Quality Interaction Between Mission Assurance and Project Team Members

Presentation
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Agenda

- **Purpose and Attributes**
- **Organizational structure**
- **Mission Assurance (MA) and Operations Teams interactions Overview**
- **How MA integrates into Operations Teams Activities**
- **Ensuring defects and/or problems are identified, captured and reporting**
- **JPL Robust Root Cause Analysis Implementation**
- **Handling difficult problems**
- **Quantitative Measurement- Problem Reports Metric**
- **Quality Risk Management**
  - Risk Assessments and Risk Reduction Activities
  - Post Launch Monthly Top Risks
- **Possible Improvements**
- **MA Phasing**
- **MA Quality Summary Statement**
- **Backups**

Purpose and Attributes

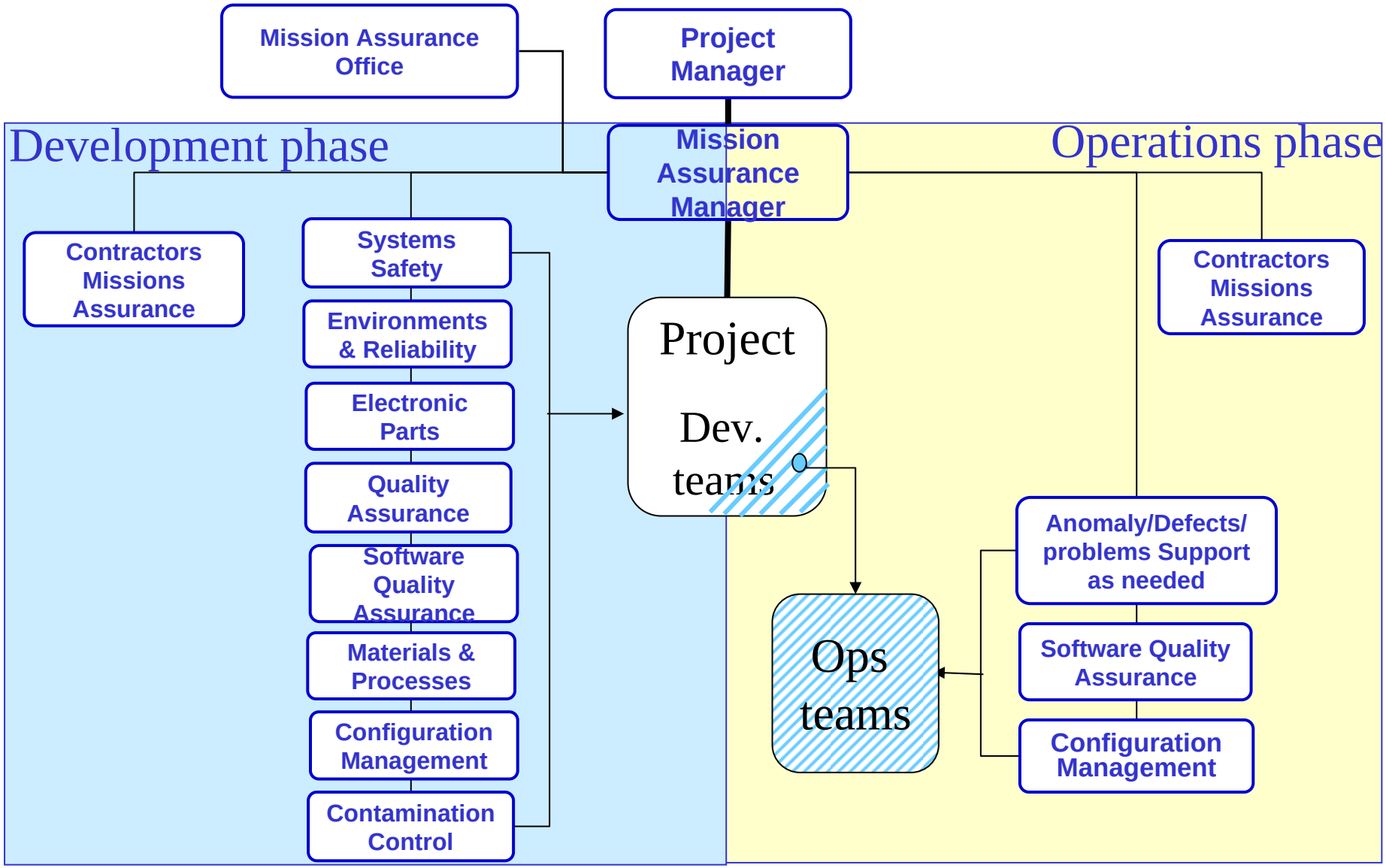
Purpose:

- To demonstrate value added Mission Assurance to flight operations in order to assure mission success and the Health and Safety of the observatory

