



# ***Small Satellite Risk Assessment & Best Practice Guide***

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# Small Satellite Risk Assessment & Best Practice Guide

*Why it exists, how it helps, and what it looks like*

- **Why:** Resource-constrained smallsat programs must balance tradeoffs in schedule, process rigor, and system performance
  - *System development and process gaps*
  - *Unrecognized or accumulated risks*
- **How:** Low-threshold, adaptable mechanism to identify program risks and provide recommendations consistent with "smallsat culture" risk posture
  - *Is an appropriate level of process rigor applied given objectives and constraints?*
  - *Is the project on track to pass the next project gate?*
  - *Are there any risks that are not being addressed?*
  - *Is there agreement on where the highest risks lie?*
  - *Are there any gaps that will inhibit the success of the program?*

## Process at a Glance

### GATHER DATA



### ASSESS



### RECOMMEND

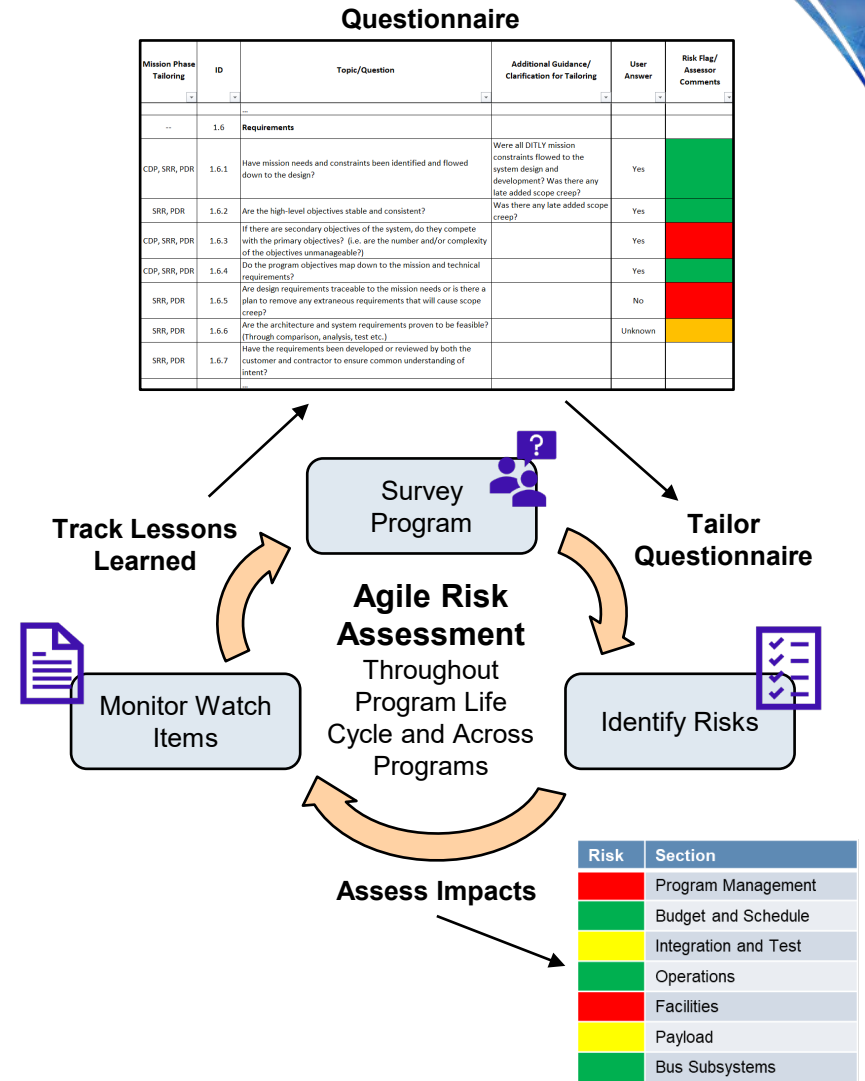


# Small Satellite Risk Assessment

*Tailorable to meet the need*



- Focused on the program's risk posture
  - *Size, cost, and mission agnostic*
- Structured risk assessment guides the process
  - *Tailorable to support speed and depth of analysis*
  - *Risk assessment identifies risks, SSBP team and/or program team can work mitigation*
- Toolbox built from Aerospace IRAD, supporting several programs with direct customer funding
  - *Compiles experiences and lessons learned from many previous missions*
- Schedule, cost, and technical risks
  - *Distills watch items and areas for attention*
- Highly tailorable, flexible process
  - *Any level of depth or effort*
  - *Targeted reach-back to select SMEs*
- “Agile” risk assessment methodology
  - *Cycle of surveying, identifying, and monitoring*
  - *Captures cross-program lessons learned*



