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

Mission Assurance at The Jet Propulsion Laboratory

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What is Mission Success?

MEETING LEVEL 1 REQUIREMENTS

WITHIN COST AND SCHEDULE

WITH ACCEPTABLE RISK AND

DOING IT SAFELY!

"A million things must go right"

What Space Missions Require

- Space missions demand high performance, reliable systems/ payloads and quality people to achieve mission success.
- Mission Success is enabled by having:
  - **Strong mission/systems engineering capability**
  - **Fully-engaged Safety and Mission Assurance program**
  - **Comprehensive, rigorous and robust test verification/validation program**
  - **Experienced, skilled employees**
  - **State-of-the-art Processes/Tools/Training**
  - **Organization and processes to identify and manage risks**
  - **Effective partnership with the space community – e.g., Industry, Academia and Government**

What We Have Learned

Risks to mission success result from several factors, most notable are:

- **Late/unclear definition of mission Level 1 requirements, priorities and criteria for full/minimum success.**
- **Incomplete understanding of the driving mission/system requirements, including the impact of time-critical mission activities.**
- **Unsubstantiated assumptions, particularly heritage.**
- **Optimistic baseline implementation plan.**
- **Insufficient margins to accommodate uncertainties and unknown-unknowns.**
- **Inadequate systems engineering and safety/mission assurance.**
- **Inadequate system design verification/validation test program.**
- **Lack of early identification of key risks (e.g. new technology, new designs) and mitigation options/impacts.**
- **Unsubstantiated optimism of the capabilities of the project team and/or its contractors/partners.**
- **Inadequate number of experienced, skilled workforce in key disciplines.**
- **Not following established processes.**

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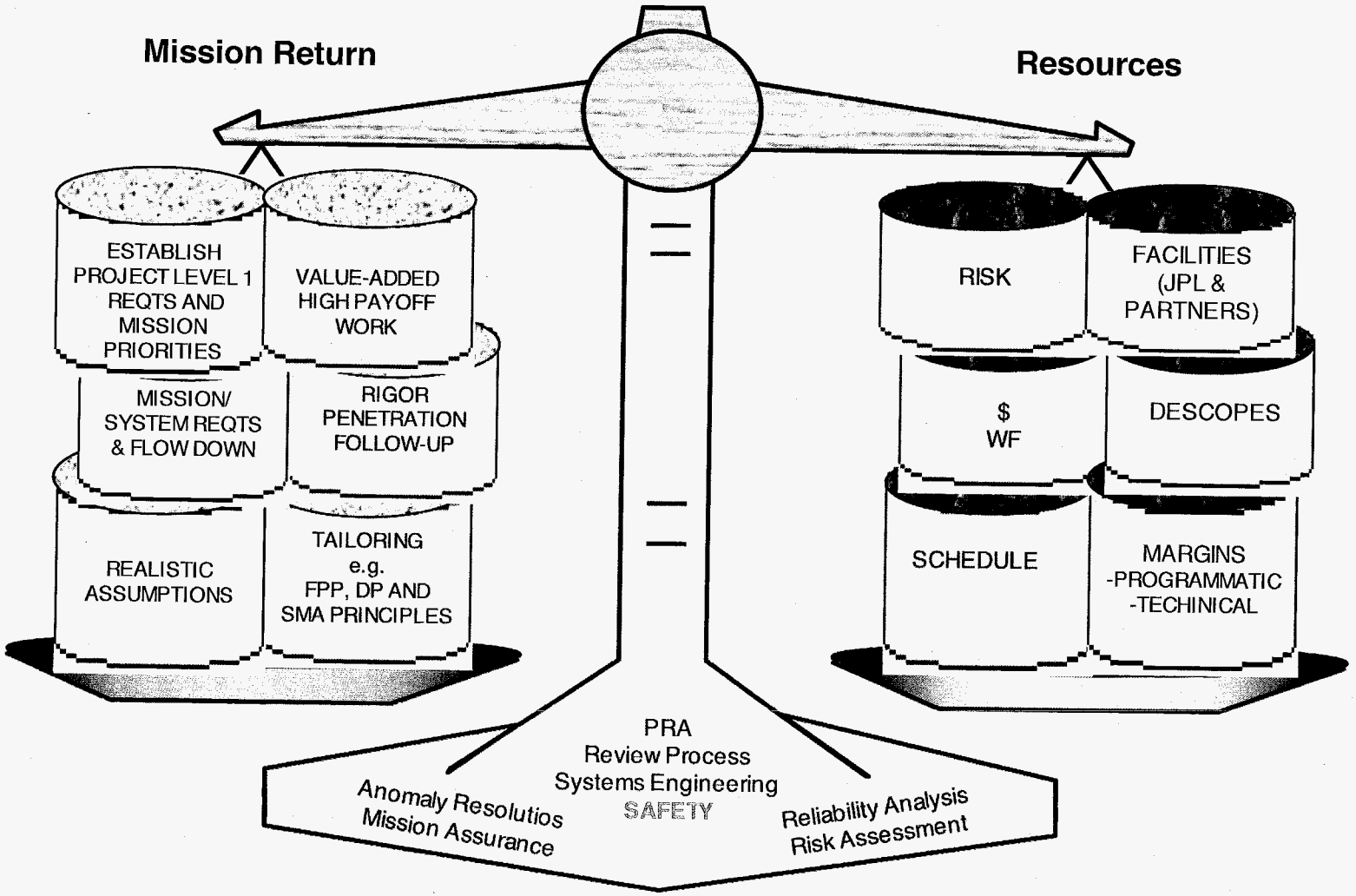
Balancing Mission Return With Mission Resources



