022.11.15
95	I S1.1.3.1.2.6	PEPDS should maximize Percent Fault Detection achieving a minimum goal of TBD.	PEPDS Prob Prob Prob 2 Gal = TBD 2.1 Maintainability Maintainability MoPs Maintainability MoPs E4 MoEs	[ref 33]	Analysis		2022.11.15
96	P S1.1.3.1.2.7	PEPDS shall maximize Percent Fault Isolation achieving a minimum threshold of TBD.	PEPDS     Percent BIT Fault Isolation     Trreshold = TBD     2.1 Maintainability     Maintainability     Maintainability MoPs     64 MoEs	[ref 33]	Analysis		2022.11.15
97	P S1.1.3.1.2.8	PEPDS should maximize Percent Fault Isolation achieving a minimum goal of TBD.	PEPDS     Pri     Prent BIT Fault Isolation     Gaal = TBD     2.1 Maintainability     Maintainability MoPs     Maintainability MoPs     64 MoEs	[ref 33]	Analysis		2022.11.15
98	P S1.1.3.1.2.9	PEPDS shall maximize Mean Operating Hours Between False Alarms achieving a minimum threshold of TBD.	PEPDS     MOHBFA     MoHBFA     Mean Operating Hours between False     Vi Threshold = TBD     2.1 Maintainability     AM MoEs     Maintainability MoPs     Maintainability MoPs     64 MoEs	[ref 33]	Analysis		2022.11.15
99	₽ S1.1.3.1.2.10	PEPDS should maximize Mean Operating Hours Between False Alarms achieving a minimum goal of TBD.	PEPDS Mean Operating Hours between False G Gal = TBD 2.1 Maintainability AM MoEs Maintainability MoPs B4 MoEs	[ref 33]	Analysis		2022.11.15
100							
113	E S1.1.3.2 PEPDS Operability						
185	E Constant States						
204	S1.2 Capability Requirements						

### Fig. 55: S1.1.3.1.2 Maintainability

#	△ Name	Text	Traced To	Source	Verify Method	Risk	Revision Date
1	S1.1 PEPDS Requirements						
2	🗄 📋 S1.1.1 PEPDS Generic Power System Requirer						
44	S1.1.2 PEPDS Innovative Requirements						
80	S1.1.3 PEPDS Performance Metrics						
81	S1.1.3.1 PEPDS RAM						
82	🕀 🛅 S1.1.3.1.1 Availability						
89	🕀 📋 S1.1.3.1.2 Maintainability						
100	🖂 🛅 S1.1.3.1.3 Reliability						
101	P S1.1.3.1.3.1	PEPDS shall maximize MTBF achieving a minimum threshold of 30,000 hours.	PEPDS     MrDF     Mean Time Between Failure     Threshold = TBD     1.3 Reliability     Reliability MoPs     Reliability MoPs     B4 MoEs	[ref 33] [ref 35]	Analysis		2022.11.15
102	P S1.1.3.1.3.2	PEPDS should maximize MTBF achieving a minimum goal of TBD.	PEPDS     Mean Time Between Failure     Goal = TBD     1.3 Reliability     Reliability MoPs     Reliability MoPs     B4 MoEs	[ref 33] [ref 35]	Analysis		2022.11.15
103	P S1.1.3.1.3.3	PEPDS shall maximize MTBM achieving a minimum threshold of 7,000 hours.	PEPDS     MrEM     Mean Time Between Maintenance     Threshold = TBD     1.3 Reliability     RAIM MoEs     Reliability MoPs     B 4 MoEs	[ref 33]	Analysis		2022.11.15
104	P S1.1.3.1.3.4	PEPDS shall maximize MTBM achieving a minimum goal of TBD.	PEPDS     MTEM     Goal = TBD     Mean Time Between Maintenance     1.3 Reliability     RAM MoEs     Reliability MoPs     B 4 MoEs	[ref 33]	Analysis		2022.11.15
105	₽ S1.1.3.1.3.5	PEPDS shall maximize MTBR achieving a minimum threshold of TBD.	PEPDS     Mean Time Between Repairs     Threshold = TBD     1.3 Reliability     Reliability MoPs     Reliability MoPs     B 4 MoEs	[ref 33]	Analysis		2022.11.15
106	P 51.1.3.1.3.6	PEPDS should maximize MTBR achieving a minimum goal of TBD.	PEPDS     Mean Time Between Repairs     Goal = TBD     1.3 Reliability     Reliability MoPs     Reliability MoPs     B4 MoEs	[ref 33]	Analysis		2022. 11. 15

Fig. 56: S1.1.3.1.3 Reliability Part 1

		PEPDS shall maximize Resiliency achieving a minimum threshold of TBD.	MTBCF			2022.11.15
			PEPDS			
			Resiliency			
107	C1 1 2 1 2 7			[ref 22]	Amphusia	
107	51.1.3.1.3.7		B 1.3 Reliability	[rel 35]	Analysis	
			B 1.5 Resilency			
			RAM MOES			
			Reliability Mors			
		PEPDS should maximize Resiliency achieving a minimum goal of TBD	E MTRCE			2022 11 15
		TET DS should maximize resiliency deliciting a minimum goar of 100.				2022.11.15
			Desiliansu			
108	<b>P</b> \$113138		a 1 3 Peliability	[ref 33]	Analysis	
100			I 5 Resiliency	[ici bo]	Pinaryara	
			PAM MoEs			
			Reliability MoPs			
			B4 MoEs			
<u> </u>		PEPDS shall maximize Power Delivery Reliability achieving a	I PEPDS		+ +	2022.11.15
		minimum threshold of TBD.	Power Delivery Reliability			
			Power Delivery Reliability			
			V Threshold = TBD			
109	P S1.1.3.1.3.9		I.3 Reliability	[ref 33]	Analysis	
			B 1.6 UPS			
			BAM MoEs			
			Reliability MoPs			
			B4 MoEs			
		PEPDS should maximize Power Delivery Reliability achieving a	PEPDS			2022.11.15
		minimum goal of TBD.	Power Delivery Reliability			
			Power Delivery Reliability			
			V Goal = TBD			
110	P S1.1.3.1.3.10		B 1.3 Reliability	[ref 33]	Analysis	
			B 1.6 UPS			
			RAM MoEs			
			Reliability MoPs			
			B4 MoEs			
		PEPDS shall maximize Life Expectancy achieving a minimum	PEPDS			2022.11.15
		threshold of TBD.	Life Expectancy			
			Life Expectancy			
			V Threshold = TBD			
111	P S1.1.3.1.3.11		B 1.3 Reliability	[ref 33] [ref 37]	Analysis	
			2.4 Long Life Expectancy			
			RAM MoEs			
			Reliability MoPs			
			B4 MoEs			
		PEPDS should maximize Life Expectancy achieving a minimum goal	PEPDS			2022.11.15
		of ToD.	Life Expectancy			
			Goal = TBD			
	_		Life Expectancy			
112	P S1.1.3.1.3.12		B 1.3 Reliability	[ref 33] [ref 37]	Analysis	
			2.4 Long Life Expectancy			
			RAM MoEs			
			Reliability MoPs			
			B4 MoEs			
113	E S1.1.3.2 PEPDS Operability					
185	E S1.1.3.3 PEPDS Safety					
204	E S1.2 Capability Requirements					

Fig. 57: S1.1.3.1.3 Reliability Part 2

#	△ Name	Text	Traced To	Source	Verify Method	Risk	Revision Date
1	S1.1 PEPDS Requirements	1	1				
2	🗉 📋 S1.1.1 PEPDS Generic Power System Requirer	n					
44	🗉 📋 S1.1.2 PEPDS Innovative Requirements						
80	S1.1.3 PEPDS Performance Metrics						
81	Image: S1.1.3.1 PEPDS RAM						
113	S1.1.3.2 PEPDS Operability						
114	S1.1.3.2.1 Power Distribution						
115	P S1.1.3.2.1.1	PEPDS shall maximize Conversion Efficiency achieving a minimum threshold of TBD.	PEPDS     Conversion Efficiency     Conversion Efficiency     Threshold = TBD     1.1 Power Efficiency     Operability MoEs     Power Distribution MoPs     B4 MoEs	[ref 36]	Analysis		2022.11.15
116	I S1.1.3.2.1.2	PEPDS should maximize Conversion Efficiency achieving a minimum goal of TBD.	PEPDS Conversion Efficiency Conversion Efficiency Gal = TBD II Power Efficiency Power Distribution MoPs Hotes Hotes	[ref 36]	Analysis		2022.11.15
117	P Si.1.3.2.1.3	PEPDS shall maximize Transmission Efficiency achieving a minimum threshold of TBD.	PEPDS Transmission Efficiency Transmission Efficiency Transmission Efficiency Threshold = TBD In 1. Power Efficiency Power Distribution MoPs Power Distribution MoPs H MoEs	[ref 36]	Analysis		2022.11.15
118	🕑 S1.1.3.2.1.4	PEPDS should maximize Transmission Efficiency achieving a minimum goal of TBD.	PEPDS     Transmission Efficiency     Transmission Efficiency     Gal = TBD     I. 1 Power Efficiency     Operability MoEs     Power Distribution MoPs     64 MoEs	[ref 36]	Analysis		2022.11.15
119	P S1.1.3.2.1.5	PEPDS should maximize Power Density achieving a minimum goal of TBD.	PEPDS Power Density Power Density Goal = TBD 1.2 Power Density Power Distribution MoPs Power Distribution MoPs 84 MoEs	[ref 36]	Analysis		2022.11.15
120	P S1.1.3.2.1.6	PEPDS shall maximize Power Density achieving a minimum threshold of TBD.	PEPDS     Power Density     Power Density     Ower Density     Threshold = TBD     1.2 Power Density     Operability MoEs     Power Distribution MoPs     04 MoEs	[ref 36]	Analysis		2022.11.15
121	₽ Sl.1.3.2.1.7	PEPDS shall maximize Power Electronic Utilization e.g. to characterize loads and sources, increase reliability, reduce response time (e.g. switching), increase reconfigurability, and enable programming achieving a minimum threshold of TBD.	PEPDS Power Electronic Utilization Power Electronic Utilization Threshold = TBD S. 3Power Electronic Interfaces S. 15 Reduce Conventional Switchgeal S. 12 Minimal Redundant Elements Operability MoEs Power Distribution MoPs B4 MoEs	[ref 50] [ref 52] [ref 58]	Analysis		2022.11.15

Fig. 58: 9	51.1.3.2.1	Power	Distribution	Part 1
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1	1		-	1		
122	P S1.1.3.2.1.8	PEPDS should maximize Power Electronic Utilization, e.g. to characterize loads and sources, increase reliability, reduce response time (e.g. switching), increase reconfigurability, and enable programming achieving a minimum goal of TBD.	PEPDS     Power Electronic Utilization     Power Electronic Utilization     Goal = TBD     S.3 Power Electronic Interfaces     S.15 Reduce Conventional Switchgear     S.12 Minimal Redundant Elements     Operability MoEs     Power Distribution MoPs     B4 MoEs	[ref 50] [ref 52] [ref 58]	Analysis	2022.11.15
123	P S1.1.3.2.1.9	PEPUS shall minimize Kesponse Time achieving a maximum threshold of TBD.	Response Time     PEPDS     PEPDS     Time     Threshold = TBD     Gorability MoEs     Operability MoEs     Power Distribution MoPs     B4 MoEs	[ref 24]	Analysis	2022.11.15
124	P S1.1.3.2.1.10	PEPDS should minimize Response Time achieving a maximum goal of TBD.	Response Time     PerDS     Response Time     Goal = TBD     3.3.3 Dynamic response     Operability MoEs     Power Distribution MoPs     B4 MoEs	[ref 24]	Analysis	2022.11.15
125	P 51.1.3.2.1.11	PEPDS shall achieve [TBD] threshold for Specific Energy.	Specific Energy     Specific Energy     Specific Energy     Threshold = TBD     Operability MoEs     Power Distribution MoPs     B4 MoEs	[ref 53]	Analysis	2022.11.15
126	P 51.1.3.2.1.12	PEPDS should achieve [TBD] goal for Specific Energy.	Image: Specific Energy           Image: Specific E	[ref 53]	Analysis	2022.11.15
127	P 51.1.3.2.1.13	PEPDS shall minimize Discharge C Rate achieving a maximum threshold of TBD.	DepDS     Discharge C Rate     Discharge C Rate     Discharge C Rate     Orreshold = TBD     Operability MoEs     Power Distribution MoPs     64 MoEs	[ref 53]	Analysis	2022.11.15
128	F 51.1.3.2.1.14	PEPDS should minimize Discharge C Rate achieving a maximum goal of TBD.	PEPDS     Discharge C Rate     Discharge C Rate     Used = TBD     Operability MoEs     Power Distribution MoPs     B4 MoEs	[ref 53]	Analysis	2022.11.15
129	P 51.1.3.2.1.15	PEPDS shall minimize Recharge C Rate achieving a maximum threshold of TBD.	PEPDS     Peros     Recharge C Rate     Recharge C Rate     Threshold = TBD     Operability MoEs     Power Distribution MoPs     44 MoEs	[ref 53]	Analysis	2022.11.15
130	P S1.1.3.2.1.16	PEPDS should minimize Recharge C Rate achieving a maximum goal of TBD.	PEPDS     Recharge C Rate     Recharge C Rate     Vi Goal = TBD     Operability MoEs     Power Distribution MoPs     B4 MoEs	[ref 53]	Analysis	2022.11.15
131	E S1.1.3.2.2 Adaptability					
142	E S1.1.3.2.3 Logistics					
109	E S1.1.3.2.4 ATTORGADILITY					
185	E C1 1 3 3 DEDDC Commu					
204	E S1 2 Capability Deguinements					
207	51.2 Capability Requirements		1			