# Small Satellite Risk Assessment Process



## Data Gathering

### Facilitated/Unfacilitated Interview Questions or Document Review

- Provides assessment team with background to conduct the high-level risk assessment
- Leading questions and reasoning can enable program to self-realize gaps
- Can be used as checklist

### Documented interview questions

- Consistency
- Process improvement
- Development of a program-specific “risk profile”

b. What are your Programmatic and Technical risk acceptance levels? (low – Mission must succeed and launch on time at all cost to high – set launch date/budget – launch as is) (if not answered by overview briefing)

i. What level of priority is this particular program to your organization (high, medium, low)?  
*Establish an understanding of organizational willingness to mitigate risk*

3. Has a security plan been established?  
a. Does a program sponsor have a security plan?  
b. If all or a portion of the program is classified, does it have a security plan?  
*Determine critical information*

4. What is the overall team approach to risk management?  
*Identify gaps and risk areas*  
a. Identify experience

<b>Government</b>
Program Manager
Chief Engineer
Lead Systems Engineer
Test Engineer
Space Segment Team
Ground Segment Team
System Engineering Team
Contract & Budget
Security Team
Test Team
Initialization & Operations Team
Organization as a whole (maturity of communications, media and general practices)
<b>Developer/Prime</b>
Program Manager
Chief Engineer
Lead Systems Engineer
Test Engineer

**Interview Questions for Improving Mission Success for National Security Space Small Satellites**

**Introduction:** This questionnaire lays the ground work to provide a consistent assessment process for identifying and assessing risk for National Security Space small satellite systems and payloads. The process is broken into 4(TBD) steps.

1. Initial interview with the project leads to establish a baseline understanding of the mission objectives, criticality, constraints, and high-level risks
2. Conduct of initial analysis of the interview responses and provided high level documentation to gauge the level of effort which in turn can be transformed into a Level of Effort Assessment.
3. Deep dive analysis in which subject matter experts grade the program on each applicable question from the high-risk sections called out in the SoW.
  - a. Interview program team members as necessary to fill any information gaps.
4. Provide recommendations to mitigate risks identified through criteria grading process.

**Phase I Initial Interview Questions and Reasoning**  
*Establish baseline understanding of mission objectives, mission criticality, mission constraints and first order risks*

1. What are the high-level objectives of the mission?
  - a. How do you define success of those objectives?  
*Identifies the priorities and measures of effectiveness to those priorities*
2. Are there any overview or status briefings that provide an overview of the government's objectives, schedule, project cost/budget, security requirements, and stakeholders associated with the program that can be provided?  
*Provides detailed information on the goals, objectives, schedule, cost, and risk of the program without having to put the time into developing new documents.*
  - a. How tightly is this program acquisition tied to the success of this particular mission or venture?  
*Establish an understanding of the criticality of the mission to the organization*
    - i. Who are your stakeholders? Who pays, who benefits, who delivers, who are you reliant on?  
*Determine if the mission has accounted for the driving stakeholders*
    - ii. What does success look like for the stakeholders and what are their priorities?
      1. Technical risk reduction, coverage, duty-cycle, sensitivities, availability, workforce development, etc?  
*Identifies prioritized performance measures to help inform risk mitigation trades*
    - iii. What happens if the mission does not succeed (full or partial)?  
*Establish an understanding of the criticality of the mission to the organization*
    - iv. What is the minimum required mission duration to meet stakeholders needs or satisfy program objectives.  
*Establish a baseline mission duration requirement*
    - v. How much schedule/budget float or margin is available for the mission?  
*Guides recommendations for process and mitigation to program*