Attributes of a Successful Mission Assurance Program

- Skilled, trained, motivated professional MA personnel
- Ability to be independent and still be viewed as value added
- Proactive, fully Integrated organization with defined roles and responsibilities
- Buy-in by the institution and partnership with the Project/Line Organizations
- Upper management commitment
- Continuous training for MA personnel and institution personnel
- Rigorous anomaly reporting process
- Incorporation of Lessons learned into operations and always have Continuous Improvement
- Well documented requirements, processes/procedures
- Work closely with the Safety organization

Attributes of a Successful Mission Assurance Leader

Ability to:

- Obtain upper management support
- Recruit talented staff and develop a team environment
- Have a solid knowledge of the product line (e.g. spacecraft, science instruments)
- Walk the fine line of independence and while still providing useful recommendations
- Identify major risk areas
- Have a trusting/working relationship with the project managers
- Tough skin

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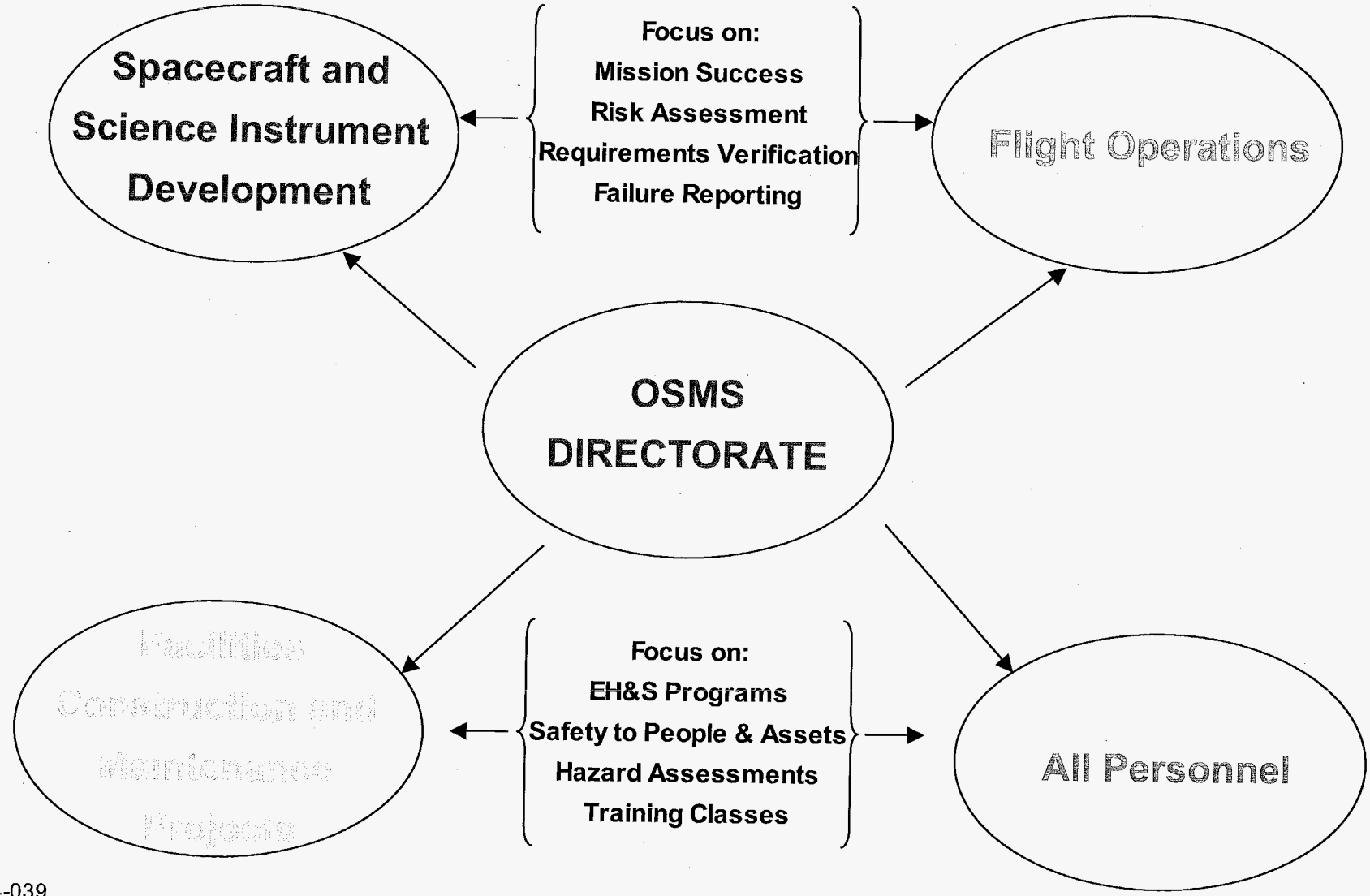
OSMS Directorate