Fig.	59:	S1.1	.3.2.1	Power	Distribution	Part 3	2
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10     <	81	S1.1.3.1 PEPDS RAM							
10     <	113	S1.1.3.2 PEPDS Operability							
10     Image: problem in the problem in	114	Image: S1.1.3.2.1 Power Distribution							
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13       11.11.21       Production in adjustic scattering array and the set of the			PEPDS shall maximize Robustness achieving a minimum threshold of	Robustness				2022.11.15	
10       Image: status s			TBD.	PEPDS					
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Image: state in the state i				Operability MoEs					
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13         13         13         13         13         13         14         14         16<				B4 MoEs					
13         10000         1000         1000			PEPDS should maximize Robustness achieving a minimum goal of					2022.11.15	
13				PEPDS					
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19         10         10.1.3.2.3         Private fritte         Pri			PEPDS shall maximize Application Adaptability achieving a minimum					2022.11.15	
134 <ul> <li> <ul> <li> <ul></ul></li></ul></li></ul>			threshold of TBD.	Application Adaptability					
14              • Field - TO				Application Adaptability					
134       Image: 11.1.3.2.3       Image: 11.1.3.2.				V Threshold = TBD					
Image: Control of the second of the	134	a c112222		B 3.6 Hotswappable	frof EO1 [r-f co1	Applicate			
1         13         13         13         13         13         14 </th <td>134</td> <td>P 51.1.3.2.2.3</td> <td></td> <td>B 5.6 Functional Control</td> <td>[ret buj [ret b8]</td> <td>Analysis</td> <td></td> <td></td>	134	P 51.1.3.2.2.3		B 5.6 Functional Control	[ret buj [ret b8]	Analysis			
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135         Image: Status in the status			PEPUS should maximize Application Adaptability achieving a minimum goal of TBD.	PEPDS				2022.11.15	
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Image: second				Operability MoEs					
Image: content in the state of explants for Cases of Applicable Sign Case				Adaptability MoPs					
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136         Image: status			which it is suitable achieving a minimum threshold of TBD.	Applicable Ship Classes					
105       Image: 100 microbiole       Image: 100 microbiole <t< th=""><td></td><td></td><td></td><td>Applicable Ship Classes</td><td></td><td></td><td></td><td></td></t<>				Applicable Ship Classes					
13         3-3-3-3-10-10-10-10-10-10-10-10-10-10-10-10-10-	136	P S1.1.3.2.2.5		V Threshold = TBD	[ref 36]	Analysis			
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137         E         51.1.3.2.2.6         PEOS shuld maxime the number of Applicable Sign Classes for high class Sign Classes applicable Sign Class				B4 MoEs					
137         Image: Substrate status and status and excising a minimum goal of TBD.         Image: Substrate status and statu			PEPDS should maximize the number of Applicable Ship Classes for	S PEPDS				2022.11.15	
137         Image: Single			which it is suitable achieving a minimum goal of TBD.	Applicable Ship Classes					
137       Image: Single S				Applicable Ship Classes					
100         101 Strandbroke	137	P S113226		Goal = TBD	[ref 36]	Analysis			
Image: Substrate Scalability achieving a minimum threshold of TBD.         Person Statulity Web's Scalability Web's Scalabil	157	51,1.5,2,2,0		3.4 Standardizable	[rei boj	Andrysis			
Image: Constraint of the second maximum second billy achieving a minimum threshold of TBD.         PEPOS and maximum Scalability achieving a minimum threshold of TBD.         PEPOS and maximum Scalability achieving a minimum goal of TDD.         PEPOS and maximum Scalability achieving a minimum goal of TDD.         PEPOS and maximum Scalability achieving a minimum goal of TDD.         PEPOS and maximum Scalability achieving a minimum goal of TDD.         PEPOS and maximum Scalability achieving a minimum goal of TDD.         PEPOS and maximum Scalability achieving a minimum goal of TDD.         PEPOS and maximum Scalability achieving a minimum goal of TDD.         PEPOS and maximum Scalability achieving a minimum goal of TDD.         PEPOS and maximum Scalability achieving a minimum goal of TDD.         PEPOS and maximum Scalability achieving a minimum goal of TDD.         PEPOS and maximum Scalability achieving a minimum goal of TDD.         PEPOS and maximum Scalability achieving a minimum goal of TDD.         PEPOS and maximum Scalability achieving a minimum goal of TDD.         PEPOS and maximum Scalability achieving a minimum goal of TDD.         PEPOS and maximum Scalability achieving a minimum goal of TDD.         PEPOS and maximum Scalability achieving a minimum goal of TDD.         PEPOS and maximum Scalability achieving a minimum goal of TDD.         PEPOS and maximum Scalability achieving a minimum goal of TDD.         PEPOS and maximum Scalability achieving a minimum goal of TDD.         PEPOS and maximum Scalability achieving a minimum goal of TDD.         PEPOS and maximum Scalability achieving a minimum goal of TDD.         PEPOS and maximum Scalability achieving a minimum goal of TDD.         PEPOS and maximum goal of TDD.         PEPOS and maximum goal				Operability MoEs					
Image: status in the status intermediation of the s				Adaptability MoPs					
138       Image: Stability in the			PEPDS shall maximize Scalability achieving a minimum threshold of	B PEPDS				2022 11 15	
138       Image: S11.13.22.7       PEPOS should maximize Scalability achieving a minimum goal of TDD.       PerPOS       PerPOS       PerPOS       Analysis       Image: S11.13.22.8       PEPOS should maximize Scalability achieving a minimum goal of TDD.       PerPOS       PerPOS       PerPOS       Image: S11.13.22.8       PerPOS should maximize Scalability achieving a minimum goal of TDD.       PerPOS       PerPOS       PerPOS       Image: S11.13.22.8       PerPOS should maximize Scalability achieving a minimum goal of TDD.       PerPOS       PerPOS       PerPOS       Image: S11.13.22.8       PerPOS should maximize Scalability achieving a minimum threshold of TBD. (e.g., managing casuality power).       PerPOS       PerPOS </th <td></td> <td></td> <td>TBD.</td> <td>PEPDS     Scalability</td> <td></td> <td></td> <td></td> <td>2022.11.15</td>			TBD.	PEPDS     Scalability				2022.11.15	
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138       Image: Stability       Image: Stability <th image:="" stabi<="" th=""><td></td><td>_</td><td></td><td>V Threshold = TBD</td><td></td><td></td><td></td><td></td></th>	<td></td> <td>_</td> <td></td> <td>V Threshold = TBD</td> <td></td> <td></td> <td></td> <td></td>		_		V Threshold = TBD				
139       Image: Simple state st	138	P S1.1.3.2.2.7		B 3 Scalability	[ref 24]	Analysis			
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139       PEPDS should maximize Scalability achieving a minimum goal of TBD.       IP pepDS				B4 MoEs					
139Image: Stability Stability Compatibility Com			PEPDS should maximize Scalability achieving a minimum goal of TBD.	PEPDS				2022.11.15	
139       Image: Still Sti				Scalability					
139       Image: S1.1.3.2.2.8       Image: S1.1.3.2.2.9       Image: S1.1.3.2.9				Scalability					
140       PEPDS shall maximize Survivability achieving a minimum threshold of TBD. (e.g., managing casuality power).       PEPDS Survivability Survivability Survivability Correlabity MoEs Adaptability MOPS Survivability Correlabity MoEs Adaptability MOPS B H MoEs       IFef 44]       Analysis       222.11.15         140       PEPDS should maximize Survivability achieving a minimum goal of TBD. (e.g., managing casuality power).       Survivability Survivability Correlabity MOPS B H MoEs       IFef 44]       Analysis       2022.11.15         141       PEPDS should maximize Survivability achieving a minimum goal of TBD. (e.g., managing casuality power).       Survivability Correlabity MOPS B H MOEs       IFef 44]       Analysis       2022.11.15         141       PEPDS should maximize Survivability achieving a minimum goal of TBD. (e.g., managing casuality power).       Survivability Correlabity MOPS B H MOEs       IFef 44]       Analysis       2022.11.15         142       D S11.13.2.2.10       IFE S11.3.2.2.10       IFef 44]       Analysis       IFef 44]       Analysis         144       D S11.3.2.4.4ffordability       IFE S11.3.2.4.4ffordability       IFE S11.3.2.1       IFE S1.1 <t< th=""><td>139</td><td>P S1.1.3.2.2.8</td><td></td><td>V Goal = TBD</td><td>[ref 24]</td><td>Analysis</td><td></td><td></td></t<>	139	P S1.1.3.2.2.8		V Goal = TBD	[ref 24]	Analysis			
140       PEPDS shall maximize Survivability achieving a minimum threshold of TBD. (e.g., managing casuality power).       PepDS shall maximize Survivability achieving a minimum threshold of TBD. (e.g., managing casuality power).       PepDS should maximize Survivability achieving a minimum goal of Coperability MoEs       PepDS should maximize Survivability achieving a minimum goal of TBD. (e.g., managing casuality power).       If ef 44]       Analysis       2022.11.15         140       PEPDS should maximize Survivability achieving a minimum goal of TBD. (e.g., managing casuality power).       If ef 44]       Analysis       Analysis         141       If s 1.1.3.2.2.10       PEPDS should maximize Survivability achieving a minimum goal of TBD. (e.g., managing casuality power).       If ef 44]       Analysis       Analysis         142       If s 1.1.3.2.3.1 Logistics       If ef 44]       Analysis       If ef 44]       Analysis       If ef 44]         159       If s 1.1.3.2.4 Affordability       If ef 44]       If ef 44] </th <td></td> <td></td> <td></td> <td>B 3 Scalability</td> <td></td> <td></td> <td></td> <td></td>				B 3 Scalability					
Image: Adaptability Moles       Image: Adaptability Moles       Image: Adaptability Moles         Image: Adaptability Moles       Image: Adaptability Moles       Image: Adaptability Moles       Image: Adaptability Moles         Image: Adaptability Moles       Image: Adaptability Moles       Image: Adaptability Moles       Image: Adaptability Moles         Image: Adaptability Moles       Image: Adaptability Moles       Image: Adaptability Moles       Image: Adaptability Moles       Image: Adaptability Moles         Image: Adaptability Moles       Image: Adaptability Moles       Image: Adaptability Moles       Image: Adaptability Moles       Image: Adaptability Moles         Image: Adaptability Moles       Image: Adaptability Moles       Image: Adaptability Moles       Image: Adaptability Moles       Image: Adaptability Moles         Image: Adaptability Moles       Image: Adaptability Moles       Image: Adaptability Moles       Image: Adaptability Moles       Image: Adaptability Moles         Image: Adaptability Moles       Image: Adaptability Moles       Image: Adaptability Moles       Image: Adaptability Moles       Image: Adaptability Moles         Image: Adaptability Moles       Image: Adaptability Moles       Image: Adaptability Moles       Image: Adaptability Moles       Image: Adaptability Moles         Image: Adaptability Moles       Image: Adaptability Moles       Image: Adaptability Moles       Image: Adaptability Moles <td< th=""><td></td><td></td><td></td><td>Operability MoEs</td><td></td><td></td><td></td><td></td></td<>				Operability MoEs					
140       PEPDS shall maximize Survivability achieving a minimum threahold of TBO. (e.g., managing casuality power).       PEPDS       Survivability       PerPDS       Survivability				Adaptability MoPs					
140       Image: Status S			PEPDS shall maximize Survivability achieving a minimum threshold					2022 11 15	
140       Image: S1.1.3.2.2.9       PEPDS should maximize Survivability achieving a minimum goal of Adaptability MoPs B H MoEs       Fef 44 Fef 44 B H MoEs       Analysis       Analysis         141       Image: S1.1.3.2.2.10       PEPDS should maximize Survivability achieving a minimum goal of B H MoEs       Survivability Survivability G G = TBD       Survivability B H MoEs       Image: S1.1.3.2.10       Analysis       Analysis       Analysis       Analysis         141       Image: S1.1.3.2.2.10       TBD. (e.g., managing casualty power).       Survivability G G = TBD       Survivability B Survivability B PEPDS       Image: S1.1.3.2.10       Analysis       Analysis       Analysis         142       Image: S1.1.3.2.3.10gistics       Image: S1.1.3.2.4 Affordability B B Survivability B D S1.1.3.2.5 Quality of Service       Image: S1.1.3.2.4 Affordability B D S1.1.3.2.5 Quality of Service       Image: S1.1.3.2.5 Quality of Service<			of TBD. (e.g., managing casualty power).	Survivability					
140       Image: Still Sti				Survivability					
141       PEDS should maximize Survivability achieving a minimum goal of TBD. (e.g., managing casuality power).       Survivability	140	P S1.1.3.2.2.9		V Threshold = TBD	[ref 44]	Analysis			
Image: Adaptability MoPs       Image: Adaptability MoPs       Image: Adaptability MoPs         Image: Adaptability MoPs       B Modes       Survivability         Survivability MoPs       Survivability MoPs       Survivability         Image: Adaptability MoPs       Survivability       Survivability         Image: Adaptability MoPs       Survivability       Survivability         Image: Adaptability MoPs       Image: Adaptability MoPs       Analysis         Image: Adaptability MoPs       Image: Adaptability MoPs       Image: Adaptability MoPs         Image: Adaptability MoPs       Image: Adaptability MoPs       Image: Adaptability MoPs         Image: Adaptability MoPs       Image: Adaptability MoPs       Image: Adaptability MoPs         Image: Adaptability MoPs       Image: Adaptability MoPs       Image: Adaptability MoPs         Image: Adaptability MoPs       Image: Adaptability MoPs       Image: Adaptability MoPs         Image: Adaptability MoPs       Image: Adaptability MoPs       Image: Adaptability MoPs         Image: Adaptability MoPs       Image: Adaptability MoPs       Image: Adaptability MoPs         Image: Adaptability MoPs       Image: Adaptability MoPs       Image: Adaptability MoPs         Image: Adaptability MoPs       Image: Adaptability MoPs       Image: Adaptability MoPs         Image: Adaptability MoPs       I				Operability MoEs					
141       PEPOS should maximize Survivability achieving a minimum goal of TBD. (e.g., managing casuality power).       Survivability Cool = TBD       Fef 44]       Analysis       Z22.11.15         141       PETOS Should maximize Survivability achieving a minimum goal of TBD. (e.g., managing casuality power).       Survivability       Geode = TBD       Fef 44]       Analysis       Z22.11.15         141       PETOS Should maximize Survivability achieving a minimum goal of TBD. (e.g., managing casuality power).       Fef 44]       Analysis       Analysis       Z22.11.15         142       DE S1.1.3.2.2.100       Survivability MOPS       B 4 MoEs       Analysis       Z       Z         143       DE S1.1.3.2.3.Logistics       E       E       E       E       Z       <				Adaptability MoPs					
141       PEPOS should maximize Survivability achieving a minimum goal of TBD. (e.g., managing casualty power).       Survivability Goal = TBD Goal =				B4 MoEs					
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141       Image: Still Sti			IBD. (e.g., managing casualty power).	Goal = TBD					
141         Extravability Mores         [ref 44]         Analysis           142         E         5.1.1.3.2.2.10         [Operability Mores         [Operability Mores <td></td> <td></td> <td></td> <td>PEPDS</td> <td></td> <td></td> <td></td> <td></td>				PEPDS					
December / Operability MoEs         Adaptability MoPs         Adaptability MoPs           142         D: 1.1.3.2.3 Logistics         B 4 MoEs         M 1           159         D: 1.1.3.2.4 Affordability         M 1         M 1           168         D: 1.1.3.2 Spally of Service         M 1         M 1           168         D: 1.1.3.2 SpeDS Safety         M 1         M 1         M 1           204         D: 1.1.2 Capability Requirements         M 1         M 1         M 1         M 1	141	P S1.1.3.2.2.10		Survivability	[ref 44]	Analysis			
Modputability mons         Modputa				Adaptability MoPr					
142         ID         5.1.3.2.3 Logistics         ID         ID <thid< th="">         ID         ID         ID<td></td><td></td><td></td><td>B4 MoEs</td><td></td><td></td><td></td><td></td></thid<>				B4 MoEs					
159     E     5.1.1.3.2.4 Affordability     Image: Shift of Shift o	142				1				
168         ID         5.1.3.3.2.5 Quality of Service         ID         ID <thid< th=""> <thid< th=""> <thid< th="">         &lt;</thid<></thid<></thid<>	159								
185         III         51.1.3.3 PEPDS Safety         IIII         IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	168	🗉 📋 S1.1.3.2.5 Quality of Service							
204 🗄 🛅 S1.2 Capability Requirements	185	S1.1.3.3 PEPDS Safety							
	204	S1.2 Capability Requirements							

