National Aeronautics and Space Administration

Risk Balance

A Key Tool for Mission Operations Assurance

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RISK – THE CONTINUING THREAT

What is Mission Success?

MEETING LEVEL 1 REQUIREMENTS

WITHIN COST AND SCHEDULE

WITH ACCEPTABLE RISK AND

DOING IT SAFELY!

What is Risk?

Risk is the likelihood of an undesirable event/outcome occurring AND the severity of the consequences of the occurrence. Risks are classified in the broad areas of implementation and mission risk.

- **Implementation risk addresses cost, schedule, technical and/or programmatic threats.**
- **Mission risk addresses the mission success criteria.**
- **Likelihood is characterized by two major parameters – conditions and window of vulnerability.**
- **Consequence is characterized as either mission impact or implementation impact, and by the set of possible outcomes should the risk item occur.**

Where do Risks Come From?

Experience indicates that risks are derived from several root causes:

- Unsettled definition of mission Level 1 requirements, priorities and full/minimum success criteria
- Incomplete understanding of the driving mission/system requirements, including the impact of mission time-critical activities
- Lack of sufficient margins (technical and programmatic)
- Unsubstantiated assumptions (which are usually optimistic)
- Incomplete identification of key risks and mitigation options
- Unsubstantiated optimism of the capabilities of the project team and/or its contractors/partners
- **Unknown Unknowns**

The Risk Iceberg

RISK TRADES, A BALANCING ACT

Approach

- **To provide an independent Mission Assurance assessment of the Project Options for dealing with the approaching conditions/event.**
- **Review the Key areas/events to identify major risk Items: (such as)**
  - Spacecraft safing history, especially during critical times
  - Maintaining redundant/backup capability
  - Swapping from a nominally performing subsystem
  - Flight Software changes
  - Hardware vulnerability
  - Schedule/resource impacts
  - First time in-flight event
- **Recommend an option based on the risk drivers**

UNDER COVER OF DARKNESS?

Major Risk Drivers for Entry Decision

- From an **earth hazard avoidance**, nighttime entry has the spacecraft targeted to the earth at E-13 days vs E-30 days for the daytime case.
- **Ground impact hazard assessment** shows a hazard track across 2 for the nighttime entry vs a longer hazard track across Canada and multiple states for the daytime entry.
- The nighttime entry conditions maintain more **SRC design margin** than the daytime.
- **Ground station coverage** provides dual site coverage for SRC release for the nighttime entry, but not for daytime entry
- **SRC processing time** would be less with a daytime entry for the anomalous hard landing case were the capsule is breached.

Minor Risk Drivers for Entry Decision

- **Backup orbit duration** for the nighttime entry is shorter by 2 years, and both enable a backup orbit with manageable Delta-V.
- **SRC release downlink data rate** is higher for nighttime entry than daytime entry - doable at either data rate.
- **STRATCOM Tracking** resources are more robust for the nighttime entry (visual, IR and radar) than for the daytime entry (radar only).

Daytime Vs Nighttime Entry Options

Risk Drivers and Rankings		Risk Trade Cases			
Risk Driver	Rank	Nighttime		Daytime	
		Human Safety	Mission Success	Human Safety	Mission Success
Earth Hazard Avoidance	Major	✓			
Ground Impact Hazard Assessment	Major	✓			
SRC Design Margin	Major		✓		
Ground Station Coverage	Major	✓	✓		
SRC Processing Time - Anomalous	Major				✓
Backup Orbit Duration	Minor		✓		
SRC Release Downlink Data Rate	Minor		✓		
STRATCOM Tracking	Minor		✓		

✓: Lower Risk Option

CAN YOU HEAR ME NOW?

TWTA Options

Risk Drivers and Ranking		Risk Trade Cases		
Risk Drivers	Rank	Switch TWTAs (Baseline Plan)	Switch WTS	Operate Both TWTAs Simultaneously
Telemetry Visibility during closest Approach	Minor	(Gap is after closest approach)	✓	✓
Hardware vulnerability	Major	✓ (slightly less than simultaneous TWTA operation)		✓
Schedule/Resource Impacts	Major	✓	✓ (slightly less than switching TWTAs)	
In-flight First Time Event	Minor	✓	✓	
✓: Lower Risk Option				

POWER BUS BALANCING ACT

Major Risk Drivers for Instrument Turn-on Decision

- **High voltage arcing** within the instrument could result in an under-voltage trip since the spacecraft is only single fault tolerant with the instrument on.
- **Dendrite growth within the capacitors** of the instrument and any appreciable time spent with a power bus rail shorted-to-chassis condition will result in the bus voltages becoming further imbalanced.
- **RTG-3 case voltage drifts** (existing soft short) leading to an uncorrectable power load that consumes wattage that could otherwise be utilized by the instrument and engineering loads.
- **Power System complexity** combined with aging effects raises the possibility of losing RTG-3 causing a deep under voltage which would cause a power-on-reset placing the spacecraft in extended sun search with propellant being expelled for up to 45 min.

Instrument Turn-on Options

Risk Drivers and Ranking		Risk Trade Cases		
Risk Drivers	**Rank**	Turn-on for extended Time period	Turn-on for Intermittent Periods	Instrument Remains Off
High Voltage Arcing	**Major**	Under Voltage causing safing which could POR the S/C	Under Voltage causing safing which could POR the S/C	✓
Dendrite Growth within the Capacitors	**Major**	Under Voltage causing safing which could POR the S/C	Under Voltage causing safing which could POR the S/C	✓
RTG-3 Case Voltage Drifts	**Major**	Uncorrectable power load that consumes wattage that could otherwise be utilized by the instrument	Uncorrectable power load that consumes wattage that could otherwise be utilized by the instrument	✓
Power System Complexity	**Major**	Could result in Bus Voltages being further imbalanced	Could result in Bus Voltages being further imbalanced	✓
✓**: Lower Risk Option**				

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