



SPEAKING A COMMON RISK MANAGEMENT LANGUAGE WITH EXECUTIVES AND PROGRAM MANAGERS

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TOPICS

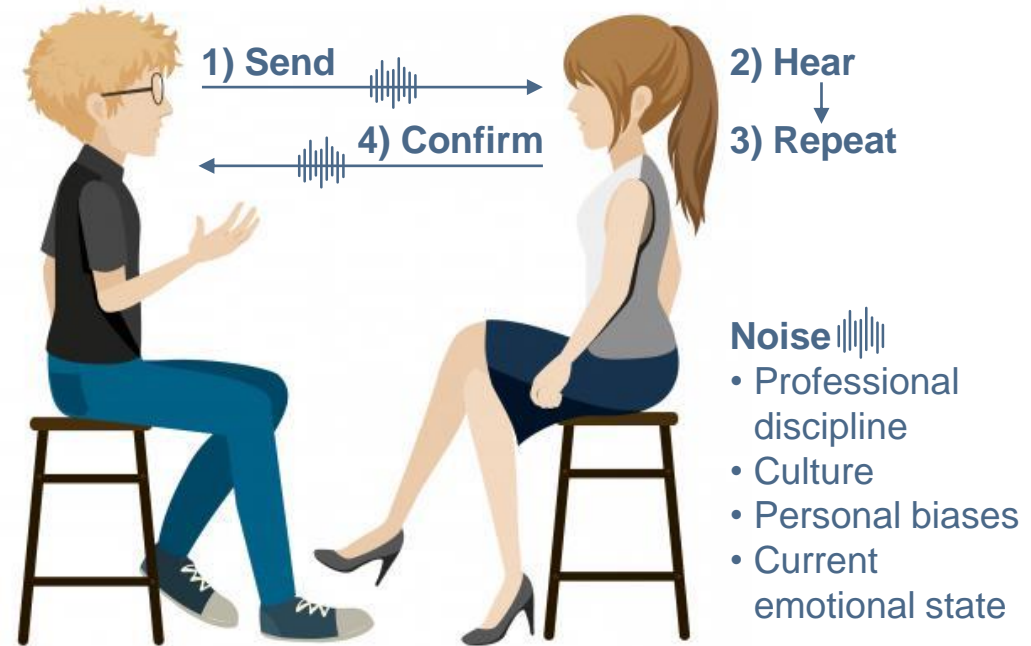
- Introduction
- Risk in Project Management
- Risk in System Safety
- Communication Disconnects
- Recommendations
 - ▶ Solution 1: Risk Program Tailoring
 - ▶ Solution 2: Quantifying Safety Impacts of Project Execution
- Wrap-Up



INTRODUCTION

- Effective communication with commanders and program managers is critical to optimize his/her decision-making.
- Risk matrices, definitions, and processes used in program management, system safety, and ammunition and explosives (AE) safety differ greatly.
- Safety engineering professionals must:
 - ▶ Communicate risks, issues, opportunities, and concerns in the decision-maker's language.
 - ▶ Articulate the solution and the impact!
 - ▶ Approaches and biases vary amongst every stakeholder.

Objective: Integrated Risk-Based Solutions



RISK IN PROJECT MANAGEMENT

1. The *Project Management Book of Knowledge (PMBOK) Guide, 6th Edition*
 - ▶ A collection of project management terms, processes, and best practices independent of specific industries. Recognized globally.
 - ▶ Defines individual project risk as “an uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives.”
 - ▶ Outlines the knowledge area of risk management, of which system safety is subset of the overall project or program risk discussion.
2. The Department of Defense (DoD) Risk Management Guide
 - ▶ The DoD System Approach to Risk Management.
 - ▶ How program risk management processes are to be applied within DoD.
 - ▶ Concepts consistent with installation commander risk considerations.
 - ▶ Defines risk as “potential future events or conditions that may have a negative effect on achieving program cost, schedule, and performance objectives.” Risks defined by:
 - (1) the probability (greater than 0, less than 1) of an undesired event or condition and
 - (2) the consequences, impact, or severity of the undesired event, were it to occur.
 - ▶ Advises the mapping of high safety risks to programmatic risks.

