

Implementation of Safety and Mission Assurance Risk Identification and Elevation to NASA Expendable Launch Vehicle Services

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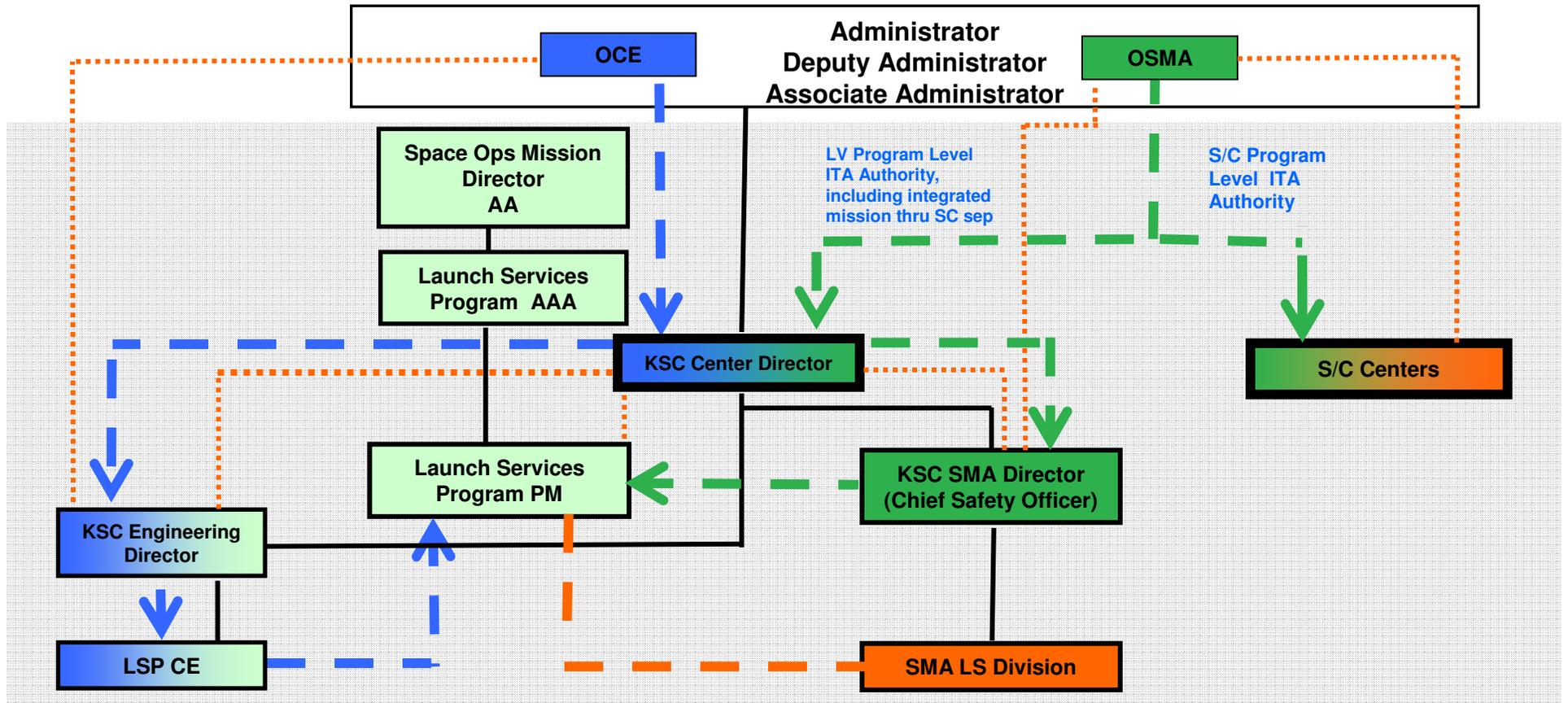
Requirement for Risk Identification

- NASA's space flight program and project management requirements establish a programmatic authority and two technical authorities (TA) for expendable launch vehicle services. This is known as the governance model. The two TA's are:
 - Engineering
 - Safety and Mission Assurance (SMA)
- These authorities provide checks and balances that assure different points of view from the various interested parties are considered when decisions are made.

Requirement for Risk Identification (continued)

- An inherent part of the decision process is the identification of the risk associated with decisions.
- From the SMA perspective, risks to safety and mission assurance are of concern. The SMA TA has established processes for identifying and elevating such risks.
- Risk elevation involves the communication of a risk to successively higher levels of authority if a lower level appeals a decision.

