

Headquarters U.S. Air Force

Integrity - Service - Excellence



Integrating Environment, Safety, and Occupational Health Risk Management into Systems Engineering Using the System Safety Methodology

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Office of the Deputy Assistant Secretary
(Science, Technology and Engineering)**

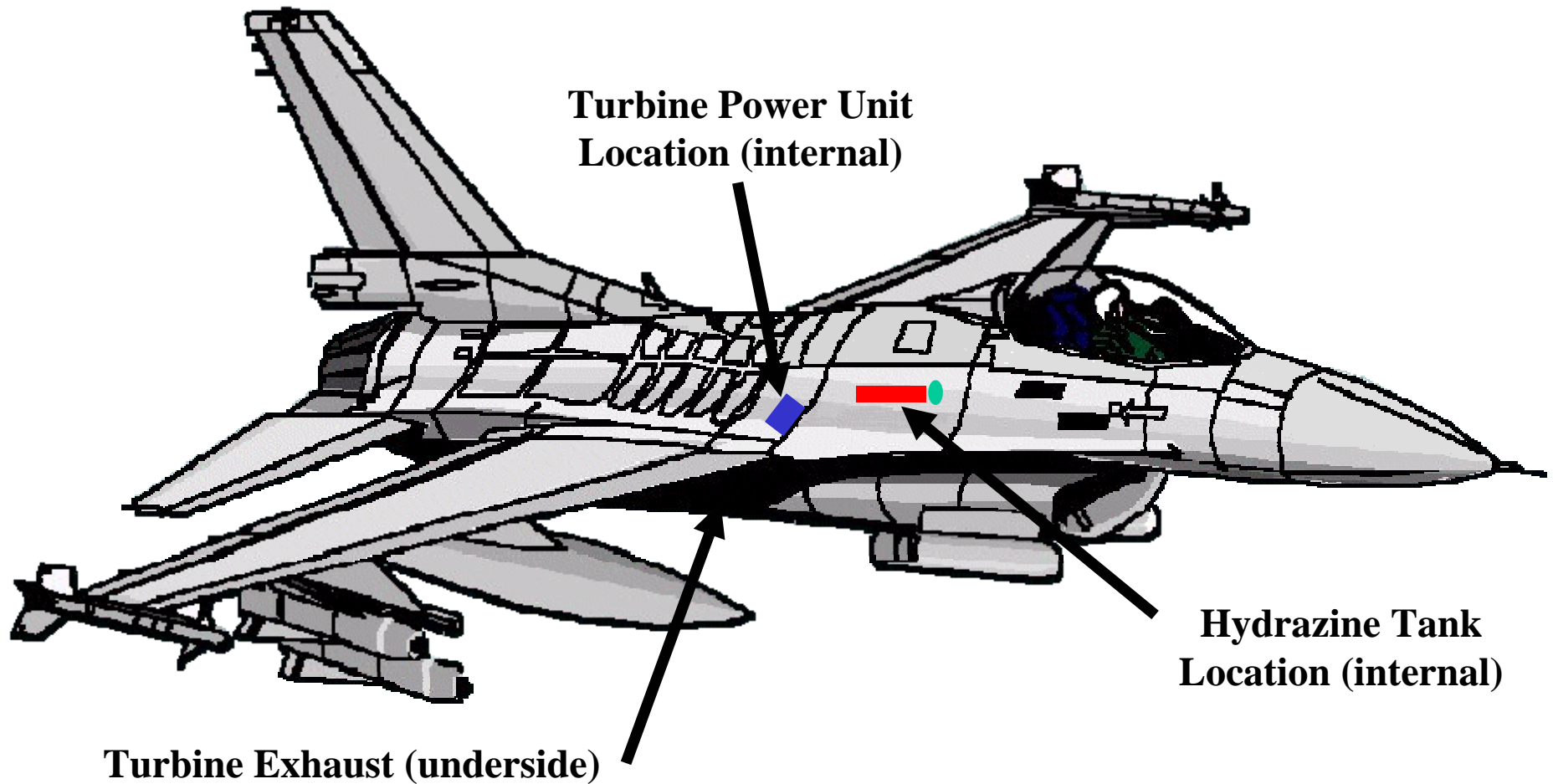


Overview

- **F-16 Emergency Power Unit Example**
 - **Integrated Environment, Safety, and Occupational Health (ESOH) Risk Management (RM)**
 - **Benchmark Approaches**
 - **System Safety - ESOH Management Evaluation Criteria Guide**
 - **Presentation of ESOH Risk Categories in Technical and Program Reviews**
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F-16 Emergency Power Unit (EPU)