RISK IN PROJECT MANAGEMENT

DoD Risk Management Guide – Sample Consequence Criteria



Level	Cost	Schedule	Performance
5 Critical Impact	10% or greater increase over APB <u>objective</u> values for RDT&E, PAUC, or APUC Cost increase causes program to exceed affordability caps	Schedule slip will require a major schedule re-baselining Precludes program from meeting its APB <u>threshold</u> dates	Degradation precludes system from meeting a KPP or key technical supportability threshold; will jeopardize program success Unable to meet mission objectives (defined in mission threads, ConOps. OMS/MP)
4 Significant Impact	5% - <10% increase over APB <u>objective</u> values for RDT&E, PAUC, or APUC Costs exceed life cycle ownership cost KSA	Schedule deviations will slip program to within 2 months of approved APB <u>threshold</u> schedule date Schedule slip puts funding at risk Fielding of capability to operational units delayed by more than 6 months	Degradation impairs ability to meet a KSA. Technical design or supportability margin exhausted in key areas Significant performance impact affecting System-of-System interdependencies. Work-arounds required to meet mission objectives
3 Moderate Impact	1% - < 5% increase over APB <u>objective</u> values for RDT&E, PAUC, or APUC Manageable with PEO or Service assistance	Can meet APB <u>objective</u> schedule dates, but other non-APB key events (e.g., SETRs or other Tier 1 Schedule events) may slip Schedule slip impacts synchronization with interdependent programs by greater than 2 months	Unable to meet lower tier attributes. TPMs, or CTPs Design or supportability margins reduced Minor performance impact affecting System-of-System interdependencies. Work-arounds required to achieve mission tasks
2 Minor Impact	Costs that drive unit production cost (e.g., APUC) increase of <1% over budget Cost increase, but can be managed internally	Some schedule slip, but can meet APB objective dates and non-APB key event dates	Reduced technical performance or supportability; can be tolerated with little impact on program objectives Design margins reduced, within trade space
1 Minimal Impact	Minimal impact Costs expected to meet approved funding levels	Minimal schedule impact	Minimal consequences to meeting technical performance or supportability requirements Design margins will be met; margin to planned tripwires

APB: Acquisition Program Baseline; APUC: Average Procurement Unit Cost; ConOps: Concept of Operations; CTP: Critical Technical Parameter; PAUC: Program Acquisition Unit Cost; PEO: Program Executive Officer; KPP: Key Performance Parameter; KSA: Key System Attribute; OMS/MP: Operational Mode Summary/Mission Profile; RDT&E: Research, Development Test & Evaluation; TPM: Technical Performance Measure