Launch Services Governance Model



Risk Identification

- The identification of risk follows a hierarchy of three processes that focus successively higher levels of management attention on issues.

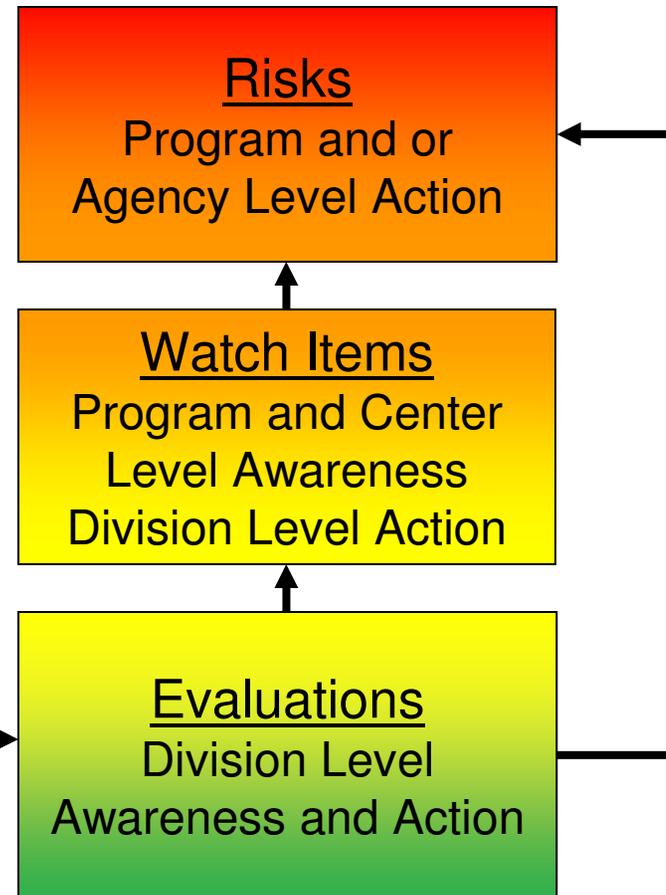
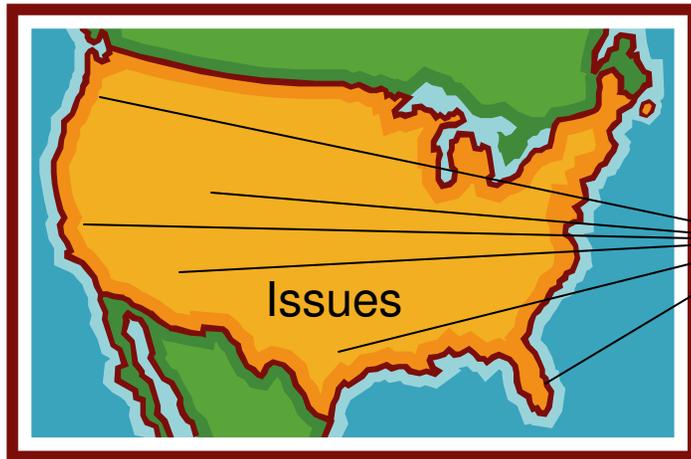
Those processes are:

1. Evaluation
2. Watch Item
3. Risk

Risk Identification

Issue-to-Risk Elevation Process

- The Launch Services SMA Division Quality, Safety, and Mission Assurance organizations receive launch vehicle relevant issues from many production, engineering and operations sites.
- Elevation from evaluations to risks is accomplished based on issue significance and potential to result in residual risk.



Risk Identification Evaluation Process

- Start:
 - SMA Launch Services (LS) Division personnel look at the many issues associated with missions and launch vehicle fleets.
- Evaluations:
 - Performed per the judgment of the cognizant SMA LS Division representative in response to items of interest or questions that arise within the normal scope of the overall Launch Vehicle Flight Readiness Assessment Process.
 - Executed to gather data, analyze, and determine whether the items of interest or questions represent significant issues or concerns.
 - Lowest level of management attention
 - Evaluations are performed on a subset of the identified issues
 - Lesser process formality
 - If the subject matter of an evaluation is determined to be a significant issue or concern, it is elevated to a Watch Item and is “worked” via the SMA LS Division Watch Item process.
- If warranted by the situation, urgency, or significance of the issue the evaluation process allows the elevation of evaluations to risks.