Overview

- F-16 Emergency Power Unit Example
- **Integrated Environment, Safety, and Occupational Health (ESOH) Risk Management (RM)**
 - Evolution of Environmental RM
 - E, S, and OH RM Comparisons
 - MIL-STD-882D ESOH RM
- Benchmark Approaches
- System Safety - ESOH Management Evaluation Criteria Guide
- Presentation of ESOH Risk Categories in Technical and Program Reviews



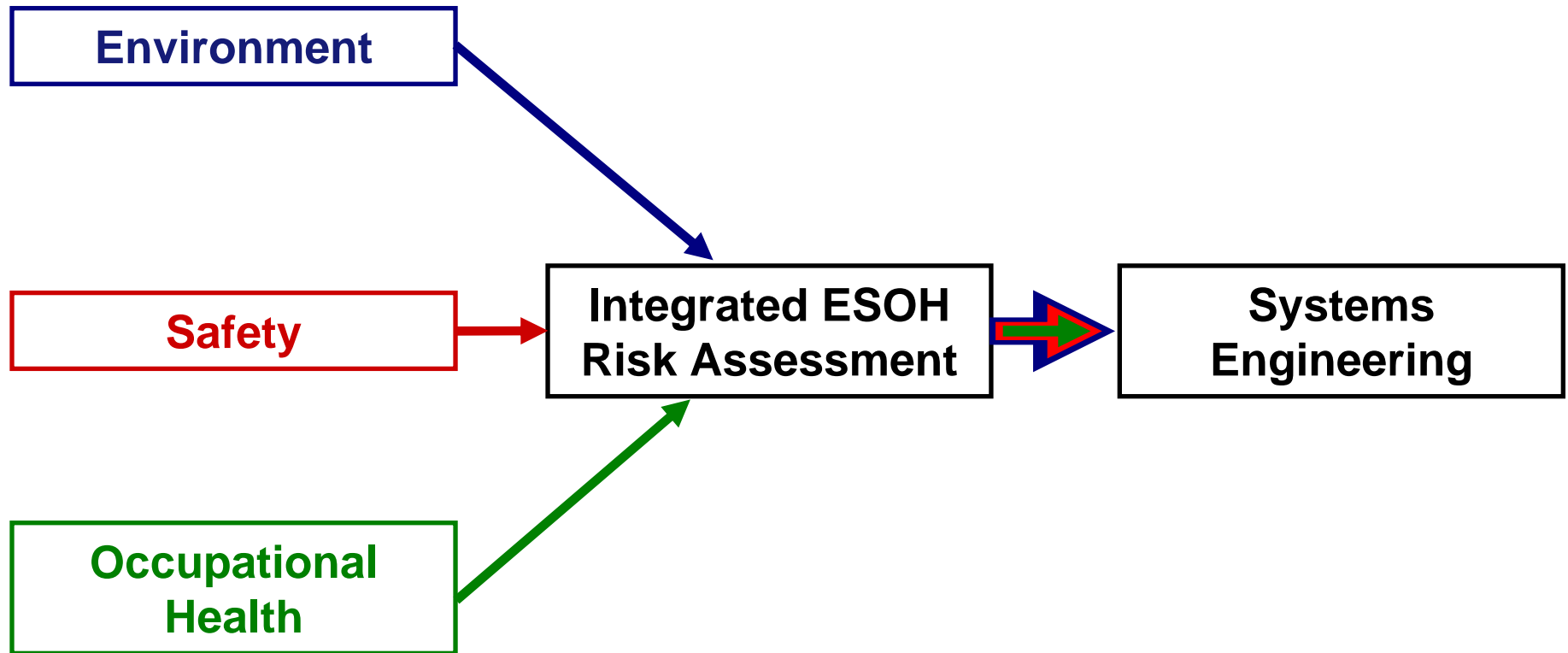
Integrated ESOH RM

- **Since 1996, DoD has focused on integrating ESOH into Systems Engineering (SE)**
 - **Objective to imbed ESOH into core Acquisition process -- SE**
 - **Utilize the System Safety process -- already part of SE**