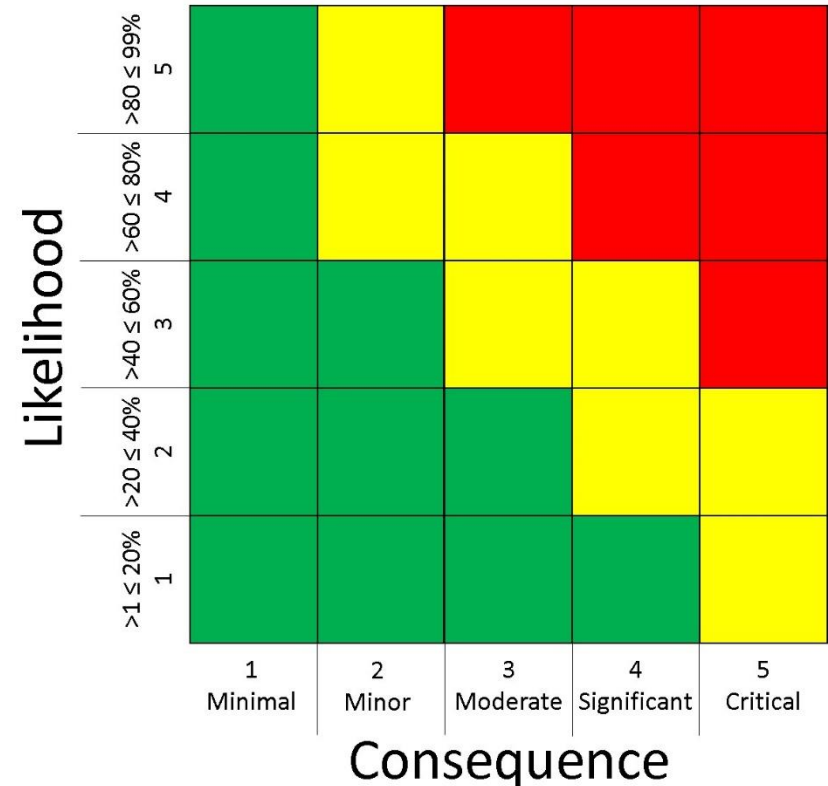
RISK IN PROJECT MANAGEMENT

DoD Risk Management Guide – Sample Probability Criteria & Resultant Risk Matrix

Level	Likelihood	Probability of Occurrence
5	Near Certainty	>80% to ≤ 99%
4	Highly Likely	>60% to ≤ 80%
3	Likely	>40% to ≤ 60%
2	Low Likelihood	> 20% to ≤ 40%
1	Not Likely	> 1% to ≤ 20%

Since safety and system hazard risks typically have cost, schedule, and performance impacts for the program, they should be addressed in the context of overall risk management. As a best practice, programs should include current high system hazard/Environmental Safety and Occupational Health (ESOH) risks together with other program risks on the prioritized risk matrix presented at key program decision points. Programs should use a Service-developed method to map these risks to the risk matrix and register, as appropriate.

- DoD Risk Management Guide



How do safety and AE risks map to program/installation risks?

RISK IN SYSTEM SAFETY

MIL-STD-882E – Risk Definition & Severity Criteria

- MIL-STD-882E is widely accepted as a primary authority on system safety practice and can serve as the system safety equivalent to the DoD Risk Management Guide.
- MIL-STD-882E defines risk as, “A combination of the severity of the mishap and the probability that the mishap will occur.”

Description	Severity Category	Mishap Result Criteria
Catastrophic	1	Could result in one or more of the following: death, permanent total disability, irreversible significant environmental impact, or monetary loss equal to or exceeding \$10M.
Critical	2	Could result in one or more of the following: permanent partial disability, injuries or occupational illness that may result in hospitalization of at least three personnel, reversible significant environmental impact, or monetary loss equal to or exceeding \$1M but less than \$10M.
Marginal	3	Could result in one or more of the following: injury or occupational illness resulting in one or more lost work day(s), reversible moderate environmental impact, or monetary loss equal to or exceeding \$100K but less than \$1M.
Negligible	4	Could result in one or more of the following; injury or occupational illness not resulting in a lost work day, minimal environmental impact, or monetary loss less than \$100K.

- Notice the lack of equivalence in severity definitions between program risk and system safety risk.
 - ▶ Personnel injury/death represents an additional asset to be protected.
 - ▶ Monetary assets do not share equivalent thresholds at severity levels.

RISK IN SYSTEM SAFETY

MIL-STD-882E – Sample Probability Criteria

Description	Level	Individual Item	Fleet/Inventory*	Quantitative
Frequent	A	Likely to occur often in the life of an item	Continuously experienced.	Probability of occurrence greater than or equal to 10^{-1} .
Probable	B	Will occur several times in the life of an item	Will occur frequently	Probability of occurrence less than 10^{-1} but greater than or equal to 10^{-2} .
Occasional	C	Likely to occur sometime in the life of an item	Will occur several times.	Probability of occurrence less than 10^{-2} but greater than or equal to 10^{-3} .
Remote	D	Unlikely, but possible to occur in the life of an item	Unlikely but can reasonably be expected to occur.	Probability of occurrence less than 10^{-3} but greater than or equal to 10^{-5} .
Improbable	E	So unlikely, it can be assumed occurrence may not be experienced in the life of an item	Unlikely to occur, but possible.	Probability of occurrence less than 10^{-6}
Eliminated	F	Incapable of occurrence within the life of an item. This category is used when potential hazards are identified and later eliminated.		