### Fig. 60: S1.1.3.2.2 Adaptability

#	△ Name	Text	Traced To	Source	Verify Method	Risk	Revision Date
1	S1.1 PEPDS Requirements						
2	E S1.1.1 PEPDS Generic Power System Requiren						
44	E S1.1.2 PEPDS Innovative Requirements						
80	S1.1.3 PEPDS Performance Metrics						
81	E S1.1.3.1 PEPDS RAM						
113	S1.1.3.2 PEPDS Operability						
114	E S1.1.3.2.1 Power Distribution						
131	E S1.1.3.2.2 Adaptability						
142	S1.1.3.2.3 Logistics						
143	P S1.1.3.2.3.1	Perus shai minimize uns Manning acheving a maximum threshold of TBD.	PEPDS     LMS Manning     LMS Manning     LMS Manning     VThreshold = TBD     2 Operability     5.11 Simplified LRU Replacement     Operability MoEs     Logistics MOPs     B4 MoEs	[ref 38]	Analysis		2022.11.15
		PEPDS should minimize LMS Manning achieving a maximum goal of TBD.	PEPDS LMS Manning LMS Manning LMS Manning				2022.11.15
144	Image: P S1.1.3.2.3.2		Image: Comparability           Image: Comparability           Image: Comparability MoEs	[ref 38]	Analysis		
		PEPDS shall minimize LMS Training achieving a maximum threshold	PEPDS				2022.11.15
145	P S1.1.3.2.3.3	of IBD.	LMS Training     LMS Training     VMS Training     Threshold = TBD     2 Operability     2.2 Operator Trainability     5.11 Simplified LRU Replacement     Operability MOEs     Logistics MOPs     Ret MoEs	[ref 38]	Analysis		
		PEPDS should minimize LMS Training achieving a maximum goal of TBD.	B4 MoEs PEPDS LMS Training LMS Training				2022.11.15
146	P S1.1.3.2.3.4		V Goal = TED  2.2 Operability  5.11 Smplified LRU Replacement  Operability MEs  Logistics MOPs B M MOEs B M MOEs	[ref 38]	Analysis		
		PEPDS shall minimize Operator Manning achieving a maximum	PEPDS				2022.11.15
147	P S1.1.3.2.3.5	threshold of TBD.	Operation Manning  Operation Manning  Threshold = TBD  2 Operability  5.11 Simplified LRU Replacement  Operability MoEs  Logistics MoPs B4 MoEs	[ref 36]	Analysis		
		PEPDS should minimize Operator Manning achieving a maximum goal of TBD.	PEPDS     Operation Manning     Operation Manning				2022.11.15
148	P S1.1.3.2.3.6		Goal = TBD     2 Operability     5.11 Simplified LRU Replacement     Operability MoEs     Logistics MOPs     B4 MoEs	[ref 36]	Analysis		
149	P S1.1.3.2.3.7	PEPDS shall minimize Operator Training achieving a maximum threshold of TBD.	PEPDS Perpos Pe	[ref 36]	Analysis		2022.11.15
150	P S1.1.3.2.3.8	PEPOS should minimize Operator Training achieving a maximum goal of TBD.	PEPDS     Operator Training     Operator Training     Operator Training     Operator Training     Operator Trainability     2.2 Operator Trainability     S.11 Simplified LRU Replacement     Operability MoEs     Logistics MoPs     B4 MoEs	[ref 36]	Analysis		2022.11.15

### Fig. 61: S1.1.3.2.3 Logistics Part 1

13         1900         19700 # Interse Core B Export schering a textme method of TSD.         19700 # Interse Core B Export schering a textme To Therefore Status         19700 # Interse Core B Export schering a textme To Therefore Status         19700 # Interse Core B Export schering a textme To Therefore Status         19700 # Interse Core B Export schering a textme To Therefore Status         19700 # Interse Core B Export To Therefore To Ther							
Image: state in the s	151	F 51.1.3.2.3.9	PEPDS shall minimize Cost for Support achieving a maximum threshold of TBD.	PEPDS Cost for Support Cost for Support To Threshold = TBD Cost 2 Operability Operability MoEs Cogistics NoPs Cost Cost Cost Cost Cost Cost Cost Cost	[ref 38]	Analysis	2022.11.15
113       PC05 dat maxime if effectiones of Support Capability and intrig a minum if registed of TB0.       PC05 data maxime if effectiones of Support Capability is findering a minum if registed of TB0.       PC05 data maxime if effectiones of Support Capability is findering a minum if registed of TB0.       PC05 data maxime if effectiones of Support Capability is findering a minum paid of TB0.       PC05 data maxime if effectiones of Support Capability is findering a minum paid of TB0.       PC05 data maxime if effectiones of Support Capability is findering a minum paid of TB0.       PC05 data maxime if effectiones of Support Capability is findering a minum paid of TB0.       PC05 data maxime is findering a maxime is findering a minum paid of TB0.       PC05 data maxime is findering a maxime is findering a minum paid of TB0.       PC05 data maxime is findering a maxime is findering a minum paid of TB0.       PC05 data maxime is findering a maxime is findering a minum paid of TB0.       PC05 data maxime is findering a maxime is findering a minum paid of TB0.       PC05 data maxime is findering a maxime is findering a minum paid of TB0.       PC05 data maxime is findering a maxime is finde	152	F \$1.1.3.2.3.10	PEPDS should minimize Cost for Support achieving a maximum goal of TBD.	B+Mocs     FEPOS     Cost for Support     Cost for Support     Cost for Support     Cost for Support     Operability     Operability MoEs     Logistics MoPs     B4MoEs	[ref 38]	Analysis	2022. 11. 15
154       PECC shade memory of TBD.       IP PECC Capability IP PECC shade memory of TBD.       IP PECC shade memory of TBD.	153	■ \$1.1.3.2.3.11	PEPDS shall maximize Effectiveness of Support Capability achieving a minimum threshold of TBD.	PEPDS     PEffectiveness of Support Capability     Effectiveness of Support Capability     Urreshold = TBD     2 Operability     Operability     Operability MoEs     Logistics MoPs     B4MOEs	[ref 38]	Analysis	2022.11.15
155       Image: Status S	154	■ \$1.1.3.2.3.12	PEPDS should maximize Effectiveness of Support Capability achieving a minimum goal of TED.	PEPDS     PEFCs     Effectiveness of Support Capability     Effectiveness of Support Capability     Goal = TBD     2 Operability     Operability MoEs     Logistics MoPs     B4MoEs	[ref 38]	Analysis	2022.11.15
156       Image: Status S	155	F S1.1.3.2.3.13	PEPOS shall minimize its Installation Time achieving a maximum threshold of TBD.	PEPDS PIrstalation Time Installation Time Threshold = TBD D Depablity S.1 Ease of Installation as a Unit Operability MOEs D Digitics MOPs D Bd MOEs D Digitics MOPs D D Digitics MOPs D D D D D D D D D D D D D D D D D D D	[ref 44]	Analysis	2022.11.15
157       PEPDS shall minimize its Removal Time achieving a maximum threshold of TED.       PEPDS memoval Time Removal Time Removal Time achieving a maximum threshold of TED.       PEPDS memoval Time       Removal T	156	P 51.1.3.2.3.14	PEPDS should minimize its Installation Time achieving a maximum goal of TBD.	Installation Time     Goal = TBD     Installation Time     Goal = TBD     Installation Time     2 Operability     5.1 Ease of Installation as a Unit     Operability MoEs     Logistics MOPs     B4 MoEs	[ref 44]	Analysis	2022. 11. 15
158       PE S1.1.3.2.3.16       PEPDS should minimize its Removal Time achieving a maximum goal of TBD.       Removal Time       Si Goal = TBD       PEPDS       PEPDS       Removal Time       PEPDS       Removal Time       Si Coal = TBD       PEPDS       PEPDS       Removal Time       Si Coal = TBD       PEPDS       Removal Time       Si Coal = TBD       PEPDS       Removal Time       Si Coal = TBD       Removal Time	157	<b>F</b> \$1.1.3.2.3.15	PEPDS shall minimize its Removal Time achieving a maximum threshold of TBD.	PEPDS     PEPDS     Removal Time     Removal Time     Peroval Time     Threshold = TBD     2 Operability     5.1 Ease of Installation as a Unit     Operability MoEs     Logistics MoPs     B4 MoEs	[ref 44]	Analysis	2022. 11. 15
159         E         E         S1.1.3.2.4 Affordability           168         E         E         S1.1.3.2.5 Oublity of Service	158	F 51.1.3.2.3.16	PEPDS should minimize its Removal Time achieving a maximum goal of TBD.	Removal Time     Goal = TBD     POPDS     Removal Time     Coperability     S.1 Ease of Installation as a Unit     Operability MOEs     Logistics MoPs     B4 MOEs	[ref 44]	Analysis	2022. 11. 15
168 🖪 🖪 S1 1 3 2 5 Quality of Service	159	E S1.1.3.2.4 Affordability					
	168	E S1.1.3.2.5 Quality of Service					
185 🕀 🗍 S.1.1.3.3 PEPDS Safety	185	E S1.1.3.3 PEPDS Safety					