**Establishes baseline level of information and documentation to conduct the assessment**



# Small Satellite Risk Assessment Process

## Risk Assessment



Mission Phase Tailoring	ID	Topic/Question	Additional Guidance	User A	Risk Flag/ Assessor	SSMA Guide Cross Reference	Reference Documents
SDP, PDR, CDR, PSR	1.7.1.1	Does the contractor have a configuration management plan that addresses space hardware, flight software, and ground systems?		yes	<span style="background-color: green; color: white;"> </span>		TOR-2019-01781-RevA - Adaptive Mission Assurance Strategy for Pre-Acquisition, Configuration Management Guidance
PDR	1.7.2	Is the program documentation stored and available in a centralized location accessible to all required stakeholders.		Yes	<span style="background-color: green; color: white;"> </span>	1.10	TOR-2019-01781-RevA - Adaptive Mission Assurance Strategy for Pre-Acquisition, Configuration Management Guidance
PDR, CDR, PSR	1.7.3	How well-controlled are the design, hardware, and critical mission documents in the program? (1- No baseline controls, 2- Work from red-lines authorized, 3- configuration management board established.		2	<span style="background-color: yellow; color: black;"> </span>	1.7, 1.10, 1.11, 3.5, 3.6, 14.4.2, 16.2	SMC-SE-HDBK - SMC Systems Engineering Primer and Handbook (2013), Chapter 4.12.2 NASA SP-2016-6105 Rev2: NASA Systems Engineering Handbook, Chapter 6.5.1.2.3, Chapter 6.5.1.2.4
PDR, CDR, AIT	1.7.4	Are test and operations procedures held to the same strict configuration management protocols as design specifications?		No	<span style="background-color: red; color: white;"> </span>	1.7	Program Management Game Changers Lessons Learned from the Space Test Program, Slide 96

- Tailorable listing of ~600 questions to assess project risks and issues
  - Tagged by phase, level of detail, and topic area to facilitate rapid tailoring
  - Typically tailored down by team to ~50-100 questions
  - Format and macros provide immediate feedback in identifying potential risk areas
- Each risk includes a pointer to a list of pertinent resources and a cross-reference to the small satellite best practices guide
- Includes link to provide feedback to the team to improve the assessment package

***Establishes a base list of potential risk and issue areas for further examination.***

***Provides an immediate mechanism to find mitigations.***



# Small Satellite Risk Assessment Process

## Risk Mitigation Recommendation

Small Satellite Best Practices Guide can be used as a stand-alone product

- Segmented by topic area and filtered by program phase
- When used with the Risk Assessment, can generate a full risk and mitigation package

Select desired Priority, Mission Phase, and Customer Sector and hit "Reformat Table" button to build Custom Guide

Priority

 Mandatory  
 Critical  
 Recommended  
 Desirable

Mission Phases

 Pre-Contract Award  
 SRR  
 PDR  
 CDR  
 Space Vehicle I&T  
 PSR  
 System I&T  
 Operations

Customer Sector

 Commercial  
 DoD/IC

Generate Guide

4.3.3 Thermal Cycle Testing	Thermal testing based on predicted temperatures of critical components with margin.	Used to verify vehicle can operate at temperatures (high and low) with margin	Mandatory	Space Vehicle I&T, PSR
4.3.4 Thermal Balance (in T-Vac)	Thermal vacuum testing for user-defined hot and cold cases to collect data for model calibration.	Used to calibrate thermal models/simulations to predict on-orbit conditions	Critical	Space Vehicle I&T
4.3.5 Thermal Vacuum Testing	Thermal vacuum testing based on predicted temperatures with margin	Used to verify vehicle can operate in vacuum at temperatures (high and low) with margin in more space-like conditions (i.e., no convection) as well as to verify outgassing levels	Recommended	Space Vehicle I&T, PSR
4.3.6 System Level Thermal Bakeout	Thermal bakeout to outgas components. Might be required by rideshare or launch integrator.	Used to reduce contamination risk to other payloads (e.g., other CubeSats, primary Payload(s)) <i>Especially important for some EP systems</i>	Mandatory	Space Vehicle I&T, PSR
4.3.7 Subsystem and Component Thermal Bakeout	Consider thermal vacuum bakeout of high-outgassing components and assemblies prior to system bakeout. Examples include: harness, epoxies and adhesives, individual electronics boards.	Baking out high-outgassing materials such as harnesses, connectors, and adhesives before they are integrated with more sensitive components (e.g., optics) reduces self-contamination.	Recommended	Space Vehicle I&T
4.3.8 Related "Do No Harm" Tests	Conduct additional tests related to issues identified from the "Do No Harm" analysis, only mandatory for rideshare missions with DNH requirement	For rideshare missions, the launch provider, integrated payload stack manager, and / or other payloads will impose DNH requirements so the payloads do not negatively affect each other or the launch vehicle	Mandatory	Space Vehicle I&T, PSR