- Notice the probability criteria minimally overlap between program risk and system safety risk – only the top two categories of MIL-STD-882E are included in the DoD Risk Management Guide’s probability categories.
 - ▶ MIL-STD-882E Level B $\geq 1\%$ $< 10\%$ - likely maps to program probability level 1.
 - ▶ MIL-STD-882E Level A $\geq 10\%$ - maps to program probability level 1.

RISK IN SYSTEM SAFETY

MIL-STD-882E – Risk Matrix

SEVERITY	Catastrophic (1)	Critical (2)	Marginal (3)	Negligible (4)
PROBABILITY				
Frequent (A) ≥ 10%	HIGH	HIGH	SERIOUS	MEDIUM
Probable (B) ≥1<10%	HIGH	HIGH	SERIOUS	MEDIUM
Occasional (C) ≥0.1<1%	HIGH	SERIOUS	MEDIUM	LOW
Remote (D) ≥0.0001<0.1%	SERIOUS	MEDIUM	MEDIUM	LOW
Improbable (E) <0.0001	MEDIUM	MEDIUM	MEDIUM	LOW
Eliminated (F)	Eliminated			

▪ Notice the risk matrix is:

- ▶ Oriented in a high, top-left configuration as opposed to a high, top-right configuration as in the DoD Risk Management Guide.
- ▶ Includes four risk categories, as opposed to three in the DoD Risk Management Guide.

AE RISK IN THE ARMY

DA PAM 385-30 – Risk Definition & Severity Criteria

- DA PAM 385-30 is the Army guidance for mishap risk management.
- DA PAM 385-30 defines risk as, “the probability and severity of loss linked to hazards. It is simply the measure of the expected loss from a given hazard or group of hazards, usually estimated as the combination of the likelihood (probability) and consequences (severity) of the loss.”

Description	Severity Category	Quantitative Value – Injury or Illness	Quantitative Value – Dollars	Definition
Catastrophic	1	1 or more death or permanent total disability	Loss equal to \$2 million or more	Death, unacceptable loss or damage, mission failure, or unit readiness eliminated
Critical	2	1 or more permanent partial disability or hospitalization of at least 3 personnel	Loss equal to or greater than \$500 thousand but less than \$2 million	Severe injury, illness, loss, or damage; significantly degraded unit readiness or mission capability
Marginal	3	1 or more injury or illness resulting in lost time	Loss equal to or greater than \$50 thousand but less than \$500 thousand	Minor injury, illness, loss, or damage; degraded unit readiness or mission capability
Negligible	4	1 or more injuries or illnesses requiring first aid or medical treatment	Loss less than \$50 thousand	Minimal injury, loss, or damage; little or no impact to unit readiness or mission capability

- Notice the quantitative values in dollars are noticeably different from MIL-STD-882E example values.

AE RISK IN THE ARMY

DA PAM 385-30 – Probability Criteria

Probability	Level	Definition
Frequent	A	Continuous, regular, or inevitable occurrences
Probable	B	Several or numerous occurrences
Occasional	C	Sporadic or intermittent occurrences
Remote	D	Infrequent occurrences
Improbable	E	Possible occurrences but improbable

- Notice the probability definitions lack:
 - ▶ Quantitative values – prevents consistent mapping to MIL-STD-882 or the DoD Risk Management Guide.
 - ▶ Exposure intervals – probability is meaningless without an exposure interval.

RISK IN THE ARMY

DA PAM 385-30 – Risk Matrix

Notice the risk matrix

- Is oriented in a high, top-left configuration, as opposed to a high, top-right configuration as in the DoD Risk Management Guide.
- Includes four risk categories, as opposed to three in the DoD Risk Management Guide.
- Uses different terms for risk categories, where the term “High” represents the 2nd highest risk level while corresponding to the highest risk category in MIL-STD-882E and the DoD Risk Management Guide.