Fig. 62: S1.1.3.2.3 Logistics Part 2

#	△ Name	Text	Traced To	Source	Verify Method	Risk	Revision Date
1	S1.1 PEPDS Requirements				Ficaliou		
2	S1.1.1 PEPDS Generic Power System Requirem	n					
44	E S1.1.2 PEPDS Innovative Requirements						
80	S1.1.3 PEPDS Performance Metrics						
81	Image: S1.1.3.1 PEPDS RAM						
113	S1.1.3.2 PEPDS Operability						
114	E S1.1.3.2.1 Power Distribution						
131	E S1.1.3.2.2 Adaptability						
142	S1.1.3.2.3 Logistics						
159	S1.1.3.2.4 Affordability						
160	P S1.1.3.2,4.1	PEPUS shall iminimize Operation Cost achieving a maximum threshold of TBD.	PEPOS     Operation Cost     Operation Cost     Operation Cost     Threshold = TBD     Operability     Operability MoEs     Affordability MoPs     H MoEs	[ref 36]	Analysis		2022.11.15
161	I S1.1.3.2.4.2	PEPDS should minimize Operation Cost achieving a maximum goal of TBD.	PEPDS     Operation Cost     Operation Cost     Operation Cost     Soal = TBD     S.5 Affordability     Operability MoEs     Affordability MoEs     B4 MoEs	[ref 36]	Analysis		2022.11.15
162	I S1.1.3.2.4.3	PEPDS shall minimize Implementation Cost achieving a maximum threshold of TBD.	PEPDS     Implementation Cost     Implementation Cost     Virreshold = TBD     3.5 Affordability     Operability MoEs     Affordability MoPs     B 4 MoEs	[ref 36]	Analysis		2022.11.15
163	P S1.1.3.2.4.4	PEPDS should minimize Implementation Cost achieving a maximum goal of TBD.	PEPDS     Implementation Cost     Implementation Cost     Goal = TaD     3.5 Affordability     Operability MoEs     Affordability MoPs     B4 MoEs	[ref 36]	Analysis		2022.11.15
164	■ S1.1.3.2.4.5	PEPDS shall minimize Installation Cost achieving a maximum threshold of TBD.	PEPDS     Installation Cost     Installation Cost     Installation Cost     JThreshold = TBD     3.5 Affordability     5.1 Ease of Installation as a Unit     Operability MoEs     Affordability MoPs     B4 MoEs	[ref 44] [ref 50]	Analysis		2022.11.15
165	III.1.3.2.4.6	PEPDS should minimize Installation Cost achieving a maximum goal of TBD.	Installation Cost     Goal = TBD     FepDs     Installation Cost     S. A firdrability     S. Lase of Installation as a Unit     Operability MoEs     Affordability MoPs     H MoEs	[ref 44] [ref 50]	Analysis		2022.11.15
166	I S1.1.3.2.4.7	PEPDS shall minimize Removal Cost achieving a maximum threshold of TBD.	PEPDS     Removal Cost     Threshold = TBD     Removal Cost     3.5 Affordability     5.1 Ease of Installation as a Unit     Operability MoEs     Affordability MoPs     H MoEs	[ref 44] [ref 50]	Analysis		2022.11.15
167	P 51.1.3.2.4.8	PEPDS should minimize Removal Cost achieving a maximum goal of TBD.	Removal Cost     Goal = TBD     PEPDS     Removal Cost     S. 5 Affordability     S. 1 Ease of Installation as a Unit     Operability MoEs     Affordability MoPs     B4 MoEs	[ref 44] [ref 50]	Analysis		2022.11.15
168	E S1.1.3.2.5 Quality of Service						
185	⊞ S1.1.3.3 PEPDS Safety						
204	S1.2 Capability Requirements						



#	△ Name	Text	Traced To	Source	Verify Method	Risk	Revision Date
1	S1.1 PEPDS Requirements						
2	E S1.1.1 PEPDS Generic Power System Requirem	1					
44	S1.1.2 PEPDS Innovative Requirements						
80	S1.1.3 PEPDS Performance Metrics						
81							
113	S1.1.3.2 PEPDS Operability						
114	E S1.1.3.2.1 Power Distribution						
131	E S1.1.3.2.2 Adaptability						
142	E S1.1.3.2.3 Logistics						
109	E S1.1.3.2.4 Affordability						
100	S1.1.3.2.5 Quality of Service	DEPINS chall minimize Mean Time to Recolve Service Interruption	Mana Tima ta Basakus Samilas Internu				2022 11 15
169	P S1.1.3.2.5.1	achieving a maximum threshold of TBD.	Vite and the construction of the construc	[ref 39]	Analysis		
170	Image: S1.1.3.2.5.2	PEPDS should minimize Mean Time to Resolve Service Interruption achieving a maximum goal of TBD.	Mean Time to Resolve Service Interru Gal = TBD PEPDS PEPDS Operability MoEs Quality of Service MoPs B4 MoEs	[ref 39]	Analysis		2022.11.15
171	₽ S1.1.3.2.5.3	PEPDS shall minimize Mean Time to Resolve Service Interruption for Un-Interruptible Load achieving a maximum threshold of 2 sec.	Mean Time to Resolve Service Interru  Threshold = 2 sec  PEPDS PEPDS Perability MoEs Quality of Service MoPs B4 MoEs	[ref 39]	Analysis		2022.11.15
172	Ist. 1.3.2.5.4	PEPDS should minimize Mean Time to Resolve Service Interruption for Un-Interruptible Load achieving a maximum goal of 10msec.	Mean Time to Resolve Service Interru     Goal = 10 msec     Si PEPDS     Mean Time to Reslove Service Interru     Operability MOEs     Quality of Service MOPs     B4 MoEs	[ref 39]	Analysis		2022.11.15
173	II. 1.3.2.5.5	PEPDS shall minimize Mean Time to Resolve Service Interruption for Short Term Interrupt Load achieving a maximum threshold of 5 min.	Mean Time to Resolve Service Interru Threshold = 5 min PEPOS Mean Time to Resolve Service Interru Operability MOEs Quality of Service MOPs BH MoEs BH MoEs	[ref 39]	Analysis		2022. 11. 15
174	₽ S1.1.3.2.5.6	PEPDS should minimize Mean Time to Resolve Service Interruption for Short Term Interrupt Load achieving a maximum goal of 2 sec.	Mean Time to Resolve Service Interru     Goal = 2 sec     PPDS     Mean Time to Resolve Service Interru     Operability MoEs     Quality of Service MoPs     B4 MoEs	[ref 39]	Analysis		2022. 11. 15
175	II. 1.3.2.5.7	PEPDS shall minimize Mean Time to Resolve Service Interruption for Long Term Interrupt Load achieving a maximum threshold of TBD.	Mean Time to Resolve Service Interru     Threshold = TBD     PEPOS     Mean Time to Resolve Service Interru     Operability MOEs     Quality of Service MOPs     B4 MoEs	[ref 39]	Analysis		2022.11.15

Fig. 64: S1.1.3.2.5 Quality of Service Part 1

175     Image: Second procession of the biologic data interms when the biologic data is singly a sampling of the biologic data is singly data is			I see a second	<u> </u>			
172       IFUS 14 accurate Survid Service The schering a minum.       Is showed Service The schering a minum.       Is	176	P 51.1.3.2.5.8	PEPDS should minimize Mean Time to Resolve Service Interruption for Long Term Interrupt Load achieving a maximum goal of 5 min.	Mean Time to Resolve Service Interru     Goal = 5 min     FEPDS     Mean Time to Resolve Service Interru     Operability MoEs     Quality of Service MoPs     B4 MoEs	[ref 39]	Analysis	2022.11.15
18     PEPDS shade maximes Survis Service Time aftering a minimum gend of Tio.     2 arvis denote Time (1 arvis)     (ef 30)     Arabys     2 arvis (ef 30)       19     PEPDS bit maximes Survis denote Time for Un-thempathe Load aftering a minimum threshold of Tio.     2 minimum threshold of Tio.     PEPDS (ef 30)     Arabys     2 minimum perpension       19     PEPDS bit maximes Survis denote Time for Un-thempathe Load aftering a minimum threshold of Tio.     2 minimum perpension     PEPDS bit maximes Survis denote Time for Un-thempathe perpension     2 minimum perpension     2 minimum	177	P S1.1.3.2.5.9	PEPDS shall maximize Survival Service Time achieving a minimum threshold of TBD.	Survival Service Time Survival Service Time FPPDS Survival Service Time Operability MoEs Quality of Service MoPs H MoEs	[ref 39]	Analysis	2022.11.15
19       PEOS And maximes Survival Service Time for Un-interruption Intervided = TOD Intervided = TOD Intervice Time for Un-interruption Intervice Time for Short Term Intervice Mole Intervice Time for Short Term Intervice Mole Intervice Mole Intervice Time for Short Term Intervice Mole Intervice Mo	178	P S1.1.3.2.5.10	PEPDS should maximize Survival Service Time achieving a minimum goal of TBD.	Survival Service Time Survival Service Time PEPDS Survival Service Time Operability MoEs Quality of Service MoPs H MoEs	[ref 39]	Analysis	2022.11.15
180       St.1.3.2.5.12       PEPOS shud maximize Survival Service Time for Un-interruption of TBD.       G Guide 1700       PepOS         181       St.1.3.2.5.12       PEPOS shud maximize Survival Service Time for Un-interruption of TBD.       G Guide 1700       PepOS         181       St.1.3.2.5.13       PEPOS shud maximize Survival Service Time for Short Term Load acheving a minimum directed of TBD.       G Guide 1700       PepOS         181       St.1.3.2.5.13       PEPOS shud maximize Survival Service Time for Short Term Load acheving a minimum directed of TBD.       G Guide 1700       PepOS         182       St.1.3.2.5.13       PEPOS shud maximize Survival Service Time for Short Term Load acheving a minimum directed of TBD.       G Guide 1700       PepOS         182       St.1.3.2.5.14       PEPOS shud maximize Survival Service Time for Short Term Load acheving a minimum directed TBD.       G Guide 1700       PepOS         183       St.1.3.2.5.14       PEPOS shud maximize Survival Service Time for Load acheving a minimum directed TBD.       G Guide 1700       PepOS         184       St.1.3.2.5.15       PEPOS shud maximize Survival Service Time for Load acheving a minimum directed Of TBD.       G Guide 1700       PepOS         183       St.1.3.2.5.15       PEPOS shude maximize Survival Service Time for Long Term Load acheving a minimum directed Of TBD.       G Survival Service Time for Long Term Load acheving a minimum directed Time for Long Term Load acheving a	179	P S1.1.3.2.5.11	PEPDS shall maximize Survival Service Time for Un-Interruptble Load achieving a minimum threshold of TBD.	Survival Service Time for Un-Interrup Threshold = TBO PEPDS Survival Service Time for Un-Interrup Operability MoEs Quality of Service MoPs B 4M MoEs	[ref 39]	Analysis	2022.11.15
181       Image: Still Sti	180	III 51.1.3.2.5.12	PEPDS should maximize Survival Service Time for Un-Interruptible Load achieving a minimum goal of TBD.	Survival Service Time for Un-Interrup Survival Service Time for Un-Interrup PEPDS Survival Service Time for Un-Interrup Operability MoEs Quality of Service MoPs B 44 MoEs	[ref 39]	Analysis	2022.11.15
182       PEPDS should maximize Survival Service Time for Short Term Load achieving a minimum goal of TBD.       Image: Survival Service Time for Short Term I achieving a minimum goal of TBD.       Image: Survival Service Time for Short Term I achieving a minimum goal of TBD.       Image: Survival Service Time for Short Term I achieving a minimum goal of TBD.       Image: Survival Service Time for Short Term I achieving a minimum goal of TBD.       Image: Survival Service Time for Short Term I achieving a minimum goal of TBD.       Image: Survival Service Time for Short Term I achieving a minimum threshold of TBD.       Image: Survival Service Time for Long Term I achieving a minimum threshold of TBD.       Image: Survival Service Time for Long Term I achieving a minimum threshold of TBD.       Image: Survival Service Time for Long Term I achieving a minimum threshold of TBD.       Image: Survival Service Time for Long Term I achieving a minimum goal of TBD.       Image: Survival Service Time for Long Term I achieving a minimum goal of TBD.       Image: Survival Service Time for Long Term I achieving a minimum goal of TBD.       Image: Survival Service Time for Long Term I achieving a minimum goal of TBD.       Image: Survival Service Time for Long Term I achieving a minimum goal of TBD.       Image: Survival Service Time for Long Term I achieving a minimum goal of TBD.       Image: Survival Service Time for Long Term I achieving a minimum goal of TBD.       Image: Survival Service Time for Long Term I achieving a minimum goal of TBD.       Image: Survival Service Time for Long Term I achieving a minimum goal of TBD.       Image: Survival Service Time for Long Term I achieving a minimum goal of TBD.       Image: Survival Service Time for Long Term I achieving a minimum goal of TBD. <t< th=""><th>181</th><th>P Si.1.3.2.5.13</th><th>PEPDS shall maximize Survival Service Time for Short Term Load achieving a minimum threshold of TBD.</th><th>Survival Service Time for Short Term 1 V Threachold = TBD PEPDS Survival Service Time for Short Term 1 Operability MoEs Quality of Service MoPs B 4 MoEs</th><th>[ref 39]</th><th>Analysis</th><th>2022.11.15</th></t<>	181	P Si.1.3.2.5.13	PEPDS shall maximize Survival Service Time for Short Term Load achieving a minimum threshold of TBD.	Survival Service Time for Short Term 1 V Threachold = TBD PEPDS Survival Service Time for Short Term 1 Operability MoEs Quality of Service MoPs B 4 MoEs	[ref 39]	Analysis	2022.11.15
183       PEPDS shall maximize Survival Service Time for Long Term Load achieving a minimum threshold of TED.       Survival Service Time for Long Term I       Fer 39]       Analysis       2022.11.1         184       PEPDS shall maximize Survival Service Time for Long Term Load achieving a minimum threshold of TED.       Perpos       Survival Service Time for Long Term I       Fer 39]       Analysis       2022.11.1         184       PEPDS should maximize Survival Service Time for Long Term Load achieving a minimum goal of TED.       Survival Service Time for Long Term I       Fer 39]       Analysis       2022.11.1         184       PEPDS should maximize Survival Service Time for Long Term Load achieving a minimum goal of TED.       Survival Service Time for Long Term I       Fer 39]       Analysis       2022.11.11         184       PEPDS should maximize Survival Service Time for Long Term Load achieving a minimum goal of TED.       Survival Service Time for Long Term I       Fer 39]       Analysis       2022.11.11         184       PEPDS should maximize Survival Service Time for Long Term Load achieving a minimum goal of TED.       Survival Service Time for Long Term I       Fer 39]       Analysis       2022.11.11         184       PEPDS should maximize Survival Service Time for Long Term I       Fer 39]       Analysis       2022.11.11         184       PEPDS Since Time for Long Term I       Fer 39]       Analysis       Perp 30	182	P 51.1.3.2.5.14	PEPDS should maximize Survival Service Time for Short Term Load achieving a minimum goal of TBD.	Goal = TED     Goal = TED     Survival Service Time for Short Term 1     Goperability MoEs     Quality of Service MoPs     B4 MoEs	[ref 39]	Analysis	2022.11.15
184       PEPDS should maximize Survival Service Time for Long Term Load achieving a minimum goal of TBD.       Survival Service Time for Long Term Ir IS Goal = TBD       Survival Service Time for Long Term Ir IS Goal = TBD       Analysis       2022.11.1         184       Image: Strate Str	183	P S1.1.3.2.5.15	PEPDS shall maximize Survival Service Time for Long Term Load achieving a minimum threshold of TBD.	Survival Service Time for Long Term In     Threshold = TB0     PEPDS     Survival Service Time for Long Term In     Operability MoEs     Quality of Service MoPs     B4MoEs	[ref 39]	Analysis	2022.11.15
	184	P S1.1.3.2.5.16	PEPDS should maximize Survival Service Time for Long Term Load achieving a minimum goal of TBD.	Survival Service Time for Long Term II Goal = TBD PFDOS Survival Service Time for Long Term II Operability MoEs Quality of Service MoPs B4 MoEs	[ref 39]	Analysis	2022.11.15
185 🗄 🛅 S1.1.3.3 PEPDS Safety	185	🗷 📋 S1.1.3.3 PEPDS Safety					
204 🗄 🛅 S1.2 Capability Requirements	204	S1.2 Capability Requirements					