# Small Satellite Best Practices Guide Approach

## Background and Perspective

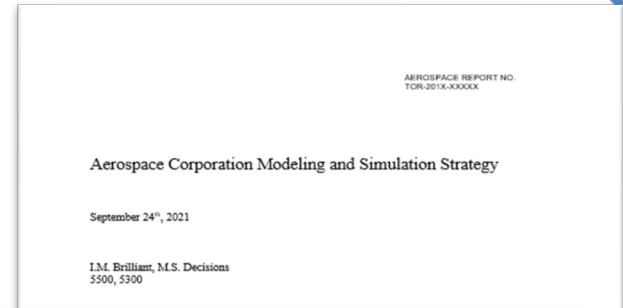
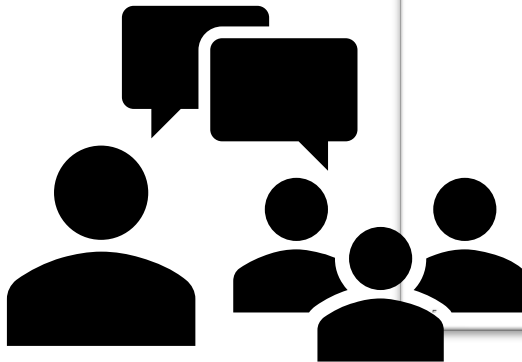
- Several ongoing efforts at the Aerospace Corporation to establish Mission Assurance practices for small satellites
- Smallsat IRAD is a “bottom-up” approach to the Mission Assurance problem
  - *Given our experience with small satellites, what do we feel are the most useful methods and practices to ensure mission success?*
  - *Not a “paring-down” of a traditional Mission Assurance standards, per se*
    - Traditional MA practices cited as reference where applicable

SSBP Guide is:	SSBP Guide is <u>not</u> :
<ul style="list-style-type: none"><li>✓ Tailorable</li><li>✓ Easy to understand</li><li>✓ Multiple use cases</li><li>✓ Based off firsthand experience and lessons learned</li><li>✓ Actionable</li></ul>	<ul style="list-style-type: none"><li>✗ Comprehensive</li><li>✗ Prescriptive</li><li>✗ Authoritative</li></ul>

***Small Satellite Best Practices guide seeks to address unique smallsat MA needs***

# Final Deliverable

- No one-size-fits-all solutions
- May take the form of:
  - A series of SME-focused conversations
  - A briefing
  - A formal report



TYPE SECURITY MARKING(S) IN SLIDE MASTER

## PROJECT XYZ Executive Summary

- Bus integration is mostly on track with some delays, significant payload risk from delay
- Top Risks
  - Risk 1: Summary
  - Risk 2: Summary
  - Risk 3: Summary

Section #	Risk Area
1	Program Management and Systems Engineering
2	Design
3	Integration and Handling
4	System Test and Analysis
5	Launch, Operations, & Decommissioning
6	Licensing/Regulation Compliance
7	Facilities
8	Payload
9	Electrical Power System (EPS)
10	Attitude Determination and Control System (ADCS)
11	Command and Data Handling (C&DH)
12	Software
13	Communications (Comms.)
14	Thermal
15	Structures and Mechanisms
16	Propulsion

Risk Assessment
Low
Moderate
Focus Area

TYPE SECURITY MARKING(S) IN SLIDE MASTER

*Tailored to Meet the Programs Specific Needs*





## ***In Summary***

- The Small Sat Risk Assessment can be introduced at any point within the lifecycle of the mission – agile and tailorable process
  - Has been demonstrated from the front of the V to the back
  - Emphasis changes as program matures
- Best practices are captured and continually updated, creating a living process for living programs
- Successfully used to support government missions across the space enterprise. A subset of success stories include:
  - *Limiting scope creep and flagging watch items*
  - *Identifying risks in specific program elements resulting in continued support*
  - *Validating risk posture and providing SME speed-dial*