		Probability (expected frequency)				
		Frequent: Continuous, regular, or inevitable occurrences	Likely: Several or numerous occurrences	Occasional: Sporadic or intermittent occurrences	Seldom: infrequent occurrences	Unlikely: Possible occurrences but improbable
Severity (expected consequence)		A	B	C	D	E
Catastrophic: Death, unacceptable loss or damage, mission failure, or unit readiness eliminated	I	EH	EH	H	H	M
Critical: Severe injury, illness, loss, or damage; significantly degraded unit readiness or mission capability	II	EH	H	H	M	L
Moderate: Minor injury, illness, loss, or damage; degraded unit readiness or mission capability	III	H	M	M	L	L
Negligible: Minimal injury, loss, or damage; little or no impact to unit readiness or mission capability	IV	M	L	L	L	L

EH – extremely high risk ; H – high risk ; L – low risk ; M – medium risk

COMMUNICATION DISCONNECTS

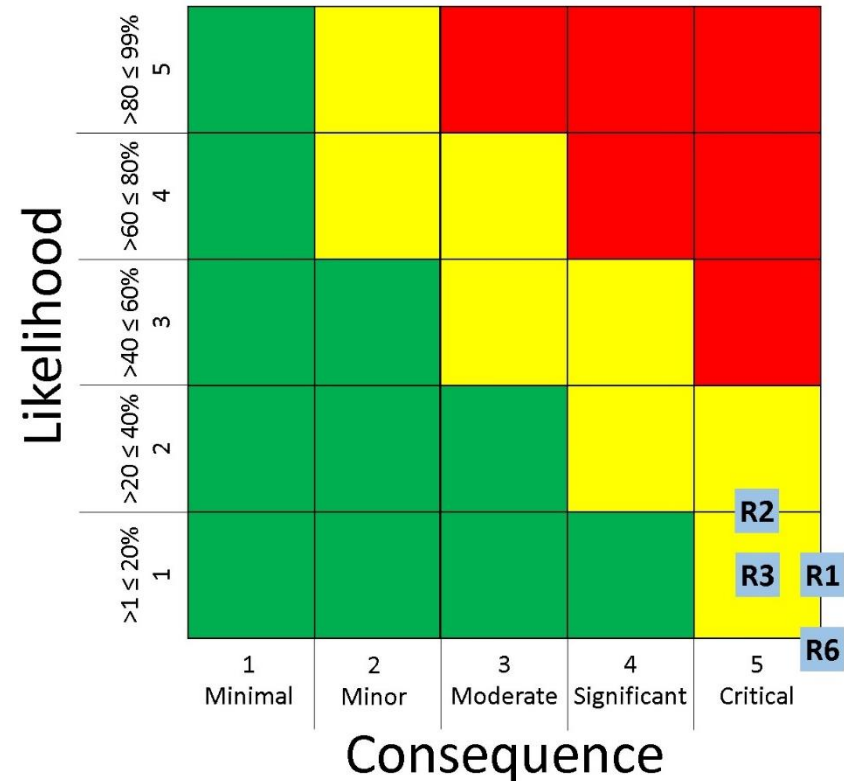


Characteristic	PM/Executive	MIL-STD-882	Services Sample – DA PAM 385-30	Assessment
Risk definition – clear and consistent?	May include uncertain positive and/or negative outcomes	Only addresses uncertain negative outcomes	Only addresses uncertain negative outcomes	Clear; Not consistent
Consequence/ severity – objective and equivalent?	Addresses cost, schedule, and performance – cost objectively	Addresses safety, environmental impact, and cost – cost and safety objectively, cost does not align with DA PAM 385-30	Addresses safety, environmental impact, and cost – cost and safety objectively, cost does not align with MIL-STD-882E	Partially objective; Not equivalent
Likelihood/ probability – ranges overlap?	Five equally divided percentage ranges between 1-99%	Five percentage ranges with order of magnitude difference between 0.0001–99%	Five subjective probability definitions	Partially objective; Minimal overlap
Risk matrices – equivalent?	Five by Five; Lowest risk in bottom left, highest risk in top right	Four by Six; lowest risk in bottom right, highest risk in top left	Four by Five; lowest risk in bottom right, highest risk in top left	Not equivalent
Risk levels – equivalent in number and required action?	Three risk levels – High, Medium, and Low; Action to burn-down High, Medium, and some Low risks. No required action to elevate risks.	Four risk levels – HIGH, SERIOUS, MEDIUM, & LOW; Action to reduce risk to extent practical. HIGH and SERIOUS risks require elevation for risk acceptance.	Four risk levels – Extremely High, High, Medium, & Low; action to reduce risk to extent practical. Risk acceptance authority based on military rank.	Not equivalent in number or required action.