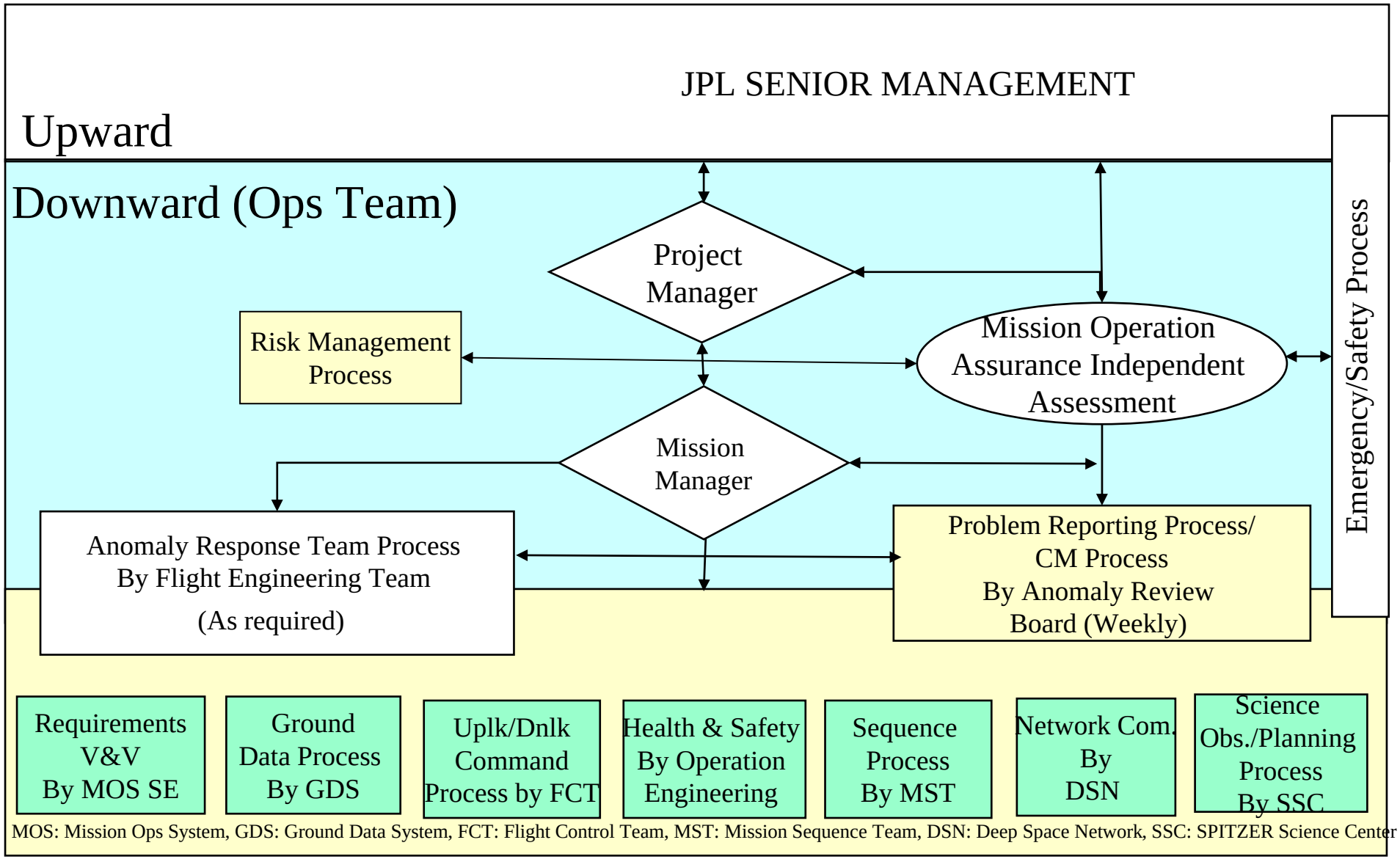
Attributes:

- Assuring Mission Success by being a proactive contributor with in the operations team
- Providing independent checks/balance of requirements, processes and procedures
- Rigorous anomaly (defects/problems) reporting process
- Performs independent technical review and risk assessment of operations issues and problem reports/anomalies
- Incorporation of Lessons learned into operations and have Continuous Improvement
- Conduct project verification via Product certification process

Organizational Structure



Mission Assurance and Operations Teams Interactions Overview



MOS: Mission Ops System, GDS: Ground Data System, FCT: Flight Control Team, MST: Mission Sequence Team, DSN: Deep Space Network, SSC: SPITZER Science Center

How MA integrates into Operations Teams Activities

Example of Project Weekly Activities

Monday Tuesday Wednesday Thursday Friday Saturday Sunday

Daily Passes to collect Science – Communication with the Observatory

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Risk Management meeting	DSN-SPITZER Tag up	Project Staff meeting	Flight Engineering Team		All Team Leads On-call 24/7	
Mission Change Board	Project Status	Mission Ops. System Design Team	Ground Data System Meeting			
Science Change Board	Sequence Kick off meeting	Mission Change Board	Command Conference			
	Anomaly Review Board Meeting	Sequence Review Meeting				
	Mission Operation Staff					

Not included here:
Workshop level meetings
Tiger team investigations
Project weekly team reports
Line Reporting

Mission Assurance Manager conducts these activities
Mission Assurance is a primary part of the Project Staff
Mission Assurance carries a proactive role with these activities