## Fig. 65: S1.1.3.2.5 Quality of Service Part 2

#	△ Name	Text	Traced To	Source	Verify Method	Risk	Revision Date
1	🗆 🛅 S1.1 PEPDS Requirements						
2	E S1.1.1 PEPDS Generic Power System Requirer	r					
44	E S1.1.2 PEPDS Innovative Requirements						
80	S1.1.3 PEPDS Performance Metrics						
81	S1.1.3.1 PEPDS RAM						
113	Image: S1.1.3.2 PEPDS Operability						
185	S1.1.3.3 PEPDS Safety						
186	S1.1.3.3.1 Personnel Safety						
		PEPDS shall minimize LRU s Liftability achieving a maximum threshold of TBD.	PEPDS LRU s Liftability LRU s Liftability LRU s Liftability Threshold = TBD L3 Safety				2022.11.15
187	₽ \$1.1.3.3.1.1		2.3.2 Liftable     2.3.2 Liftable     5.1 Simplified LRU Replacement     RUs     RUs     Crew     Safety MoEs     Personnel Safety MoPs     64 MoEs	[ref 50]	Analysis		
188	P 51.1.3.3.1.2	PEPDS should minimize LRU's Liftability achieving a maximum goal of TBD.	PEPOS      LRU s Liftability      RU s Liftability      Z.3 Safety      2.3.2 Liftable      2.3.2 Liftable      Safety      Crew      RUs      Safety MoEs      Personel Safety MoPs      B4 MoEs      Hots      H	[ref 50]	Analysis		2022.11.15
189	■ \$1.1.3.3.1.3	PEPDS shall maximize LRU s Transportability achieving a minimum threshold of TBD.	PEPDS  RU 5 Transportability  RU 5 Transportability  Threshold = TBD  2.3.2 Urtable  5.11 Simplified LRU Replacement  Crew  RU  RU  Safety MoEs  Personel Safety MoPs  B4 MoEs	[ref 50]	Analysis		2022.11.15
190	■ \$1.1.3.3.1.4	PEPDS should maximize LRU s Transportability achieving a minimum goal of TBD.	PEPDS LRU s Transportability LRU s Transportability C Goal = TBD 2.3.2 Liftable 5.11 Simplified LRU Replacement Crew LRUs Safety MoEs Personnel Safety MoPs Bd MoEe	[ref 50]	Analysis		2022.11.15
191	P \$1.1.3.3.1.5	PEPDS shall maximize Thermal Safety achieving a minimum threshold of TBD.	PEPDS  Thermal Safety  Thermal Safety  3.1 Serial Thermal Management  2.3.1 Serial Thermal Management  2.3.1 Thermally Touchable  3.2.3 Safety  Safety Safety Safety Bafety B4 MoEs  B4 MoEs	[ref 24]	Analysis		2022.11.15
192	S1.1.3.3.16	PEPDS should maximize Thermal Safety achieving a minimum goal of TBD.	PEPDS     Thermal Safety     Thermal Safety     Goal = TBD     3.1 Serial Thermal Management     2.3.1 Serial Thermal Management     2.3.3 Safety     Safety     Safety MoEs     Personnel Safety MOPs     B4 MoEs	[ref 24]	Analysis		2022.11.15
193	S11.3.3.1.7	PEPDS shall maximize Electrical Safety achieving a minimum threshold of TBD.	PEPDS     Ectrical Safety     Ectrical Safety     Treshold = TBD     2.3.3 Electrically Insulated     2.3 Safety     Safety MoEs     Personnel Safety MoPs     P4 MoEs	[ref 36]	Analysis		2022.11.15
194	P 51.1.3.3.1.8	PEPDS should maximize Electrical Safety achieving a minimum goal of TBD.	PEPDS     Ectrical Safety     Ectrical Safety     Soal = TBD     2.3.3 Electrically Insulated     2.3 Safety     Safety MoEs     Personnel Safety MOPs     4 MoEs	[ref 36]	Analysis		2022.11.15
195	S1.1.3.3.2 System Safety						
204	S1.2 Capability Requirements				1		
				1			

# Fig. 66: S1.1.3.3.1 Personnel Safety

#	△ Name	Text	Traced To	Source	Verify Method	Risk	Revision Date
1	S1.1 PEPDS Requirements						
2	Image: S1.1.1 PEPDS Generic Power System Requirem						
44	E S1.1.2 PEPDS Innovative Requirements						
80	S1.1.3 PEPDS Performance Metrics						
81	E S1.1.3.1 PEPDS RAM						
113	E S1.1.3.2 PEPDS Operability						
185	S1.1.3.3 PEPDS Safety						
186	E S1.1.3.3.1 Personnel Safety						
195	S1.1.3.3.2 System Safety						
196	P S1.1.3.3.2.1	PEPDS shall maximize Tolerance to Environmental Loads achieving a minimum threshold of TBD.	FPDS     Tolerance to Environmental Loads     Tolerance to Environmental Loads     Threshold = TBD     J. Serial Thermal Management     Safety MoEs     System Safety MoPs     B4 MoEs	[ref 24]	Analysis		2022.11.15
197	P 51.1.3.3.2.2	PEPDS should maximize Tolerance to Environmental Loads achieving a minimum goal of TBD.	FPDS     Tolerance to Environmental Loads     Tolerance to Environmental Loads     Goal = TBD     S. 1. Serial Thermal Management     Safety MoEs     System Safety MOPS     E4 MoEs	[ref 24]	Analysis		2022.11.15
198	I S1.1.3.3.2.3	PEPDS shall minimize Mean Time to Detect Cybersecurity Intrusion achieving a maximum threshold of TBD.	Mean Time to Detect Cybersecurity In Threshold = TBD Threshold = TBD CyberMTTD S.3.2.2 Cyber Security S.8 Automated Self-check Safety MoEs System Safety MoPs H MoEs H	[ref 50]	Analysis		2022.11.15
199	E S1.1.3.3.2.4	PEPDS should minimize Mean Time to Detect Cybersecurity Intrusion achieving a maximum goal of TBD.	Mean Time to Detect Cybersecurity In Mean Time to Detect Cybersecurity In Detect CyberMTD Of CyberMTD S.S. Automated Self-check Safety MoEs System Safety MoPs H MoEs	[ref 50]	Analysis		2022.11.15
200	E S1.1.3.3.2.5	PEPDS shall minimize Mean Time to Resolve Cybersecurity Intrusion achieving a maximum threshold of TED.	Mean Time to Resolve Cybersecurity I Mercehold = TBD PEPDS CyberMTTR 3.3.2 Cyber Security System Safety MoEs System Safety MoPs H MoEs	[ref 24]	Analysis		2022.11.15
201	■ S1.1.3.3.2.6	PEPDS should minimize Mean Time to Resolve Cybersecurity Intrusion adhieving a maximum goal of TBD.	Mean Time to Resolve Cybersecurity I Mean Time to Resolve Cybersecurity I PEPDS CyberMTIR 3.3.2 Cyber Security Safety MoEs System Safety MoPs H MoEs	[ref 24]	Analysis		2022.11.15
202	<b>I</b> 51.1.3.3.2.7	PEPDS shall minimize Mean Time to Contain Cybersecurity Intrusion achieving a maximum threshold of TBD.	Mean Time to Contain Cybersecurity I Mean Time to Contain Cybersecurity I PEPDS CyberMTTC S.3.2 Cyber Security Safety MoEs System Safety MoPs H4 MoEs	[ref 24]	Analysis		2022.11.15
203	I S1.1.3.3.2.8	PEPDS should minimize Mean Time to Contain Cybersecurity Intrusion achieving a maximum goal of TBD.	Mean Time to Contain Cybersecurity I Gal = TBD PEPDS CyberMTTC G 3.3.2 Cyber Security Safety MoEs System Safety MoPs B4 MoEs	[ref 24]	Analysis		2022.11.15
204	S1.2 Capability Requirements						