Finding: ESOH risks cannot be directly mapped to program risks without modifications in severity, probability, and risk levels.

COMMUNICATION DISCONNECTS VISUALIZED

- In almost all cases, safety and AE risks are relegated to the bottom-right blocks of the program risk matrix, and are unlikely to be considered above a Medium program risk, no matter the severity.
- This approach to risk mapping does not sufficiently characterize program risks to allow differentiation.
- For example, a 10% risk of one fatality, or 10 or 20 fatalities would be categorized as a Medium program risk.



RECOMMENDATIONS

Solution 1: Risk Program Tailoring

Level	Cost	Schedule	Performance	Safety
6 Catastrophic Impact	15% or greater increase over APB <u>objective</u> values	N/A	Degradation precludes system from meeting multiple key technical supportability thresholds; will jeopardize program success	Results in one or more fatalities
5 Critical Impact	10%- <15% increase over APB <u>objective</u> values	Schedule slip will require a major schedule re-baselining Precludes program from meeting its APB schedule <u>threshold</u> dates	Degradation precludes system from meeting a key technical supportability threshold; will jeopardize program success Unable to meet mission objectives	Results in one or more of the following: permanent total disability, irreversible significant environmental impact
4 Significant Impact	5% - <10% increase over APB <u>objective</u> values	Schedule deviations will slip program to within 2 months of approved APB <u>threshold</u> schedule date Schedule slip puts funding at risk	Technical design or supportability margin exhausted in key areas Significant performance impact affecting System-of-System interdependencies. Work-arounds required to meet mission objectives	Results in one or more of the following: permanent partial disability, injuries or occupational illness that may result in hospitalization of at least three personnel, reversible significant environmental impact.
3 Moderate Impact	1% - < 5% increase over APB <u>objective</u> values	Can meet APB <u>objective</u> schedule dates, but other non-APB key events may slip	Unable to meet lower tier attributes. Design or supportability margins reduced Minor performance impact affecting System-of-System interdependencies Work-arounds required to achieve mission tasks	Results in one or more of the following: injury or occupational illness resulting in one or more lost work day(s), reversible moderate environmental impact.
2 Minor Impact	Costs that drive unit production cost increase of <1% over budget	Some schedule slip, but can meet APB objective dates and non-APB key event dates	Reduced technical performance or supportability; can be tolerated with little impact on program objectives Design margins reduced, within trade space	Results in one or more of the following: injury or occupational illness not resulting in a lost work day, minimal environmental impact.
1 Minimal Impact	Minimal impact Costs, expected to meet approved funding levels	Minimal schedule impact	Minimal consequences to meeting technical performance or supportability requirements Design margins will be met	N/A