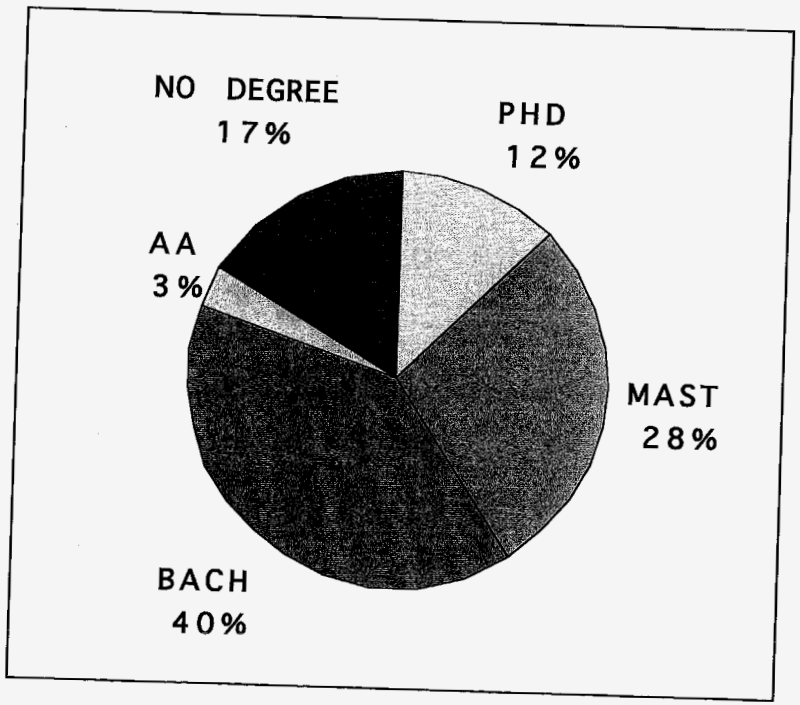


Mission Assurance Office

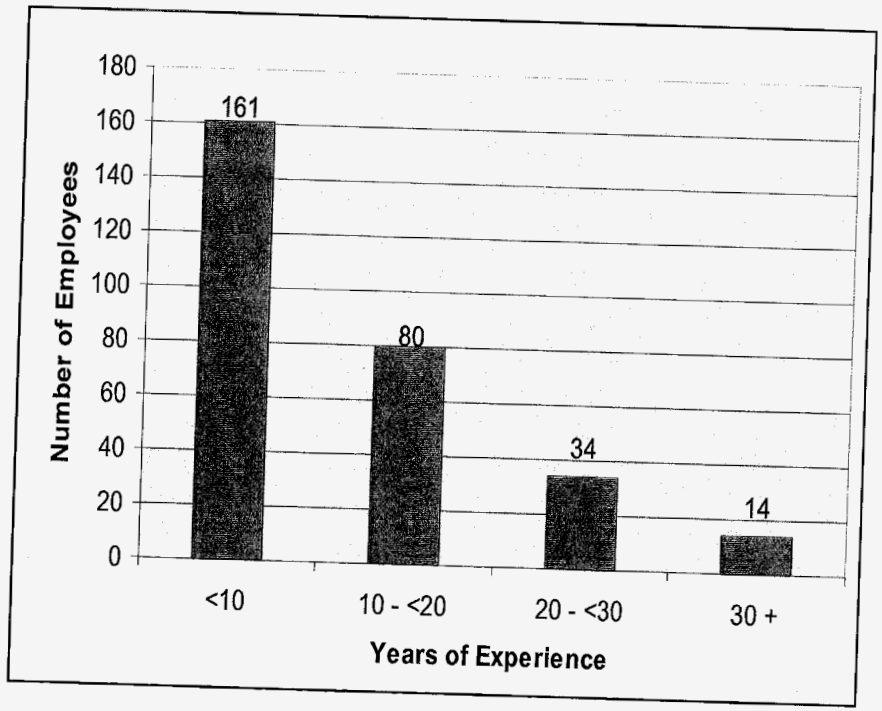
- Reports to the Director for OSMS.
- Comprised of a total of 273 personnel.
- Proactively participates with Projects to enhance the prospects for mission success.
- Provides Mission Assurance Managers (MAMs) to coordinate SMA discipline activities to Projects.
- Performs independent technical review and risk assessment of development issues and problem reports/anomalies.
- Provides Mission Assurance training to line managers/engineers/technicians on a regular/as-needed basis.