There is no such thing as quiet flight operations

Ensuring defects or problems are Identified, Captured and Reporting

- How does Mission assurance ensure defects or problems are being identified and captured?
  - Active participation in flight team meetings and activities to ensure that problems/issues discussed are documented in a timely manner (staff meetings, weekly status, team meetings, work shops, etc….)
  - Provide a friendly-non threatening open environment to promote anomalies to be documented
  - Have knowledge on team processes, plans and procedures with sufficient familiarity to be able to recognize any implementation deviations
  - Monitor Real-time operations *(DSN,* Daily alarms and Event reports)
  - Review test results from post launch code changes, and tests results from problems/anomalies resolutions
- SPITZER uses the Incident Surprise Anomaly (ISA) reports to capture defects/problems/anomalies
- Mission assurance manager reports regularly to project manager and to the office of Safety and Mission Success

JPL Robust Root Cause Analysis Implementation

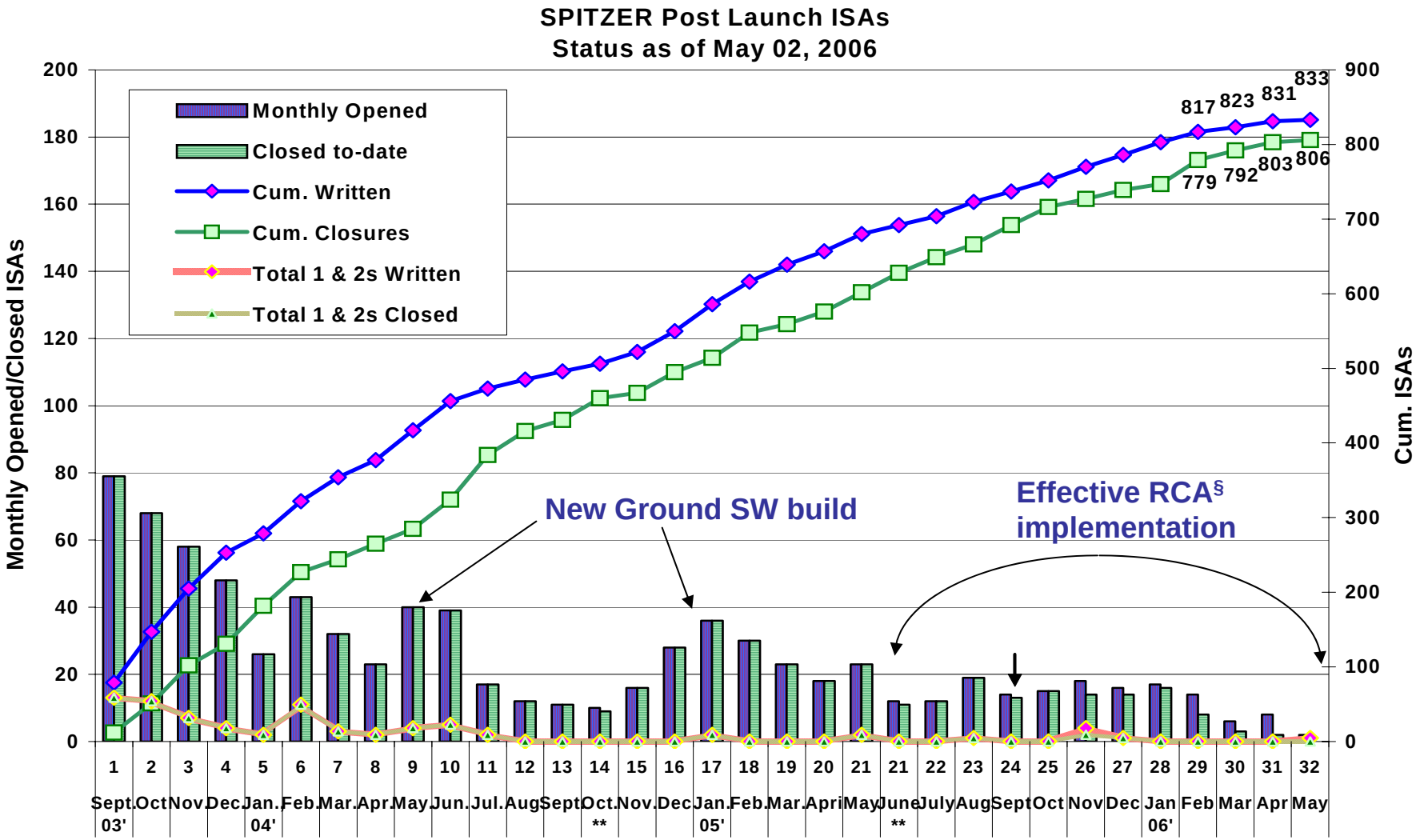
- **How do we Mitigate problems or prevent problems from re-occurring?**
  - **On SPITZER, Root Cause Analysis are being implemented for all problem reports and are documented in ISAs**
    - Identify the undesired outcome and assess the ISA criticality
    - Analysis description
      - –How was the problem found, and is this a repeating problem?
      - –Identification of Proximate cause
      - –Identification of all possible Contributing causes (all potential threads that can lead to the root cause)
      - –Identification of Root cause
      - –Fish bone analysis or fault tree analysis required (problems with higher criticality ratings)
    - Corrective Action
      - –Solution description, problem repeatability and solution verifiability
      - –Identification of a possible violation of flight rule, mission rule, flight or ground idiosyncrasy
      - –Evaluate if this is a simple design feature change?
      - –Identify if the solution require Hardware repair, a new SW build or a patch
      - –List of tests performed and identify test results reviewer
      - –Evaluate whether the engineer is familiar with the changes or perhaps need additional training?