APB: Acquisition Program Baseline

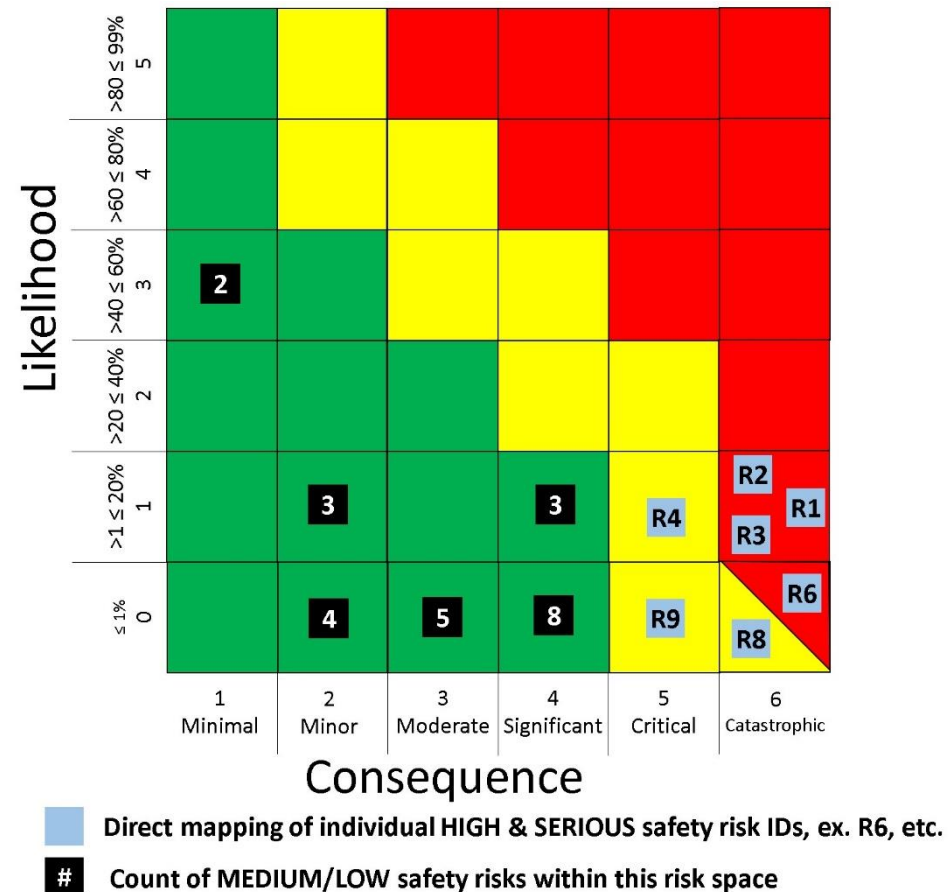
Aligning severity definitions is the first step to mapping safety risks to program risks.

RECOMMENDATIONS

Solution 1: Risk Program Tailoring

Level	Likelihood	Probability of Occurrence
5	Near Certainty	>80% to ≤ 99%
4	Highly Likely	>60% to ≤ 80%
3	Likely	>40% to ≤ 60%
2	Low Likelihood	> 20% to ≤ 40%
1	Not Likely	> 1% to ≤ 20%
0	Remote	≤ 1%

- A sixth likelihood definition category is added to encompass the bottom three non-zero system safety probability categories.
- Tailoring would allow for direct mapping of HIGH (Extremely High) and SERIOUS (High) safety and AE risks to the program risk matrix as well as a numerical count of MEDIUM and LOW risks into the program risk categories.



RECOMMENDATIONS

Solution 2: Quantifying Safety Impacts on Project Execution

- Track safety and AE risks impacting external (or internal) stakeholders on the project risk matrix if they are:
 - SERIOUS/HIGH (High/Extremely High) risks after mitigation verification; or
 - SERIOUS/HIGH risks pre-verification if verification data are to arrive near the required risk decision point.