***Part of the Ongoing Acquisition Transformation
(Reform) Dating Back to 1996***



Integrated ESOH RM



E, S, and OH inputs need to be optimized across the disciplines



Integrated ESOH RM

- **MIL-STD-882D, *DoD Standard Practice for System Safety*, eight elements**
 - Document strategy for SE integration
 - Identify hazards
 - Assess risks
 - Identify mitigation measures
 - Reduce risks to acceptable levels
 - Verify risk reductions
 - Formally accept residual risks
 - Track and report ESOH hazards
-



Evolution of Environmental RM

- **1970 NEPA Environmental Impact Analysis Process essentially RM**
 - **Identify potential environmental impacts**
 - **Assess significance of the impacts**
 - **Evaluate and implement mitigation measures as necessary**
 - **Approval of analysis and procedures by appropriate authority**



Evolution of Environmental RM

- **1980s-1990s emphasis on Pollution Prevention (P2)**
 - **Environmental risk mitigation strategy**
 - **Based on a hierarchy of mitigation measures**
 - **Eliminate at the source**
 - **Re-use/Recycle**
 - **Treatment**
 - **Disposal**



Evolution of Environmental RM

- **1996 ISO 14001 Environmental Management System (EMS) RM approach**
 - **Document EMS approach**
 - **Identify activities for analysis**
 - **Identify their environmental aspects**
 - **Identify their environmental impacts**
 - **Evaluate significance**
 - **“Control, manage, and improve”**
 - **Review with management**
-



E, S, & OH RM Comparisons

- **1996 - International Organization for Standardization ISO 14001, EMS**
- **1999 - Occupational Health and Safety Assessment Series (OHSAS) 18001, Occupational Health and Safety Management Systems**
- **2000 - MIL-STD-882D, Standard Practice for System Safety, tailored for ESOH RM in SE**



E, S, & OH RM Comparisons

System Safety MIL-STD-882D	Environmental ISO 14001	OH OHSAS 18001
Hazard	Aspect	Hazard
Mishap	Impact	Accident
Risk	Significance	Risk



E, S, & OH RM Comparisons

MIL-STD-882D <u>Mitigation Measures</u>	ISO 14001 <u>Preventive Actions</u>	OHSAS 18001 <u>Controls</u>
Design selection	Eliminate at the source	Eliminate hazard
Safety devices	Re-use/Recycle	Engineering controls/isolation
Warning devices	Treatment	Administrative
Procedures & training	Disposal	Personal Protective Equipment



MIL-STD-882D ESOH RM

MIL-STD-882D Severity Categories

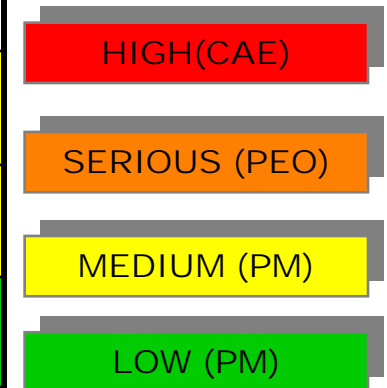
Description	Category	Environmental, Safety, and Health Result Criteria
Catastrophic	I	Could result in death, permanent total disability, loss exceeding \$1M, or <u>irreversible severe environmental damage that violates law or regulation.</u>
Critical	II	Could result in permanent partial disability, injuries or occupational illness that may result in hospitalization of at least three personnel, loss exceeding \$200K but less than \$1M, or <u>reversible environmental damage causing a violation of law or regulation.</u>
Marginal	III	Could result in injury or occupational illness resulting in one or more lost work days(s), loss exceeding \$10K but less than \$200K, or <u>mitigatable environmental damage without violation of law or regulation where restoration activities can be accomplished.</u>
Negligible	IV	Could result in injury or illness not resulting in a lost work day, loss exceeding \$2K but less than \$10K, or <u>minimal environmental damage not violating law or regulation.</u>