Handling difficult problems

- What happens when Root Cause can not be identified?
  - Perform risk assessment, identify the residual risk as appropriate
  - Close the problem as Unverified Failure and keep track of similar problems
    - Discuss with applicable stakeholders
  - Document the issue and discuss with Project manager and Mission Manager
  - Report to Office of Safety and Mission Success at monthly review

Note: Detail approach-see back up charts

Quantitative Measurement - Problem Reports Metric



Cycle end date (24th of each month)

**Running ISA capturing ground and instrument Idiosyncrasies

§RCA-Root Cause Analysis

Quality Risk Management

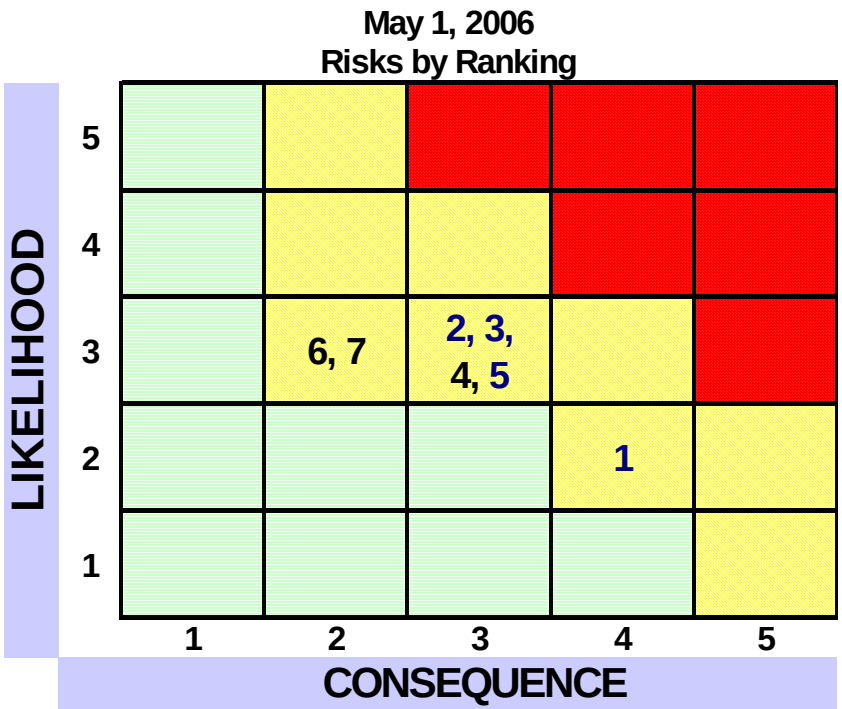
- Office of Safety and Mission Success (OSMS) owns and maintains the Risk Management Process for JPL Flight Projects
  - Project Manager owns and operates the process applied to his/her project
  - Mission Assurance (OSMS) provides tools, training and consultation
- OSMS owns and operates the Independent Risk Assessment process for JPL projects
- Mission Assurance Manager (MAM) On SPITZER
  - Provides the training to project team members on risks implementation
  - Maintains the risk database for the project
  - Conducts regular project risk mitigation meetings
  - Makes independent assessments on mitigated risks
  - Discusses risks posture with Project manager
  - Reports risk status to upper senior management

Note: Detail Risk Management Process and Comparison Summary-see back up charts

Risk Assessment and Risk Reduction Activities

- Risk Assessments are made of the following:
  - Decision impacting the Health and Safety of the Observatory
  - Waivers
  - Solutions to problems
  - Mission Changes: FSW patches, configuration file updates, documentation, etc..
  - Team processes and procedures
  - Products delivery
  - Accepting no fix as a solution (i.e. Unverified failures, idiosyncrasies)
- Risks reduction activities
  - Operations risk identification
  - Pre-launch residual risks reviews and tracking
  - Consumable trending (i.e. Cryogen/Mass, thruster cycle, thermal cycle, etc…) to monitor potential hardware failures/degradation
  - Space environment monitoring (Solar Flare)
  - Software Fault Protection efficiency improvement
  - Flight team cross training to maintain staff knowledge efficiency
  - Documentation update (contingencies, plans, procedures)
  - Requirements clarification and/or refinement
  - Modification of operational resources need (i.e. DSN antenna) as constraints/limitations are identified.