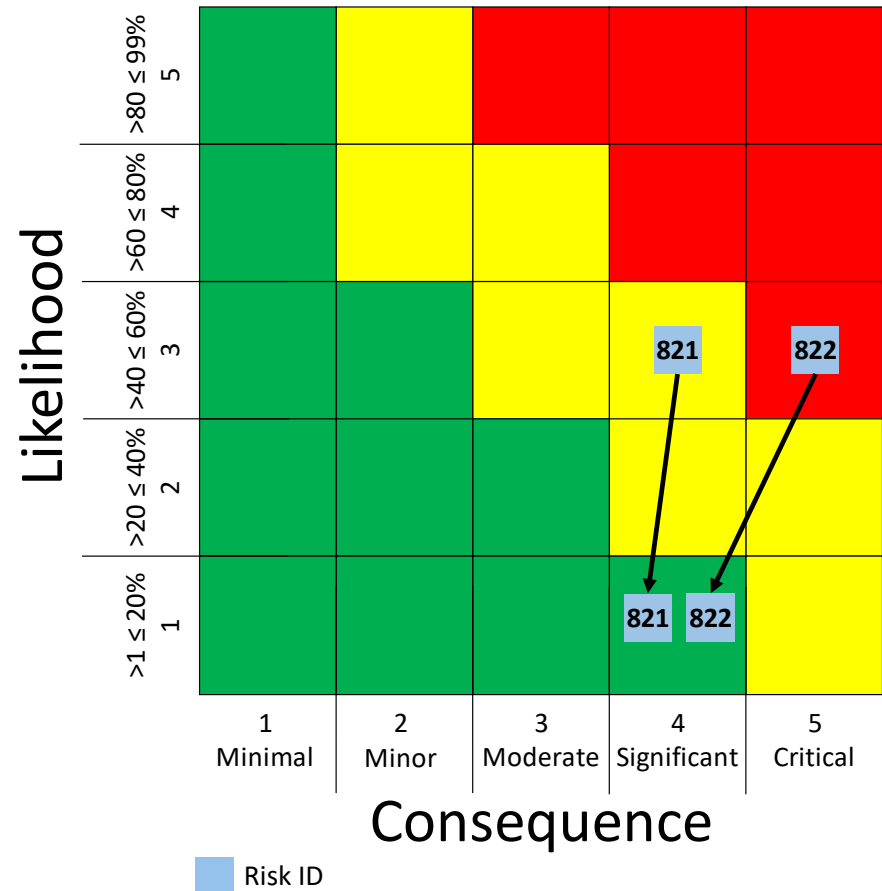
Example:

Risk Number	821	822
Linked WBS/IMS ID#	3.1.2	3.1.2
Owner	Smith	Smith
Type of Risk	Technical - Safety	Technical - Safety
Status	Open	Open
Risk Event	Residual SERIOUS risk "Support arm failure due to corrosion" may be unacceptable to demil range	Residual HIGH risk "Sensitivity to shock/vibe during transit" may be unacceptable to ship commander
Likelihood, Consequence Rating	L=3, C=4	L=3, C=5
Risk Mitigation Strategy	Control – Prioritize completion of verifications on subject risk; Include demil rep in safety verification planning	Control – Prioritize completion of verifications on subject risk; Include ship rep in safety verification planning; Coordinate alternate transport
Risk Identified Date	8/20/2015	8/20/2015
Risk Approval Date	2/10/2016	2/10/2016
Planned Closure Date	7/15/2016	7/15/2016
Target Risk Rating	L=1, C=4	L=1, C=4
Plan Status	On Schedule	On Schedule

RECOMMENDATIONS

Solution 2: Quantifying Safety Impacts of Program Execution

- Program risk should be documented and socialized due to an inability to control an external stakeholder's risk appetite.
- Approach would drive more efficient scheduling of safety-related testing and necessitate improved communication between stakeholders.



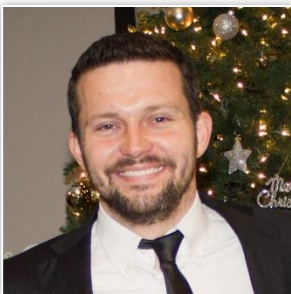
WRAP-UP

- PMs, Commanders, and/or Executives require a clear snapshot of safety risks
- Integrated solution must consider cost/schedule/performance impacts
- Most, if not all, risk assessments require a multi-functional approach
- Questions?

ABOUT THE AUTHORS



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Mr. Nix is a Systems Safety Engineer and Project Manager with APT Research, Inc. in Huntsville, AL. He has been responsible for various areas of safety-related work in APT's business base, including project management and serving as an instructor for APT's System Safety and Software Safety professional development courses. His primary role is system safety support to the Missile Defense Agency (MDA). Mr. Nix holds a M.S. in Missile Systems from the University of Alabama in Huntsville and recently acquired a Project Management Professional (PMP) Certification.