MIL-STD-882D ESOH RM

Hazard Risk Index and Acceptance DoDI 5000.2, E7.7 & MIL-STD-882D

FREQUENCY OF OCCURRENCE	HAZARD CATEGORIES			
	I CATASTROPHIC	II CRITICAL	III MARGINAL	IV NEGLIGIBLE
(A) Frequent	1	3	7	13
(B) Probable	2	5	9	16
(C) Occasional	4	6	11	18
(D) Remote	8	10	14	19
(E) Improbable	12	15	17	20





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- **Benchmark Approaches**
 - **Future Combat Systems (Track 2, PM)**
 - **GD Electric Boat**
- System Safety - ESOH Management Evaluation Criteria Guide
- Presentation of ESOH Risk Categories in Technical and Program Reviews



GD Electric Boat Charts

**Following 13 charts from the
August 2006 International System
Safety Conference presentation
by Don DiGenova and Ricky
Milnarik of the General Dynamics
Electric Boat corporation**



GD Electric Boat Background

Electric Boat has been building submarines for the U.S. Navy for over 100 years.

In 1900 Electric Boat delivered the U.S. Navy's first submarine, the USS HOLLAND.





GD Electric Boat Background

Subsequent to the USS HOLLAND, Electric Boat has delivered over 270 submarines to the U.S. Navy.

In October 2004 the USS VIRGINIA, the first ship in a new class of fast attack submarines, was delivered to the U.S. Navy.





GD Electric Boat Background

Currently, the first four ships of the OHIO Class are part of a unique design and construction program converting them from an SSBN to SSGN configuration

The USS Ohio and the USS Florida conversions have been completed





VIRGINIA Class Submarine Environmental & Safety

Environmental engineers and System Safety engineers were each integrated into DBTs, but...



**Environmental
Engineering**

**Shipbuilding Specification
Section 070**



**System Safety
Engineering**

**Shipbuilding Specification
Section 077**

SEPARATE PARALLEL PROCESSES



VIRGINIA Class Submarine Environmental & Safety

Environmental Engineering developed a Programmatic ESOH Evaluation (PESHE).

PESHE

System Safety Engineering developed a System Safety Description Document (SSDD).

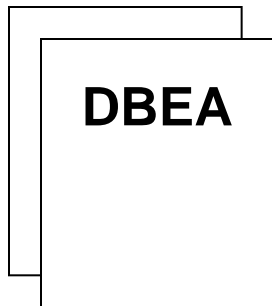
SSDD

SEPARATE PARALLEL PROCESSES

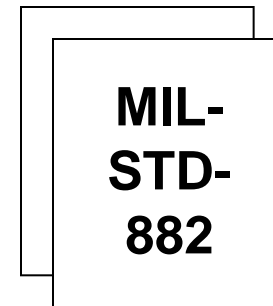


VIRGINIA Class Submarine Environmental & Safety

Environmental Engineering
conducted Design/Build
Environmental Analyses
(DBEA) on ship systems and
components.



System Safety Engineering
conducted traditional MIL-
STD-882 Hazard Analyses
on ship systems.



SEPARATE PARALLEL PROCESSES

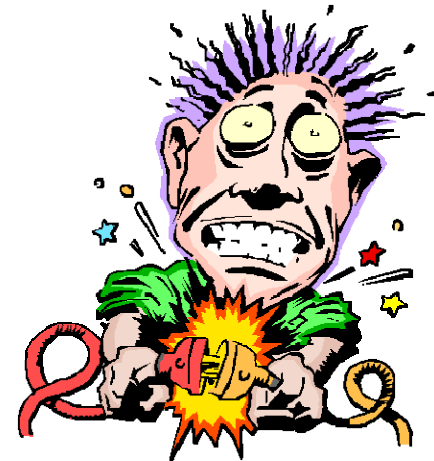


VIRGINIA Class Submarine Environmental & Safety

Environmental Engineering
identified and mitigated
environmental impacts.