Post Launch Operations
Top Risk List & Risk Matrix



Criticality	L x C Trend	Approach
High	⇩ Decreasing (Improving)	M - Mitigate
Med	⇧ Increasing (Worsening)	W - Watch
Low	⇨ Unchanged	A - Accept
	☐ New Since Last Period	R - Research

Risk & Trend	Risk ID	Approach	Post Launch Risk Title
1	OET-4	M	Unexpected Swap to C&DH B-Side
2	OET-3	M	Unexpected Hardware Degradation or Failure
3	MOS-21	M	MMC Fill Response
4	MA-20	M	Efficiency of Anomaly Response Team decision
5	SSC-1	M	SSC staff inter-discipline knowledge
6	OET-5	M	Flight Staffing & Knowledge Retention
7	MOS-22	M	70 meter Antenna reliability

Possible Improvements

- **Problem Solving:**
  - Do not accept solution that have not addressed the root cause (static vs. dynamic)
  - Apply Root Cause analysis early in the project for all problems found in development

  Impact to Operations: Problem may continue to surface and could cause more science loss

- **Hardware, software and their interfaces:**
  - At design phase, ask "why do we need this fault protection?" and document it
  - Design fault protection management appropriately and wisely, be flexible and have sufficient margins (i.e. fault triggering, persistence)

  Impact to Operations: Problem causes standby or safe-mode entry unnecessarily, and ultimately reduces observatory efficiency

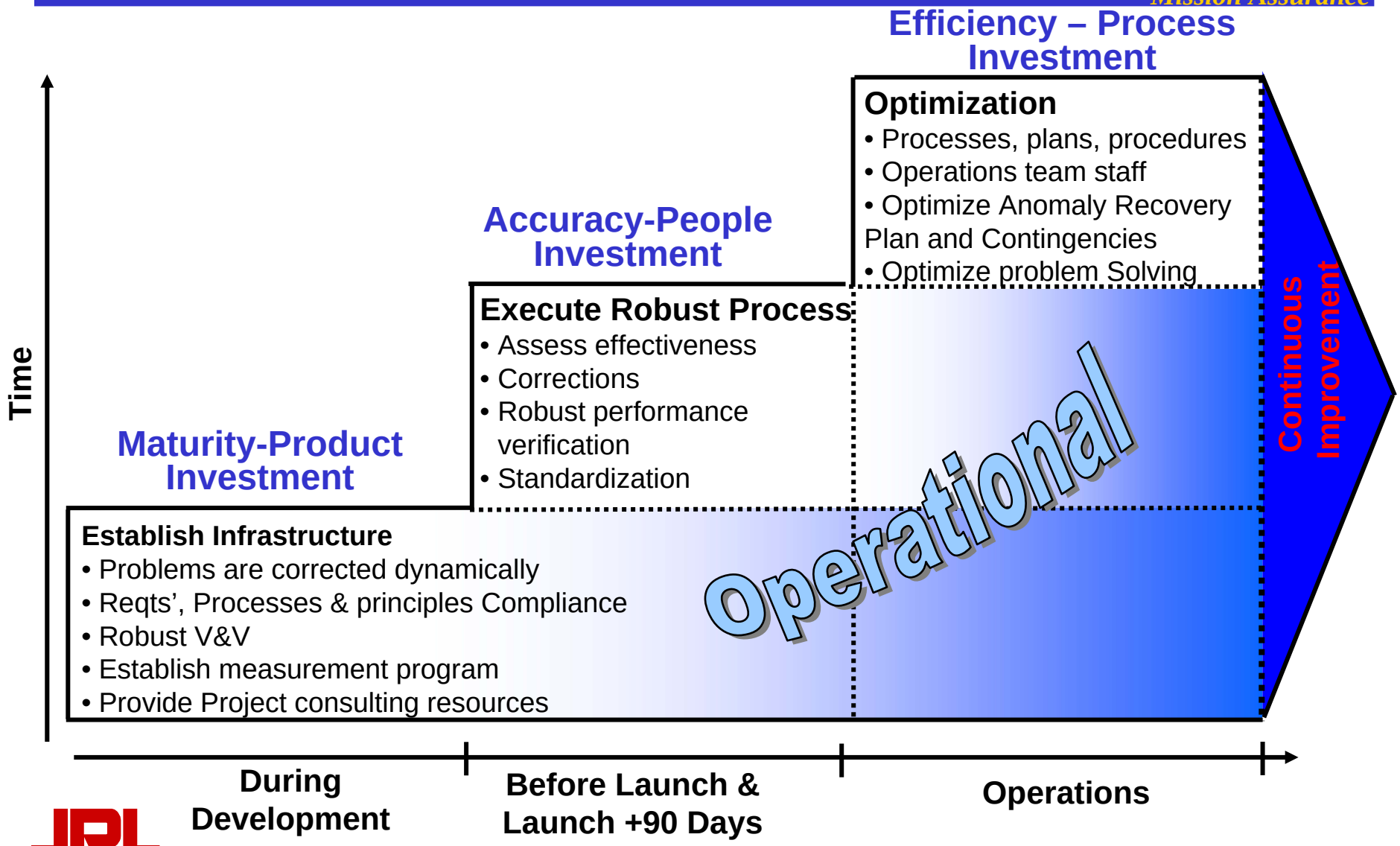
- **Testing:**
  - Don't compromise on verification testing
  - During development, WHEN safe, prefer testing on the flight hardware after it has been tested with the testbed, and/or the simulator
  - During operations: Do not use the observatory as a testbed

  Impact to Operations: Incomplete requirements verification could yield greater challenges to operations team

- **Knowledge, Documentation:**
  - Transition key development team members into operations to maintain the spacecraft design knowledge
  - Ensure everyone understands their subsystem's architecture and dependencies, and have operational fault tree for each subsystems.