Risk Identification Watch Item Process

- A Watch Item is a significant issue or concern that requires increased attention, response, and monitoring from the SMA LS Division personnel.
 - Can affect safety or mission assurance if not closed or dispositioned for missions and vehicle fleets.
 - May be elevated to a Launch Services Program residual risk if the issue has a credible detrimental consequence with an associated likelihood of occurrence.
 - Increased level of management attention
 - Formal process that requires Watch Item Panel for Watch Item approval, disposition, risk elevation, and closure.
 - SMA Actions required to work the Watch Item are part of this process.
 - Watch items are performed on a subset of the evaluations.

Risk Identification Risk Process

- The SMA LS Division utilizes the Launch Services Program risk process
 - SMA identifies safety or mission assurance risks for missions and vehicle fleets using the Agency 5x5 risk matrix (next chart).
 - SMA risks result from a subset of the watch items.
 - Programmatic and Agency level of management attention.
 - Formal process that requires Launch Services Program Risk Control Board action for opening, closing, and risk acceptance.
 - Actions required to mitigate the risk are part of this process.
 - The SMA and engineering technical authorities weigh in with their respective context and position on programmatic safety and mission assurance risks.
 - Launch Services Program is responsible for risk acceptance.

Risk Identification

5x5 Risk Matrix

Probability	5	1 X 5	2 X 5	3 X 5	4 X 5	5 X 5
	4	1 X 4	2 X 4	3 X 4	4 X 4	5 X 4
	3	1 X 3	2 X 3	3 X 3	4 X 3	5 X 3
	2	1 X 2	2 X 2	3 X 2	4 X 2	5 X 2
	1	1 X 1	2 X 1	3 X 1	4 X 1	5 X 1
		1	2	3	4	5
		Impact				

Risk Identification

Risk Impact Definitions

Level	1	2	3	4	5
Label	Very Low	Low	Moderate	High	Very High
Safety	No injury or significant damage to flight HW/SW or GSE	Slight injury or small damage to flight HW/SW or GSE	Serious injury/illness or significant damage to flight HW/SW or GSE	Permanent disability or major damage to flight HW/SW or GSE	Loss of life, flight HW/SW or GSE
Technical Performance	Minimal or no impact	Moderate impact due to reduced performance or data, with same approach retained; acceptable loss of vehicle/mission capability	Moderate impact due to reduced performance or data, using available workarounds; can meet mission requirements with some degradation (e.g., loss of redundancy)	Major impacts due to degraded performance or data, with workarounds to be established; significant degradation of mission requirements (e.g., partial mission loss per success criteria)	Unacceptable technical impacts; technical goals cannot be met; loss of mission (e.g., mission success criteria will not be met)

Risk Identification

Risk Probability Definitions

Level	1	2	3	4	5
Label	Very Low	Low	Moderate	High	Very High
Guidance for Probability Level Selection	Probability of occurrence is very low. Existing processes and mitigation efforts are strong and very likely to prevent this risk scenario	Probability of occurrence is low. Existing processes and mitigation efforts are usually sufficient to prevent this risk scenario; additional actions may be required.	Probability of occurrence is moderate. Existing processes and mitigation efforts may prevent this risk scenario, but additional actions will be required.	Probability of occurrence is high. Existing processes and mitigation efforts cannot prevent this risk scenario; a different process or mitigation effort might.	Probability of occurrence is very high. Existing processes and mitigation efforts cannot prevent this risk scenario; no alternative processes or mitigation efforts are available.

Risk Identification Mission Example

- The SMA LS Division engages in the assessment of mission risk at about the time of mission authority to proceed (ATP) and continues assessment through launch.
 - ATP occurs between 30 and 36 months before launch
 - Focus is on the launch vehicle and its integration with the spacecraft for the mission

Risk Identification

Mission Example – Mission Team

- A team of personnel is assigned by the SMA LS Division to support the mission.
 - A Mission Assurance Manager (MAM) to lead and integrate the flight readiness assessment effort.
 - Safety Representative
 - Quality Representative
 - Mission Assurance Engineers (as required)
 - Contractor Support (as required)

Risk Identification

Mission Example - Insight

- Insight into launch vehicle issues comes from a variety of sources in which the SMA LS Division has participation either directly or through contract SMA personnel. Issue sources include:
 - Previous mission or fleet anomalies or observations
 - Hardware reviews
 - Surveillance activities at launch service contractor (LSC) and supplier's facilities
 - LSC's nonconformance and corrective actions
 - LSC's reliability program
 - Design reviews
 - Engineering review boards
 - Mission integration meetings
 - Technical interchange meetings
 - Testing
 - Readiness reviews
 - Operations reviews