System Safety Engineering
identified and mitigated safety
hazards.



SEPARATE PARALLEL PROCESSES



VIRGINIA Class Submarine Environmental & Safety

Environmental Engineering tracked environmental impacts in a DBEA database and Hazardous Material Map.



System Safety Engineering tracked hazards in a Hazard Tracking List database.



SEPARATE PARALLEL PROCESSES

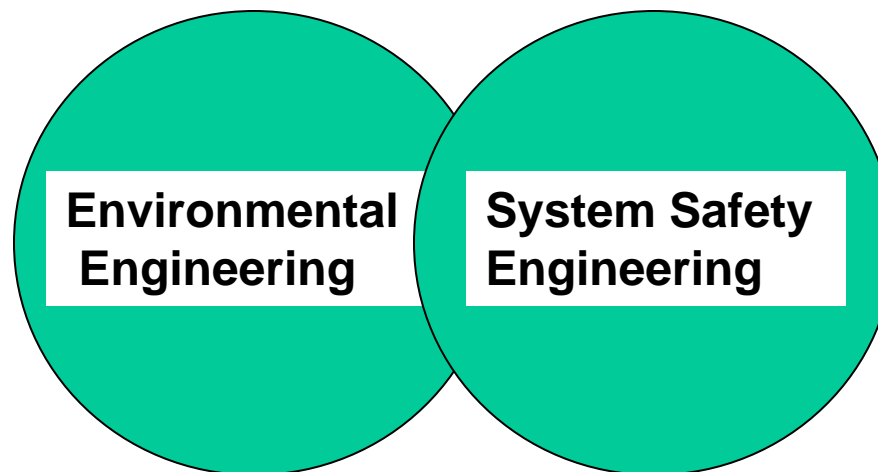


SSGN Conversion ESOH Program





SSGN Conversion ESOH Program



**ESOH Shipbuilding Specification
Section 9310-3**

**Environmental and System Safety were integrated
into a DODI 5000.2 compliant ESOH Program.**



SSGN Conversion ESOH Program

“The SSGN Submarine Program is entirely committed to ensuring that SSGN life-cycle activities are conducted in accordance with all applicable and foreseeable environmental, safety, and occupational health [ESOH] requirements.”

OHIO Class SSGN Conversion Program - ESOH Master Plan

Environmental and System Safety were integrated into a DODI 5000.2 compliant ESOH Program.



SSGN Conversion ESOH Program

- **Key ESOH Program Plan features included:**
 - **Making ESOH the responsibility of the DBT**
 - **Integrating experienced Safety & Environmental engineers into DBTs**
 - **Defining applicable ESOH hazard analyses for designated systems**
 - **Establishing an audit trail of ESOH issues (safety hazards/environmental impacts) in single hazard tracking system**



SSGN Conversion ESOH Program

ESOH Hazard Analyses	PHA	SHA	SSHA	O&SHA	Final ESOH Analysis
Attack Weapons Support Systems (AWSS)	X	X	X	X	
SOF Diver Host Ship Support Systems	X	X	X	X	X
SOF Ordnance Stowage & Handling Systems	X	X	X	X	



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System Safety - ESOH Management Evaluation Criteria Guide

- Prepared in response to tasker from USD (AT&L) after 23 Sep 04 *Defense Acquisition System Safety* memo
- Developed by DoD Acquisition ESOH IPT
- Published by DUSD (A&T)/SSE
 - Chair of the Defense Safety Oversight Council (DSOC) Acquisition and Technologies Programs Task Force (ATP TF)
 - ATP TF provides great support for IPT efforts



System Safety - ESOH Management Evaluation Criteria Guide

- **Four metrics for each life cycle phase**
 - **ESOH Planning**
 - **Systems Engineering Plan (SEP)**
 - **Programmatic ESOH Evaluation (PESHE)**
 - **TEMP**
 - **Etc**
 - **ESOH Hazard Identification, Analysis, and Risk Acceptance**
 - **ESOH Requirements**
 - **Personnel and Funding for ESOH**