  Impact to Operations: Avoid time spent in gathering information while keeping the Spacecraft in safe-mode longer than necessary.

Mission Assurance — Phasing



MA Quality Summary Statement

The SPITZER program has established and is maintaining an operational MA program resulting in continuous Improvement of operational processes with a goal of preserving the Health and Safety of the Observatory.

Back up

Handling difficult problems and proper Evaluations-detail

- Other features to look for
  - Sometimes, a problem report can have 2 different unique problems
  - Solutions may require more than one team to resolve
  - A fix to a problem could cause potential problems for other teams
  - Multiple paths to root cause
  - Recognizing patterns/signs that require additional team training

- Evaluate corrective actions (solutions/fixes) for acceptability
  - Problems that are repeatable and have proper fixes
  - Necessary procedures, plans or processes update
  - New checklist to close communication gap
  - Problems that are not real problems but need enhancement
    - Unique features that require mission change requests
  - A point build of new software delivery is needed

Problems Report by Criticality and Elements

Total Open and Closed ISA by Criticality

	Crit 1	Crit 2	Crit 3	Crit 4	Total
Open	0	3	20	4	27
Closed	0	73	664	69	806
Total	0	76	684	73	833

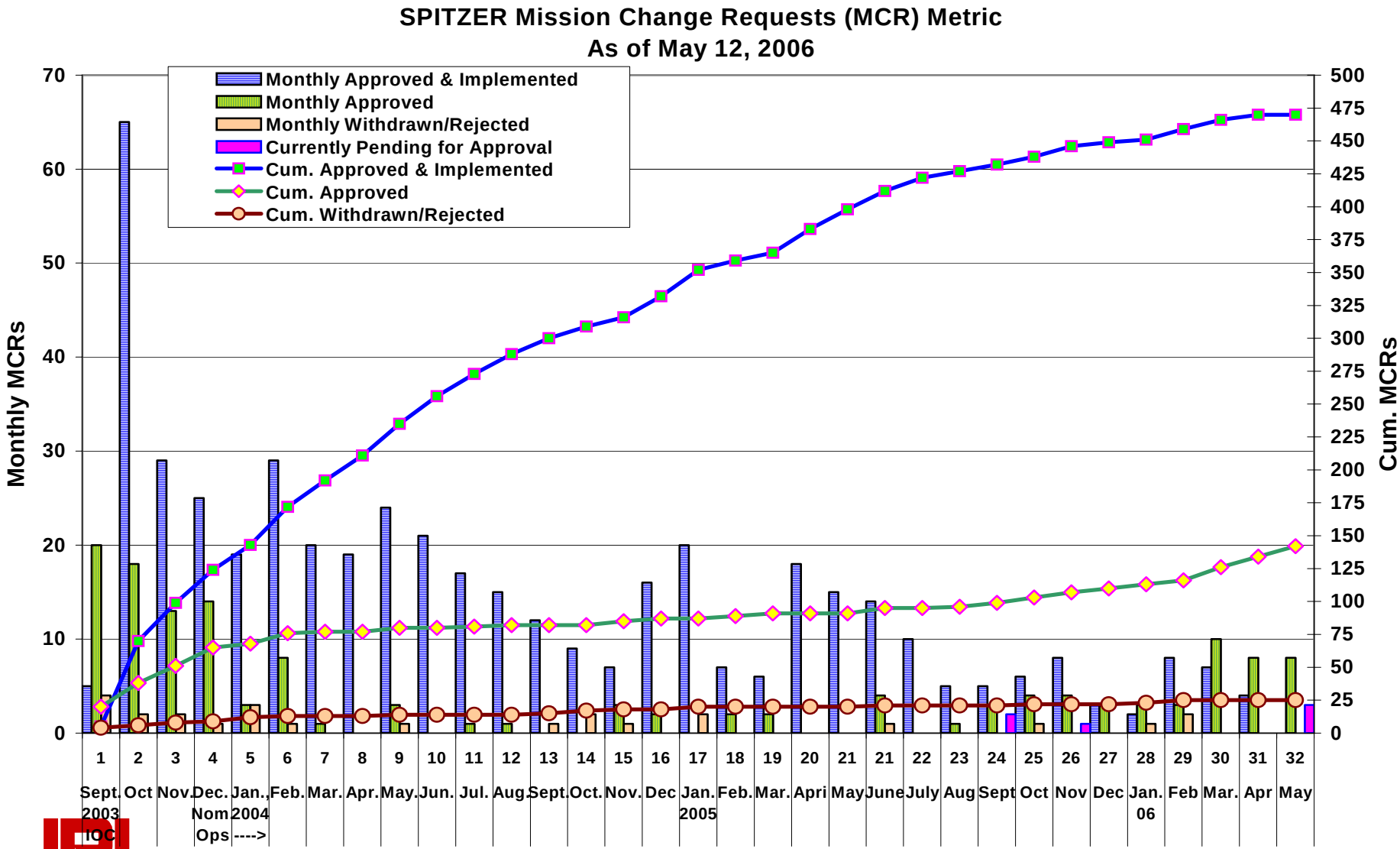
Open ISAs by Elements and by Criticality