Risk Identification

Mission Example – Evaluation

- Issues identified through insight activities are evaluated by SMA LS Division personnel.
- Division personnel identify applicability of issues to particular missions. The MAM tracks all evaluations applicable to assigned mission, and reports them at the KSC SMA (SA) readiness review (SARR).
- Evaluations are documented by the cognizant SMA LS Division personnel, and reported to Division branch management and the MAM.
 - Depending on issue complexity, the evaluation may be performed by one or more SMA LS Division personnel.
- A judgment is made as to the significance of the evaluated issue.
 - Evaluator presents the results of the evaluation with significance judgment to the MAM and SMA LS Division management
 - If the issue has been properly resolved the evaluation is closed.
 - If the issue is significant and requires further action, the evaluation is submitted into the Watch Item process.

Risk Identification

Mission Example – Watch Items

- Issues elevated from Evaluations are worked in the Watch Item process.
- Upon opening a new watch item, SMA LS Division personnel are assigned to work the watch item based on the specialties required to resolve the issue (e.g. quality, safety, etc.).
 - One of the assignees is made the watch item integrator to maintain watch item inputs consistency.
- Watch items identify the issue, its effects, fleet and mission effectivity, and SMA actions that are to be performed to enable watch item mission disposition or closure.
 - Watch items may be applicable to multiple missions, and can involve one or more launch vehicle fleets (e.g. Atlas V, Delta II, Pegasus XL, etc.)
 - Watch item resolution may involve long term corrective action implementation.
 - Watch Items remain open until issue resolution.

Risk Identification

Mission Example – Watch Items

- The MAM tracks all watch items applicable to the mission, and reports them at the various readiness reviews (e.g. SARR, LVRR, and SMSR).
- Watch item resolution must be brought to the Watch Item Panel (includes SMA LS Division management).
- Watch items must be resolved or elevated as follows prior to launch:
 - Dispositioned – The issue has been resolved to the point that flight readiness with respect to the issue can be affirmed.
 - Closed – The issue has been fully resolved and flight readiness with respect to this issue can be affirmed for this and all future missions.
 - Elevated to Risk – The issue has a detrimental impact with an associated probability of occurrence, and the issue will be elevated as an SMA risk into the Launch Services Program risk process.
 - Flight acceptance rationale recommendation for the mission is required.

Risk Identification

Mission Example – Risks

- Watch items elevated to risks are brought to the Launch Services Program Risk Control Board for entry into the LSP risk system.
 - SMA TA context is provided with the risk.
- The MAM tracks all mission applicable residual risks, and reports them at the various readiness reviews (e.g. SARR, LVRR, and SMSR).
- Once in the SMA risk is in the LSP risk system:
 - Engineering TA context is added to the risk.
 - Risk mitigation actions are identified and worked.
 - Upon completion of mitigation actions, risk acceptability recommendations are made by the SMA and engineering TA.
 - The LSP Program Manager decides on risk acceptance.

Risk Identification

Mission Example – SMA Appeals

- The NASA governance model presented previously has been instituted to provide avenues to appeal when disputes arise between a TA and a program. There are two appeal paths for the TA's supporting the LSP (see Governance Model figure on page 5):
 - Engineering TA Path
 - SMA TA Path (discussed in this presentation)
- The appeals process was created to ensure that disputed issues are thoroughly and openly considered from multiple points-of-view by the decision authorities.
- Example Appeal: The Program Manager can decide to accept a risk for which the SMA TA cannot recommend risk acceptance. This situation can initiate an SMA appeal if the SMA TA disputes the Program's decision.

Risk Identification

Mission Example – SMA Appeals

- Given the aforementioned dispute, the SMA TA would elevate an appeal of the Program's decision to successively higher levels within the TA authority chain. Those successively higher levels are:
 - KSC Center Director
 - Chief, Safety and Mission Assurance (OSMA)
 - NASA Administrator (highest appeal authority within the Agency)
- At each level of appeal, the SMA TA and the Program present their position regarding the dispute. The appeal authority decides whether to uphold or deny the appeal.
 - Upheld - the program decision would be changed to satisfy the SMA TA dispute.
 - Denied – the SMA TA can choose to appeal to the next higher authority, or accept the appeal denial.
- For successive appeals, the process is the same.
- Appeals end once either the appeal is upheld, or the highest decision authority denies the appeal.

Summary

- The risk identification methodology and processes have been discussed, and the tie-in with the NASA governance model has been shown.
- An example using a typical launch services mission was used to show how issues elevate to risks.
- Finally, the acceptance of risk and how disputes regarding risk acceptance are appealed and decided has been presented.
- Questions?