### Fig. 67: S1.1.3.3.2 System Safety

	△ Name	Text	Traced To	Source	Verify Method	Risk	Revision Date
1	E S1.1 PEPDS Requirements						
204	S1.2 Capability Requirements     S1.2.1 Control Capability Requirements						
206	S1.2.1.1 Control Capability Generic Require	•					
207	S1.2.1.1.1	The Control Capability shall control capabilities through Commands based on the Control Strategy.	Control Capability Commands Control Strategy W2.1 Control PEPDS W2.1 Control PEPDS W4 Dontrol Strategy onto PEPDS Act Ja Issue Protitade Commands	[ref 52]	Analysis		2022.11.15
208	<b>3</b> 51.2.1.1.2	The Control Capability shall send Feedback with PEPOS status to Ship Control and the Crew.	PEPDS Control Capability Ship Control Feedback W.2.1.1 Control Information W.W.2.1.1 Control PEPDS W.2.1 Control PEPDS W.2.3 Control PEPDS Co	[ref 52]	Analysis		2022.11.15
209	<b>5</b> 1.2.1.1.3	PEPDS Feedback dhall provide a projection of intended automatic divides to the Crew.	PEPDS     Grew     Feedback     W2.1 Control PEPDS     W2.1.1 Control Information     Report on PEPDS	[ref 52] [ref 54]	Analysis		2022.11.15
210	S1.2.1.2 Control Capability Innovative Rec	The Control Capability's course of action shall be any independent	Control Capability				2022.11.15
211	51.2.1.2.1	or coordinated use of PEPOS Capabilities.	PEPDS     Finite Capability     Finite Carse of Action     W2.1.1 Control Information     W2.1.2 Control PEPDS Capabilities     W2.1 Control PEPDS	[ref 48], [ref 47]	Analysis		
212	<b>5</b> 1.2.1.2.2	The Control Capability shall issue Prioritzed Commands to the capabilities.	Control Capability Commands Commands W2.1.2 Control PEPDS Capabilities S.5 Integrated Control W2.1.2 Control PEPDS	[ref 50] [ref 52]	Analysis		2022.11.15
213	<b>512.1.2.3</b>	The Control Capability shall analyze capability needs based on capability Feedback to Determine Course of Action.	Control Capability Capability Needs Capability Needs Capability Needs Carge of Action Carge of Action Carge V2.1.1 Control Information Carge State Feedback Carge Needback Carge W2.1 Control PEPDS	[ref 52]	Analysis		2022.11.15
214	<b>5</b> 12.1.2.4	The Control Capability shall Determine Course of Action based on the Control Strategy, Commands from Ship Control and Crew, analysis of capability needs, power source supply, and power load demand.	Control Strategy Control Strategy Control Strategy Control Capability PEPOS Outsetmine Course of Action Value: A control Information Freedback Commands Analyze Coability Needs Analyze Control Commands Shandyze Dower Source Supply Crew Shandyze Dower Source Supply Crew Commands Control	[ref 52]	Analysis		2022.11.15
215	■ \$1.2.1.2.5	The Control Capability shall applate the Control Strategy based on Crew Commands, Ship Control Commands, analyzing Capability Needs, power source supply, and power load demand.	Control Capability Control Strategy Analyze CapabilityNeeds Graw Crew Crew Crew Control Strategy Control Commands Wu 21.1 Control PEPDS Wu 21.1 Control Information Analyze Power Load Demands Analyze Power Source Supply Offboard Power Suptems Othoard Power Suptems	[ref 52] [ref 58]	Analysis		2022.11.15
216	I \$1.2.1.2.6	The Control Capability shal analyze power load needs based on power load Characterization and the Control Strategy.	Control Capability Control Capability Control Strategy W.2.1.1 Control Information S.7 Adaptive Controls Analyze Power Load Demands W.2.1 Control PPPDS W.2.1 Control PPPDS	[ref 52] [ref 58]	Analysis		2022.11.15
217	S1.2.1.2.7	The Control Capability shall ensure system stability during normal operations while meeting all demands for Electrical Power.	Electrical Power     Control Capability     S. 7 Adaptive Controls     W2.1 Control PPDDS     Electric Systems	[ref 51]	Analysis		2022.11.15
218	S1.2.1.2.8	The Control Capability shall direct PEPOS operations to ensure system stability by accommodating pulse loads.	PEPDS     Control Capability     Control Capability     S. 7 Adaptive Controls     W2.1 Control PEPDS     Onboard Power Loads     Ofboard Power Systems	[ref 51]	Analysis		2022.11.15
219	<b>S</b> 1.2.1.2.9	The Control Capability shall direct PEDCs operations to ensure system stability by accommodating mismatched loads.	PEPDS     Control Capability     S.7. Adaptive Controls     W2.1 Control PEPDS     Orboard Power Loads     Offboard Power Systems	[ref 51]	Analysis		2022.11.15
220	<b>5</b> 1.2.1.2.10	The Control Capability shall direct PEPDS operations to ensure system stability by accommodating stochastic loads.	PEPDS Control Capability S.7 Adaptive Controls W.2.1 Control PEPDS Orboard Power Loads Offboard Power Systems	[ref 51]	Analysis		2022.11.15

### Fig. 68: S1.2.1 Control Capability Requirements Part 1

		The Control Capability shall direct PEPDS operations to ensure	PEPDS			2022.11.15
221	S1.2.1.2.11	system stability by accommodating large loads.	Control Capability  S.7 Adaptive Controls  C.1 Control PEPDS  Onboard Power Loads  Offboard Power Systems	[ref 51]	Analysis	
222	I 51.2.1.2.12	The Control Capability shall direct PEPOS operations to ensure system stability while servicing and sheeding loads.	Control Capability PEPDS Command Service Loads W.2.1 Control PEPDS Capabilities W.2.1.2 Control PEPDS Capabilities S.2.1 Control PEPDS Capabilities S.2.1 Control PEPDS Capabilities Command Shed Loads Command Shed Loads Offboard Power Loads Offboard Power Systems	[ref 52]	Analysis	2022.11.15
223	<b>G</b> 51.2.1.2.13	The Control Capability shall direct HPDS operations to ensure system stability while accessing and de-accessing sources.	Control Capability PEPDS VI.1.2 Control PEPDS Capabilities VI.1.2 Control PEPDS Capabilities Orboard Power Sources Offboard Power Sources Offboard Power Systems VI.1 Control PEPDS Command Access Source Power Command De-access Source Power	[ref 52]	Analysis	2022.11.15
224	<b>5</b> 1.2.1.2.14	The Control Capability shall drect PEPOS operations to ensure system stability by accommodating mismatched sources.	Control Capability  PEPDS  S. 7 Adaptive Controls  V2.1 Control PEPDS  Control PEPDS  Onboard Power Sources  Offboard Power Systems	[ref 51]	Analysis	2022.11.15
225	51.2.1.2.15	The Control Capability shall direct PEPOS operations to ensure system stability by accommodating startup surge power.	PEPOS     Control Capability     G. 7. Adaptive Controls     Electrical Power     Dobard Power Sources     Offboard Power Systems     Gibbard Power Systems     Gibbard Power Systems	[ref 51]	Analysis	2022.11.15
226	<b>5</b> 1.2.1.2.16	The Control Capability shall direct PEPOS operations to ensure system stability according to prointents from an assessment of PEPOS state and Crew Commands.	Control Capability FEPDS Feedback Gommands Commands Gommands Gomm	[ref 51]	Analysis	2022.11.15
227	■ S1.2.1.2.17	The Control Capability shall be able to Program Communication Networks.	Control Capability Control Capability Control PEPDS Control PEPDS Control Information Control S.6 Functional Control	[ref 50]	Analysis	2022.11.15
228	III S1.2.1.2.18	The Control Capability shall be able to Program Power Networks.	E Control Capability U.1. Control PEPDS U.2.1.1 Control Information S.6 Functional Control Program Power Networks	[ref 50]	Analysis	2022.11.15
229	☑ S1.2.1.2.19	The Control Capability shall be able to Program PEPDS components.	E Control Capability 양 W2.1 Control PEPDS 양 W2.1.1 Control Information 등 S.6 Functional Control 양 Program PEPDS Components	[ref 50]	Analysis	2022.11.15
230	■ 51.2.1.2.20	The Control Capability shall provide an assessment of the impact of programming Communication networks, sown networks, and PEPDS components based on the Control Strategy in its Feedback.	Control Capability Control Strategy Control Strategy PEPOS V2.1 Control IPEPOS V2.1 Control Information S.6 Functional Control S.6 Functional Control S.6 Automated Self-check Program Communication Networks Program Power Networks	[ref 50]	Analysis	2022.11.15
231	S1.2.1.2.21	The Control Capability shall Capture and Store Data to be used in analysis for CBM+.	Control Capability Capability SW2.1.1 Control Information S.9 Integrated CBM+ W2.1 Control PEPDS Capture Data Store Data	[ref 48], [ref 47]	Analysis	2022.11.15
232	II 51.2.1.2.22	The Control Capability shall Transmit Data to support external CBM+ activities.	E Control Capability 양 W2.1.1 Control Information 고 5.9 Integrated CBM+ 양 W2.1 Control PEPDS 양 Transmit Data	[ref 48], [ref 47]	Analysis	2022.11.15
233	<b>5</b> 1.2.1.2.23	The Control Capability shall Perform CBM+ analysis as instructed by the Control Strategy.	Control Capability Control Capability Control PEPDS Control Strategy Control Strategy Control Information So Integrated CBM+ Control Information So Integrated CBM+ Control Information	[ref 48], [ref 47]	Analysis	2022.11.15
234	512.1.2.24	The Control Capability shall implement change to the Maintenance Strategy based on tata analysis, Silv-Control Maintenance Strategy, and PEPOS Control Strategy.	Control Capability Control PEPOS Ship Control PEPOS Control PEPOS Control Information S.S. Integrated CBM+ Control Strategy	[ref 48], [ref 47]	Analysis	2022.11.15
235	■ 5121225	The Control Capability shall execute self-learning by tracking and improving based on the Control Capability operations, Control Shateyy, Feddback from PEPDS capabilities and Commands form Crew and Ship Control.	Control Capability Control Strategy Control Strategy FPDC S. J. L1 Control Information S. S. Self Learning S. J. Diteprated CBM+ W. 21. Control PEPDS W. 21. Control PEPDS Commands Co	[ref 48], [ref 47]	Analysis	2022.11.15
236	S1.2.1.2.26	The Control Capability should be capable of self-learning in order to improve PEPDS performance over time.	E Control Capability PEPDS G 5.4 Self Learning 안 W2.1.1 Control Information 양 W2.1 Control PEPDS	[ref 48], [ref 47]	Analysis	2022.11.15
245	S1.2.2 Protection Capability Requirements      S1.2.3 Electrical Distribution Canability Description					
261	E S1.2.4 Thermal Management Capability Requir			1		

## Fig. 69: S1.2.1 Control Capability Requirements Part 2

#	△ Name	Text	Traced To	Source	Verify Method	Risk	Revision Date
1	S1.1 PEPDS Requirements						
204	🗉 📋 S1.2 Capability Requirements						
205	🗄 📋 S1.2.1 Control Capability Requirements						
237	🖂 📋 S1.2.2 Protection Capability Requirements						
238	🖂 📋 S1.2.2.2 Protection Capability Innovative F						
		The Protection Capability shall provide the Control Capability Feedback enabling protection related Commands	Protection Capability				2022.11.15
		·	Control Capability				
			Feedback				
230	E S12221		E E Integrated Control	[ref 52]	Analysis		
255			B 5 7 Adaptive Controls	[ici b2]	Analysis		
			5.13 Integrated Power and Energy Po				
			W2.2 Protect PEPDS				
			Send(context Protection Capability)				
		The Protection Capability shall Analyze Source and Load Interfaces	Protection Capability				2022.11.15
		Characteristics in order to detect incipient failures.	PEPDS				
240	<b>1</b> (1) (1) (1)		∑ Failure	[rof E0]	Analysis		
240	F 51.2.2.2.2		🔁 Analyze Power Source and Load Inter	[rei so]	Aridiysis		
			🔁 W2.2 Protect PEPDS				
			5.13 Integrated Power and Energy Po				
		The Protection Capability shall Analyze PEPDS Performance in and a to detect indicate follows	Protection Capability				2022.11.15
		order to detect indpient failures.	PEPDS				
241	<b>F</b> S1.2.2.2.3		Analyze PEPDS Performance(context	[ref 50] [ref 58]	Analysis		
			W2.2 Protect PEPDS				
			B 5.13 Integrated Power and Energy Po				
		The Protection Comphility shall Determine Operational Needs for					2022 11 15
		Safety, Performance, and Resilience based on the Control	Protection Capability				2022.11.15
		Strategy and Commands from the Control Capability.	Control Strategy				
			Commands				
242	F 51.2.2.2.4		S 5 Integrated Control	[ref 52]	Analysis		
			B 5.7 Adaptive Controls				
			B 5.13 Integrated Power and Energy Po				
			W2.2 Protect PEPDS				
			🔁 Determine Operational Needs for Safe				
		The Protection Capability shall perform accurate diagnosis and	Protection Capability				2022.11.15
		prognosis when a failure event occurs.	W2.2 Protect PEPDS				
			5.9 Integrated CBM+				
243	F S1.2.2.2.5		5.13 Integrated Power and Energy Power	[ref 50]	Analysis		
			Perform Diagnosis(context Protection				
			Perform Prognosis(context Protection				
		The Protection Comphility shall Select Protection Degrees					2022 11 15
		on the diagnosis and prognosis of the failure event and the need	Protection Capability				2022.11.15
		for system safety, performance and resiliency.	B 5.5 Integrated Control				
			B 5 13 Integrated Power and Energy Pr				
			W2.2 Protect PEPDS				
244	F S1.2.2.2.6		Perform Diagnosis (context Protection	[ref 50] [ref 52]	Analysis		
			Perform Prognosis(context Protection				
			Select Protection Response(context P				
			B Determine Operational Needs for Safe				
			∑ Failure				
245	🗄 🛅 S1.2.3 Electrical Distribution Capability Require						
261	🗉 📋 S1.2.4 Thermal Management Capability Requir						