Post-Launch ISAs Element	Criticality 1	2	3	4	Still Open	CA-Signed	Closed	Total	(%)
OET		1	0	0	1		45	46	5.52
FET		2	0	0	2		92	94	11.28
GDS		0	2	3	5		231	236	28.33
MST		0	0	0	0		14	14	1.68
MMS-OP		0	10	0	10		272	282	33.85
FCT		0	1	0	1	1	17	18	2.16
SE/MM		0	2	0	2		10	12	1.44
IRAC		0	0	0	0		8	8	0.96
CE		0	0	0	0		8	8	0.96
IRS/MIPS		0	0	0	0		5	5	0.60
SSC		0	5	1	6		104	110	13.21
Grand total	**0**	**3**	**20**	**4**	**27**	**1**	**806**	**833**	
Pre-Launch ISAs	**0**	**0**	**0**	**0**	**0**	**0**	**1236**	**1236**	

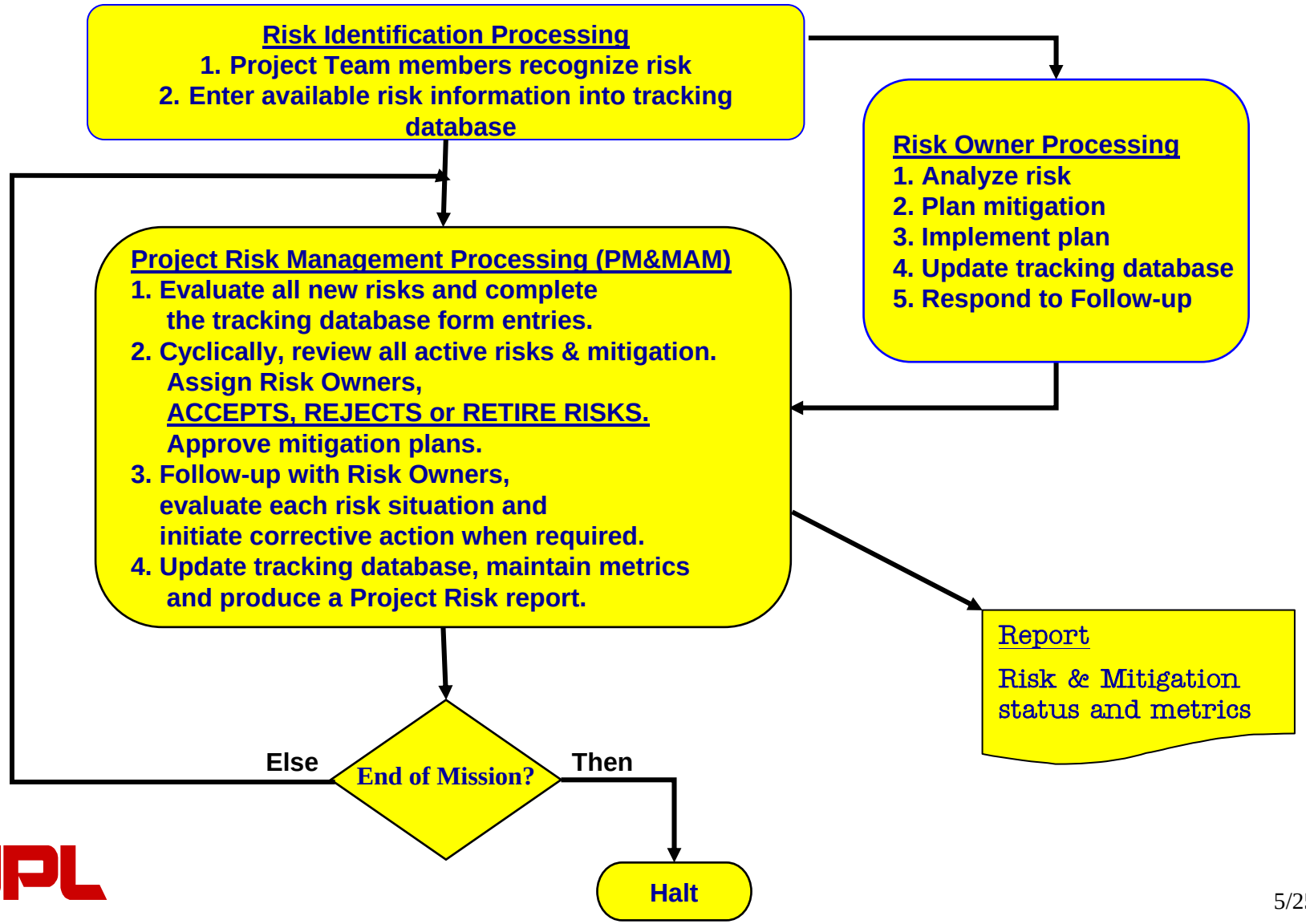
Updated definitions Per D-8091, Anomaly Resolution Standard, released 4/05:

Criticality 1: represents major impact or threat to achieving full mission success
Criticality 2: represents significant impact or threat to achieving full mission success
Criticality 3: represents negligible impact or threat to achieving full mission success
Criticality 4: represents no risk or threat to achieving full mission success