System Safety - ESOH Management Evaluation Criteria Guide

- **Evaluation criteria (R/Y/G) for each metric**
- **Formula for combining each of the four metric evaluations into single overall rating of Red, Yellow, or Green**
- **Copies are available here today**
- **Uses include:**
 - **OSD Program Support Reviews**
 - **Technical and Program Reviews**



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Presentation of ESOH Risk Categories in Technical and Program Reviews

■ Requirements

- 23 Sep 04 USD (AT&L) memo, *Defense Acquisition System Safety*
 - Use MIL-STD-882D to integrate ESOH risk management into Systems Engineering
 - Include ESOH risk status in technical and program reviews
- New USD (AT&L) memo, *Reducing Preventable Accidents*
 - Present status of all High and Serious risks in Program Reviews
 - No guidance on how to do this



One Possible Approach

DoD Acquisition Risk Management Guide

L I K E L I H O O D	5	Green	Yellow	Red	Red	Red
	4	Green	Yellow	Yellow	Red	Red
	3	Green	Green	Yellow	Yellow	Red
	2	Green	Green	Green	Yellow	Yellow
	1	Green	Green	Green	Green	Yellow
		1	2	3	4	5
C O N S E Q U E N C E						

MIL-STD-882D

P R O B A B I L I T Y	A	Yellow	Orange	Red	Red
	B	Yellow	Orange	Red	Red
	C	Green	Yellow	Orange	Red
	D	Green	Yellow	Yellow	Orange
	E	Green	Yellow	Yellow	Yellow
		IV	III	II	I
S E V E R I T Y					



Severity Categories (MIL-STD-882D, Table A-I)

Description	Category	ESOH Result Criteria
Catastrophic	I	Could result in death, permanent total disability, loss exceeding \$1M, or irreversible severe environmental damage that violates law or regulation.
Critical	II	Could result in permanent partial disability, injuries or occupational illness that may result in hospitalization of at least three personnel, loss exceeding \$200K but less than \$1M, or reversible environmental damage causing a violation of law or regulation.
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Probability Levels (MIL-STD-882D, Table A-II)

Description	Level	Specific Individual Item	Fleet or Inventory
Frequent	A	Likely to occur often in the life of an item, with a probability of occurrence greater than 10^{-1} in that life.	Continuously experienced.
Probable	B	Will occur several time in the life of an item, with a probability of occurrence less than 10^{-1} but greater than 10^{-2} in that life.	Will occur frequently.
Occasional	C	Likely to occur some time in the life of an item, with a probability of occurrence less than 10^{-2} but greater than 10^{-3} in that life.	Will occur several times.
Remote	D	Unlikely but possible to occur in the life of an item, with a probability of occurrence less than 10^{-3} but greater than 10^{-6} in that life.	Unlikely, but can reasonably be expected to occur.
Improbable	E	So unlikely it can be assumed occurrence may not be experienced, with a probability of occurrence less 10^{-6} in that life.	Unlikely to occur, but possible.



One Possible Approach

DoD Acquisition Risk Management Guide

L I K E L I H O O D	5	Green	Yellow	Red	Red	Red
	4	Green	Yellow	Yellow	Red	Red
	3	Green	Green	Yellow	Yellow	Red
	2	Green	Green	Green	Yellow	Yellow
	1	Green	Green	Green	Green	Yellow
		1	2	3	4	5
C O N S E Q U E N C E						

MIL-STD-882D

P R O B A B I L I T Y	A	Yellow	Orange	Red	Red
	B	Yellow	Orange	Red	Red
	C	Green	Yellow	Orange	Red
	D	Green	Yellow	Yellow	Orange
	E	Green	Yellow	Yellow	Yellow
		IV	III	II	I
S E V E R I T Y					

L I K E L I H O O D	5		IVA		IIA	IA
	4		IVB	IIIA IIIB IIIC		IB
	3		IVC	IIID IIIE	IIC	IC
	2		IVD		IID IIE	ID
	1		IVE			IE
			1	2	3	4
CONSEQUENCE						



Summary

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Questions?