Fig. 70: S1.2.2 Protection Capability Requirements

#	△ Name	Text	Traced To	Source	Verify Method	Risk	Revision Date
1	S1.1 PEPDS Requirements						
204	S1.2 Capability Requirements						
205	S1.2.1 Control Capability Requirements      S1.2.2 Protection Capability Requirements						
245	S1.2.3 Electrical Distribution Capability Require						
246	🖂 🛅 S1.2.3.1 Electrical Distribution Capability G	6					
247	F 51.2.3.1.1	The Power Conversion Capability shall Convert Electrical Power based on Commands from the Control Capability.	Power Conversion Capability For Conversion Capability Commands Common Capability Convert Convert For V.3. Distribute Power Fertraical Distribution Capability	[ref 50] [ref 52]	Analysis		2022.11.15
248	<b>S</b> 1.2.3.1.2	The Energy Storage Capability shall Store Electrical Power received from the Power Conversion Capability based on Commands by the Control Capability.	Control Capability Control Capability Control Capability Commands Commands Commands Store W. 32 Distribute Power F. W2.3 Distribute Power F. Problem Domain Electrical Distribution Capability	[ref 50] [ref 52]	Analysis		2022.11.15
249	I S1.2.3.1.3	The Power Conversion Capability shall send Electrical Power to the Power Transportation Capability as appropriate.	Power Conversion Capability Electrical Power Electrical Distribution Capability W 2.3 Distribute Power Power Transportation Capability	[ref 50] [ref 52]	Analysis		2022.11.15
250	S1.2.3.1.4	The Power Transportation Capability shall Transport Electrical Power based on Commands from the Control Capability.	Power Transportation Capability For Extrical Power Commands Commands Control Capability Company Compa	[ref 50] [ref 52]	Analysis		2022.11.15
251	<b>S</b> 1.2.3.1.5	The Energy Storage Capability shall discharge Electrical Power to the Power Conversion Capability based on Commands by the Control Capability.	Electrical Distribution Capability Commands Control Capability Energy Storage Capability Electrical Power Power Conversion Capability W2.3 Distribute Power	[ref 50] [ref 52]	Analysis		2022.11.15
252	f S1.2.3.1.6	The Power Conversion Capability shall receive Electrical Power from the Power Transportation Capability as appropriate.	Power Conversion Capability Electrical Power Power Transportation Capability W2.3 Distribute Power Electrical Distribution Capability	[ref 50] [ref 52]	Analysis		2022.11.15
253	F S1.2.3.1.7	The Power Transportation Capability shall send Feedback to the Control Capability.	Power Transportation Capability Redback Control Capability Control Capability RedV2.3 Distribute Power Electrical Distribution Capability	[ref 50] [ref 52]	Analysis		2022.11.15
254	I S1.2.3.1.8	The Energy Storage Capability shall send Feedback to the Control Capability.	Energy Storage Capability Feedback Control Capability W2.3 Distribute Power Electrical Distribution Capability	[ref 50] [ref 52]	Analysis		2022.11.15
255	■ S1.2.3.1.9	The Power Conversion Capability shall receive Electrical Power from the Energy Storage Capability as appropriate.	Power Conversion Capability     Energy Storage Capability     Electrical Power     W2.3 Distribute Power     Electrical Distribution Capability	[ref 50] [ref 52]	Analysis		2022.11.15
256	S1.2.3.1.10	The Power Conversion Capability shall send Feedback to the Control Capability.	Power Conversion Capability Control Capability Feedback W2.3 Distribute Power Electrical Distribution Capability	[ref 50] [ref 52]	Analysis		2022.11.15
257	E \$1.2.3.1.11	The Power Conversion Capability shall send Electrical Power to the Energy Storage Capability as appropriate.	Power Conversion Capability Electrical Power Energy Storage Capability W2.3 Distribute Power Electrical Distribution Capability	[ref 50] [ref 52]	Analysis		2022.11.15
258	🖂 📋 S1.2.3.2 Electrical Distribution Capability In	The Power Transportation Canability shall Transport Electrical	Bill Power Transportation Canadility				2022, 11, 15
259	<b>S</b> 1.2.3.2.1	Power from support users to loads, either of which may be onboard or offboard the Electric Ship.	"Over Transportation Capability     "Dectrical Power     W2.3 Distribute Power     S.2 Load Interface Design     Constraints     Transport     Electrical Distribution Capability     Orboard Power Sources     Ofboard Power Systems	[ref 50] [ref 52]	Analysis		
260	■ S1.2.3.2.2	The Power Conversion Capability shall Convert source Electrical Power in order to service loads from dc to dc, dc to ac, ac to dc, ac to ac at various voltages and frequencies.	W2.3 Distribute Power     W2.3 Distribute Power     5.14 Distributed Power Conversion     G. Convert     Offboard Power Systems     Onboard Power Loads     Power Conversion Capability     Onboard Power Sources     Electrical Distribution Capability	[ref 51]	Analysis		2022.11.15
261	🗉 🛅 S1.2.4 Thermal Management Capability Requir						

Fig. 71: S1.2.3 Electrical Distribution Capability Requirements

#	△ Name	△ Name Text Traced To Source				Risk	Revision Date
1	S1.1 PEPDS Requirements						
204	S1.2 Capability Requirements						
205	S1.2.1 Control Capability Requirements						
237	E S1.2.2 Protection Capability Requirements						
245	E S1.2.3 Electrical Distribution Capability Require						
261	🖂 📋 S1.2.4 Thermal Management Capability Requir						
262	😑 📋 S1.2.4.1 Thermal Management Capability (						
263	S1.2.4.1.1	The Thermal Management Capability should regulate the thermal load of PEPDS capabilities to minimize the Environmental Load on PEPDS.	Thermal Management Capability PPDS Expross Comparison Formal Load Comparison	[ref 11]	Analysis		2022.11.16
264	■ S1.2.4.1.2	The Thermal Management Capability shall regulate the thermal load of PEPDS capabilities to protect Crew.	Thermal Management Capability TPDS Personnel Safety MoPs Cew Svew Regulate PEPDS Internal Thermal Load Environmental Load	[ref 11] [ref 52]	Analysis		2022. 11. 15
265	F S1.2.4.1.3	The Thermal Management Capability shall regulate the thermal load of PEPDS capabilities as necessary to maintain operations.	Thermal Management Capability FEPDS W2.4 Manage Thermal Load of PEPDS Environmental Load Regulate PEPDS Internal Thermal Load	[ref 11]	Analysis		2022.11.15
266	S1.2.4.1.5	The Thermal Management Capability shall regulate the thermal loads of PEPDS capabilities in accordance with the Commands from the Control Capability.	Thermal Management Capability Tortrol Capability Control Capability PEPDS Commands PEPDS Commands Environmental Load of PEPDS Environmental Load Co Regulate PEPDS Internal Thermal Load	[ref 11]	Analysis		2022.11.16
267	■ S1.2.4.1.6	The Thermal Management Capability shall send Feedback to the Control Capability.	Thermal Management Capability Control Capability Feedback W.2.4 Manage Thermal Load of PEPDS	[ref 11]	Analysis		2022.11.15
268	😑 📋 S1.2.4.2 Thermal Management Capability I						
269	₣ S1.2.4.2.1	The Thermal Management Capability should utilize the Electric Ship's environmental services to regulate the thermal load of PEPDS capabilities.	Thermal Management Capability Christian Capability Christian Capability Christian Capability Christian Capability Christian Capability Christian	[ref 14]	Analysis		2022.11.15

Fig. 72: 51.2.4 Thermai Wanagement Capability Requirement
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# **11.3 System Model Appendix**



Fig. 73: 9 System Model Appendix

-	△ Term	Description	Active Hyperlink
1	• [ref 1]	R. M. Cuzner, R. Soman, M. M. Steurer, T. A. Toshon and M. O. Faruque, "Approach to Scalable Model Development for Navy Shipboard Compatible Modular Multilevel Converters," in IEEE Journal of Emerging and Selected Topics in	The https://daeavologa.iaae.org/document/7587363
	e fier ti	Power Electronics, vol. 5, no. 1, pp. 28-39, March 2017, doi: 10.1109/JESTPE.2016.2616222.	Trubs://seeshore.sees.org/outurent/36/363
2	t [ref 2]	R. Soman, M. M. Steurer, T. A. Toshon, M. O. Faruque and R. M. Cuzner, 'Size and Weight Computation of MVDC Power Equipment in Architectures Developed Using the Smart Ship Systems Design Environment," in IEEE Journal of Execution and Elected Technologic In Brane Flattancians, und Electrometer 2015, 2015 (2015)	https://eeexplore.ieee.org/document/7736151
		Direging and refected region in the Development David Section 2017 (2017) 2	
3	t [ref 3]	c. mydawi, percent rogani myduraw readiu na cane o nie prozvat na prosta na myduraw cane o reade a su downe, so wagrazzi, jorningi, kwaade na cane o nie prozvat na mydurawi kategoria. html #/downent/95.4#41124154c5.266d697e0424.597d6312d25610b3416.facesset; 30.4ug-2021.	https://rcpc.awsapps.com/workdocs/index.html#/folder/60d382205eb7578435d89089352e2b5dccf63f44c9d5f2cd845fbd2620c6ae1d
4	10000	"Expanded Work Breakdown Structure Weight Classification Guidance - SAWE, "SAWE ESWBS RP 03042011, 04-Mar-2011. [Online]. Available: https://www.sawe.org/files/SAWE%20ESWBS%20RP%2003042011.pdf. [Accessed:	C LL
	e Berel	08-May-2022].	En Indust//www.sawe.org/intes/skvtc.sedecs/vbs/sedecs/ubs/sedecs/ti-put
5	t [ref 5]	NAVSEA, "SHIPBOARD HABITABILITY DESIGN CRITERIA AND PRACTICES MANUAL (SURFACE SHIPS) FOR NEW SHIP DESIGNS AND MODERNIZATION", DIRECTION OF COMMANDER, NAVAL SEA SYSTEMS COMMAND, 2016.	Attps://habitability.net/WebData/T9640-AC-DSP-010_HAB.pdf
6	t'] [ref 6]	R. Cuzner, Functional Architectural Requirements', University of Wisconsin-Milwaukee, 2022.	[e] https://cpc.awsapps.com/workdocs/index.html#/folder/7d5c804f5dddf7666ad16501634f1b48529470ba463082610caa9995aca1c231
7	t [ref 7]	<ol> <li>Chaitant, ANY Navy Ship Power Distribution System   PEPOS, Massachusetts Institute of Technology, 2022.</li> </ol>	(e) https://cpc.awsapps.com/workdocs/index.html#/document/606680bc8de29ad4c0132b34a538ecc1199ef05027ea9ae9b50143426e41bd8b
0	t [ref 8]	n, Grin, DDS 2000 IPS integration - Dectric Srip Design Symposium, University or source Carolina, 2009.	[§] https://rcpc.awsapps.com/workdocs/index.html#/document/d998d3UC571de3f34C9C05db1u5d9aee3e05bb107758be01758be001758be001758be001758be01758be01758be01758be001758be001758be001758be01758be0001758be0001758be000000000000000000000000000000000000
9	t" [ref 9]	N. Kitty G. Kotty, W. Kitty and K. Chury, A Preliminary social on an Automative single Propulsion System Proceed by Animonal: Environmental and Economic Assessments, Journal of Marine Science and Engineering, vol. 6, 100. Sp. 165, Mar. 2020, doi:10.3390/mse8030183.	https://www.mdpi.com/2077-1312/8/3/183/htm
10	+1 [rof 10]	H. Xing, C. Stuart, S. Spence, and H. Chen, "Fuel Cell Power Systems for Maritime Applications: Progress and Perspectives," Fuel cell sustainability - 13-01213, January 2021. [Online]. Available: https://cpc.awsapps.	A https://www.mdoi.com/0071-1000/12/2/1212/adf
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11	t'] [ref 11]	3. Ordonez, Thermal interconnections', University of Wisconsin-Milwaukee, 25 August, 2021.	Intps://cpc.awsapps.com/workdocs/index.html#/document/4f78436b73b8e8a91f11a7424206de3ab83ec5751f757a1ibeb8ead29160dc3c
12	t [ref 12]	R. Cuzner, Ship Service Loads, University of Visconsin-Miniaukee, 11 August, 2021.	[c] https://cpc.awsapps.com/workdocs/index.html#/document/2b0fedd4972fc01e69d49a2fd5916a826de92b6dc2b5b9b25c7b438a8207dc607
13	t [ref 13]	Challence She Support Managhranghang meaning, ringina tech - Center the Power Decisionics Systems, to August, 2021.	(注) 市町5://でた.avisapps.com/workdoc5/index.html=/document(e430/324613ffeb2ff3390452786127861278612786127861278612786127861
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Fig. 75: Bibliography Part 2 of 2