Quantitative Measurement - Configuration Management Metric



Quality Risk Management Detail Process



National Aeronautics and Space Administration
Jet Propulsion Laboratory
California Institute of Technology

Comparison of Pre-Launch and Post Launch

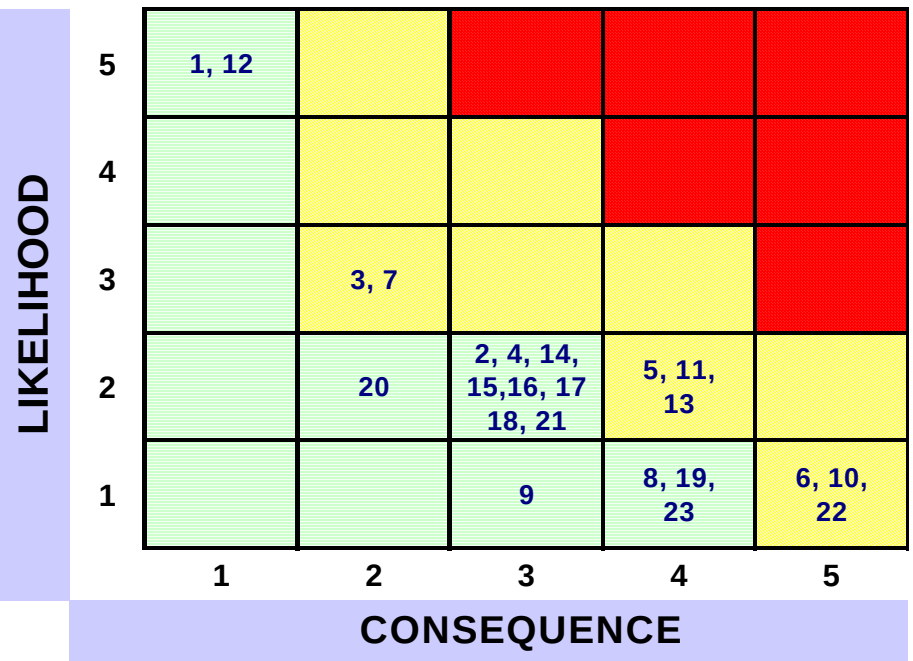
SPITZER SPACE TELESCOPE

Mission Assurance

Pre-Launch Risks

August 25, 2003

Pre-Launch Residual Risks by ID

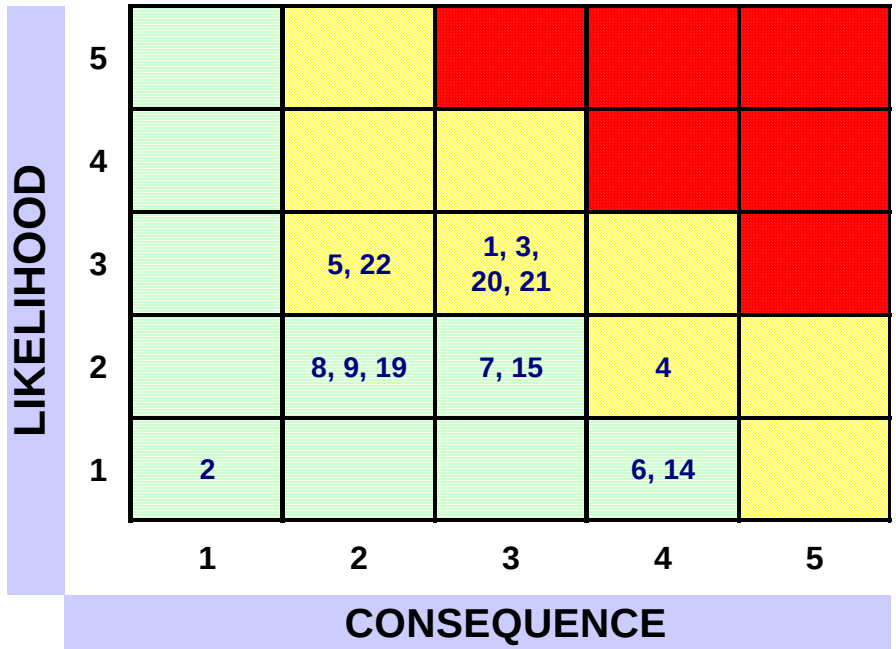


Med. Risks (yellow) -8
Low Risks (green) -15

Post Launch Risks

May 1, 2006

Risks by ID



Med. Risk (yellow)-7
Low Risks (green) -7

In reviewing risks posture pattern, the med. risks of pre-launch residuals are similar to current post launch risks status, however, after 2.5 years of mission, the number of low risks have reduced by 50% (please note that the above pre and post launch risks listed in the matrix are not the same risks).

Can all risk mitigation be performed before Launch?

JPL

Successful Mission Assurance Practices

- Ensure Staff training Opportunities and promote cross training
  - Refresh processes and procedures periodically
  - Implementation of Root Cause Analysis
  - Lessons Learned post each major and minor anomaly events
  - Staff Knowledge, avoid Single Point Failures
- Know your team members and understand their processes
- Ensure Team members to comply with instructional rules, requirements, practices, and principles
- Be sensitive to the team members needs, Don't criticize, provide solution when possible
- Be Proactive!