	A Torm	Decaviphing	Deferences
1	t acwp	Actual Cost of Work Performed	the fact and
1		Administrative Delay Time	i jier /5j
-		Budgeted Coch of Work Deformed	t [ref 35]
,	DCWP	Dudgeted Cost of Work Performed	t [ret /5]
•	LE BCWS	budgeted Cost or Work Scheduled	t [ref 76]
	IT BIT	Duilt-in test	t [ref 33]
	t CAPS	Center for Advanced Power Systems	t [ref 29]
	t CB	Capacitor Bank	t [ref 25]
	t CBM+	Conditioned Based Maintenance Plus	t [ref 61]
	t CBRN	Chemical, Biological, Radiological, and Nuclear	t [ref 62]
D	t CCDC	Current Commutating Drive Circuit	t [ref 25]
1	t CHIL	Controller Hardware-in-the-Loop	t [ref 24]
2	T CPI	Cost Performance Index	t [ref 75]
3	t cv	Cost Variance	t [ref 75]
4		Mean Time to Contain Cybersecurity Failure	t [ref 63]
	t CuborMTTD	Mean Time to Detect Cybercecurity Failure	t [rendo]
	CyberMTTD	Mean Time to Berolye Cybersecurity Failure	
,	+ ODTS	Digital Peal Time Simulator	t [reros]
60 200	DRID		t [ref 24]
8	ECM	Energy Conversion Module	t [ref 31]
•	EMC	Electromagnetic Compatibility	t [ref 66]
)	t EMCB	Electro-Mechanical Circuit Breaker	t [ref 25]
4	t EMI	Electromagnetic Interference	t [ref 66]
1	t ESM	Energy Storage Module	t [ref 25]
3	t EWS	Electronic Warfare System	t [ref 26]
ł.	t FA	Fan Assembly	t [ref 25]
0	t FA-1	Filter Assembly	t [ref 25]
i.	T FH	Flight Hours (i.e., Functional Hours)	t [ref 23]
7	T FMS	Fast Mechanical Switch	t [ref 25]
i K	T HEXA	High Frequency Transformer Assembly	t [ref 25]
	T HXA	Heat Exchanger	t fref 251
1	T IA	Inductor Assembly	t [ref 25]
e.		Immediately Dangerous to Life or Health	thef 67
		integrated Dower Electronic Dublics Dedu	t [rei o/]
		Integrated Power Lieururiit Duilding Diotks	[] [ret 24]
) स	IPEC	Integrated Power and Energy Cutting	t [ref 41]
+	IPES	Integrated Power and Energy System	t [ret 24]
5	IT LCC	Line Lycle Cost	t" [ref 38]
5	t LCS	Load Commutating Switch	t [ref 25]
2	t LDT	Logistics Delay Time	t [ref 35]
ĺ,	t LMS	Logistics, Maintenance, and Support	t [ref 38]
•	t lru	Line Replaceable Unit	t [ref 6]
)	t LRUs	Line Replaceable Units	t [ref 6]
ſ	t MAMT	Mean Active Maintenance Time	t [ref 35]
2	t MCD	Most Common Denominator	t [ref 24]
3	T MCMT	Mean Corrective Maintenance Time	t [ref 35]
1	t MDT	Mean Downtime	t [ref 35]
5	T MMH	Maintenance Man Hours	t [ref 23]
	T MoF	Measurement of Effectiveness	t [ref 27]
,	T MOHREA	Mean Operating Hours Between Fake Alarm	t [ref 32]
2	T MoP	Measurement of Performance	t [ref 27]
1	T MPMT	Mean Preventative Maintenance Time	t [r=f 25]
1		Mean Time Retween Critical Esiliwa	U grer 35j
		Maan Time Between Chuidi Fellure	[1] [ret 33]
	IN MUBE	Marcan Time Detween Failure	t [ret 23]
1	t MTBM	mean Time Between Maintenance	t" [ref 33]
ų,	t MTBOMF	mean Time Between Operational Mission Failure	t [ref 33]
R.	t MTBR	Mean Time Between Repair	t [ref 33]
	t MTTR	Mean Time to Repair	t [ref 24]
	t MVAC	Medium Voltage Alternating Current	t [ref 24]
	T MVDC	Medium Voltage Direct Current	t [ref 24]
	1 NIPEBB	Navy iPEBB	t [ref 71]
ĵ,	T NIPEC	Navy integrated Power and Energy Corridor	t [ref 42]
6	T NLSw	No Load Switch/DC Disconnect	t [ref 25]
i.e.	t OBE	Overcome By Events	t [ref 68]
	T PCB	Printed Circuit Board	t [ref 25]
	T PCM	Power Conversion Module	t [ref 25]
		Power Distribution Module	+ (ref 20)
88 19	PERB PERB	Power Electronic Building Block	t [ref 24]
		Dower Electronic Dower Distribution Contern	L [rel 24]
i i	PEPUS	Power clear one rower distribution bystem	t [ref 24]
0 20	T PFD	Percent Fault Detection	t [ref 33]
\$) 	T PFI	Percent Fault Isolation	t" [ref 33]
)	t PGM	Power Generation Module	t [ref 25]
)	t PHIL	Power Hardware-in-the-Loop	t [ref 24]
L	t PMM	Propulsion Motor Module	t [ref 25]
2	t RAM	Reliability, Availability, and Maintainability	t [ref 23]
	t RateCM	Corrective Maintenance Rate	t [ref 35]
Ŗ	t RateF	Failure Rate	t [ref 35]
	t RatePM	Preventative Maintenance Rate	t [ref 35]
	t RTS	Real Time Simulator	t fref 241
,	T SHIPALT	Shin Alteration	t [ref 33]
		State of Charge	[Fer 52]
2	LE SUC	Schedule Derformmente Terleu	t [ref 30]
0	IT SPI	sureque Perrormance Index	t [ref 76]
ť.	t SSSw	Solid State Switch	t [ref 25]
L	t SV	Schedule Variance	t [ref 76]
	t TBD	To Be Determined	t [ref 69]
	t TEM	Tactical Energy Management	t [ref 24]
F	THD THD	Total Harmonic Disorder	t [ref 70]
-	t TPM	Technical Performance Measure	t [ref 38]
;	t UPS	Uninterruptible Power Supply	t [ref 28]
٩0.	1000 CTAST	The second s	C = 1 = 0]

### Fig. 76: System Model Acronyms

#	Term	Description	Active Hyperlink
1	t Electrical Load	An electrical load is an electrical component of a circuit that consumes electrical power.	
2	t Electrical Source	An electrical source is a device that dissipates electrical power.	
3	t Failure	Anything that degrades or disrupts the operation of the system. Response time varies. Includes Faults.	
4	t Fault	Disruptive event to the normal operation of the system that requires immediate response of the system because of imminent danger to personnel or system inside or outside PEPDS. Is a type of Failure.	
5	t Tappable	Points at which Electrical Power provided by PEPDS may be accessed.	
6	t Reconfigurability	Changing system behavior by altering interconnections between components and/or selection of predefined options available for components, thereby treating components as black boxes.	
7	t Reconfiguration	see reconfigurability	
8	t Re-programmability	Changing system behavior by altering internal functions of components, e.g. through firmware or software, thereby treating components as white boxes.	
9	t Programming	see re-programmability	
10	t Program	see re-programmability	
11	t Diagnosis	identification of the nature and cause of a failure	
12	t Prognosis	a forecast of the consequences of a failure if not addressed	
13	t Prognoses	see prognosis	
14	t Diagnoses	see diagnosis	

#### Fig. 77: System Model Glossary



Fig. 78: PEPDS 5 Year Plan



Fig. 79: Events and Milestones





Fig. 81: PEPDS Architecture Team Diagram

#	Organization	Name	Main Research Topic	Supporting Team Members
	🛅 Florida State University	Michael "Mischa" Steurer	<ul> <li>(Architectures)</li> </ul>	P Carmen E. Araujo - Lead MBSE - Team Point of Contact
		(Lead Architect)	<ul> <li>(Abilities)</li> </ul>	P David C. Gross - MBSE
			<ul> <li>(System Integration)</li> </ul>	P Naqash Ali
1				P Jodie Bell
				P Karl Schoder
				P Matthew Bosworth
				P Sihun Song
2	🛅 Florida State University	Juan Ordonez	<ul> <li>(Thermal Management)</li> </ul>	
	Massachusetts Institute of Technology		O (NIPEC)	P Matt Kruse
3		📃 Julie Chalfant	<ul> <li>(Naval Architecture)</li> </ul>	P Drake Platenberg
				P Avi Chatterjee
4	🛅 University of South Carolina	📕 Herbert L. Ginn	O (Controls)	P Aaron De La O Perez
	University of Texas at Arlington		<ul> <li>(Energy Storage)</li> </ul>	P Shawn 'Tyler' Scoggin
5		David A. Wetz		P Hayden Atchison
				P Alex Johnston
	University of Wisconsin-Milwaukee		<ul> <li>(Virtual Prototyping)</li> </ul>	P Jacob David Gudex
				Joey Authement
6		Pobert M. Cuzper		P William Joseph Koebel
		Kober (M. Cuzher		P Jose Antonio Trujillo Parra
				P Hamed Shabani
				Rounak Siddaiah
7	🛅 Virginia Tech	Dong Dong	(NIPEBB)	P Daniel Sathri
· ·		E bong bong		P Marie Lawson
8	NSWCPD	Aaron Scherr		
9	NSWCPD	Nathan Spivey		
10	NSWCPD	Robert "Bob" Irwin (PI)	<ul> <li>(Stability Design &amp; Assessment)</li> </ul>	
11	NSWCPD	Shawn Plesnick (AI)	<ul> <li>(Stability Design &amp; Assessment)</li> </ul>	
	🛅 Other			P Igor Cvetkovic - VT
				P Rolando Burgos - VT
				P Richard Zhang - VT
12		Previous Team Members		P Dushan Boroyevich - VT
12		Previous Leam Members		P Christina DiMarino - VT
				Salman Hussain - FSU
				P Ceca Mijatovic - FSU
				P James Narey - UTA

Fig. 82: PEPDS Architecture Team Table

#	Owner	Name
1	🔁 Submit Feedback	PEPDS Feedback Log.docx
2	🔁 W2.2 Protect PEPDS	PEPDS FMECA.xlsx





Fig. 84: Typical Power Distribution Components



Fig. 85: PEPDS Innovations



Fig. 86: S3.x Cuzner Gray Box Class



Fig. 87: Model Navigation Road Map



Fig. 88: MBSE in PEPDS



Fig. 89: Archived Task Plan




PEPUS LAMEO MODEL FEEDBACK LOG	PEPDS CAMEO MODEL FEEDBACK LOG				
Date:	Feedback:				
Reviewer:					
	B4: Measurements of Effectiveness				
Please provide feedback in the corresponding section. Do not forget to put your name in the document	Black Box MoEs				
neader above. Unce complete, forward the document to ssongbig/isu.edu.	Feedback:				
Table of Content (Sections Hyperlinked)	W2: Functional Analysis				
B1: Stakeholder Needs	Convert Power and Deliver				
B2: Use Cases	Feedback				
B3: System Context					
B4: Measurements of Effectiveness	W3: Logical Architecture				
	Interfaces				
W2: Functional Analysis	Feedback:				
W3: Logical Architecture					
W4: Measurements of Effectiveness	Logical Subsystems				
	Feedback:				
B1: Stakeholder Needs					
Stakeholder Needs Table	W4: Measurements of Effectiveness				
Feedback:	White Box MoEs				
	Feedback:				
B2: Use Cases					
Use Cases					
Feedback:					
Distribute Power					
Feedback:					
B3: System Context					
Ship Electric Environment					
Florida State University – Center for Advanced Power Systems 2000 Levy Ave. Tallahassee, FL 32310	Florida State University Center for Advanced Power Systems 2000 Levy Ave. Tallahassee, PL 32210				

Fig. 91: Archived Feedback Log

ad (Anching) Agrilves V(2.2.1 HETCS Falure Examples (Archined V(2.2.1 HETCS Falure Examples )) Modification date 3/7/23 8:30 FM comment.						
Last modifie by J cost 44  Last modifie by J cost 44  Last modifie by Cost 44  Last modifie by Cost 44  Last modifie by Cost 44  Perce Article and Cost 44						
		alicates provis				
calecates	valocates Control Canability	valocates Protection Canability		calocates Restrical Distribution Canability		calocates Thermal Management Carability
			valicates Power Transportation Capability	ealocates Power Conversion Capability	enlocates Energy Storage Capability	
Jack         Jack <t< td=""><td>science Court Casality Court Casalit</td><td>Under a second s</td><td>store There Transported regarding There Tra</td><td>faint and a second seco</td><td>numeri Forge Brook (Construction) Stress Research Stress Research Stre</td><td></td></t<>	science Court Casality Court Casalit	Under a second s	store There Transported regarding There Tra	faint and a second seco	numeri Forge Brook (Construction) Stress Research Stress Research Stre	
-Stock Register Real Reg Register Stocket						

Fig. 92: Archived W2.2.1 PEPDS Failure Examples

# 11.4 MagicGrid<sup>®</sup> Index Package Diagrams

# 11.4.1 MagicGrid<sup>®</sup> Index Package Diagrams for Problem Domain Requirements

pkg [Package] B1 Stakeholder Needs [ B1 Stakeholder Needs ]
Modification date 1/3/23 1:46 PM
Last modified by ceal4e
B1 Stakeholder Needs
B1 Stakeholder Needs Table
B1 Stakeholder Needs Diagram
«comment» Return to Road Map or MagicGrid MagicGrid Index

Fig. 93: B1 Stakeholder Needs Package Diagram



#### 11.4.2 MagicGrid<sup>®</sup> Index Package Diagrams for Problem Domain Behavior





#### Fig. 95: W2 Functional Analysis Package Diagram



## 11.4.3 MagicGrid<sup>®</sup> Index Package Diagrams for Problem Domain Structure

Fig. 96: B3 System Context and Logical Architecture Subsystems

## **11.4.4 MagicGrid® Index Package Diagrams for Problem Domain Parameters**



Fig. 97: B4 Measurements of Effectiveness Package Diagram



Fig. 98: W4 Measurements of Performance Package Diagram

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## 11.4.5 MagicGrid<sup>®</sup> Index Package Diagrams for Solution Domain Requirements





#### 11.4.6 MagicGrid<sup>®</sup> Index Package Diagrams for System Model Appendix

Fig. 100: System Model Appendix Package Diagram