OFFICE OF SAFETY AND MISSION SUCCESS (OSMS)
JPL EMPLOYEES (289)
AS OF APRIL 2005

DEGREE DISTRIBUTION



TOTAL EXPERIENCE



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Mission Assurance Disciplines

Mission Assurance Requirements

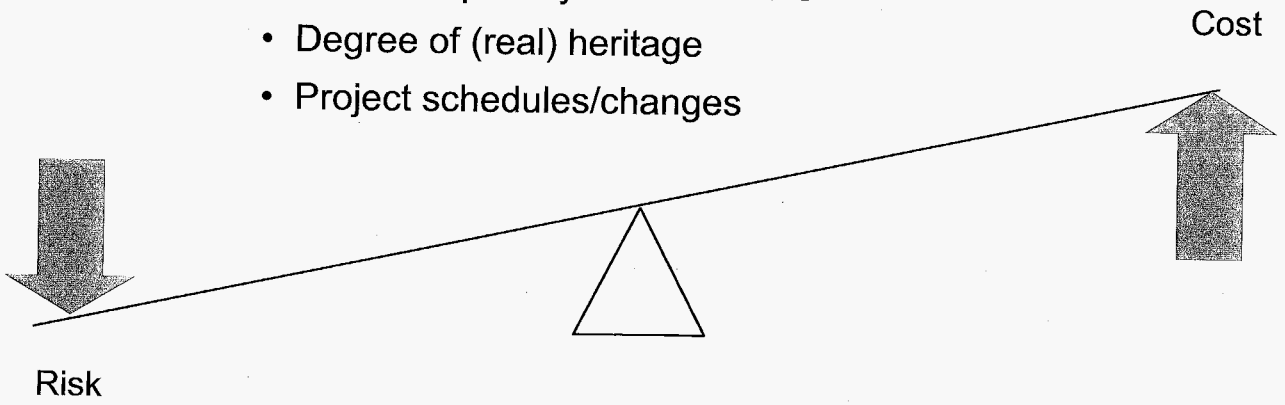
- Developed via active Mission Assurance participation in all projects/proposals from Pre-phase A through Operations
  - The earlier the better
- Structured around project's needs, constraints, risk posture and documented in Mission Assurance Plan
  - We define the program together
- Implemented through the Mission Assurance Manager (MAM) and his/her team
  - Key project team member

Timely identification of the right Mission Assurance requirements is necessary for smooth implementation and cost control

MA Requirements Tailoring

Factors we consider:

- Risk posture of project
- Visibility/importance to laboratory
- Mission Complexity
- Hardware and Software complexity
- S&MA Capability of contractors
- Degree of (real) heritage
- Project schedules/changes



MA Interaction with Projects

- MA plays a principal role in assuring safety and mission success by being a proactive contributor, providing independent checks/balances and independent risk assessments/reporting.
- MA facilitates managing risk (e.g. balancing of risk across the systems).
- Provides Mission Assurance discipline experts(e.g. QA, Reliability, Electronic Parts, Environmental).
- Assigns Mission Assurance Managers to projects. The managers are matrixed from OSMS to each Project and report directly to the project manager and to the independent MA senior management and Director.
- MA management and the project management negotiate project support and budget consistent with the project/program and JPL/NASA accepted risk level.

MA Interaction with Projects (Cont'd)

- MA-assigned managers are active participants in project decision making, technical design/implementation reviews, and also responsible for the implementation of the anomaly reporting process.

- MA senior managers, independent from the Project, participate as review board members at Risk Reviews and Mission/System Reviews, e.g., PMSR, PDR, CDR, ARR and CERR.

- MA-assigned managers meet weekly with Chief Mission Assurance Managers to discuss critical project and cross-project issues.

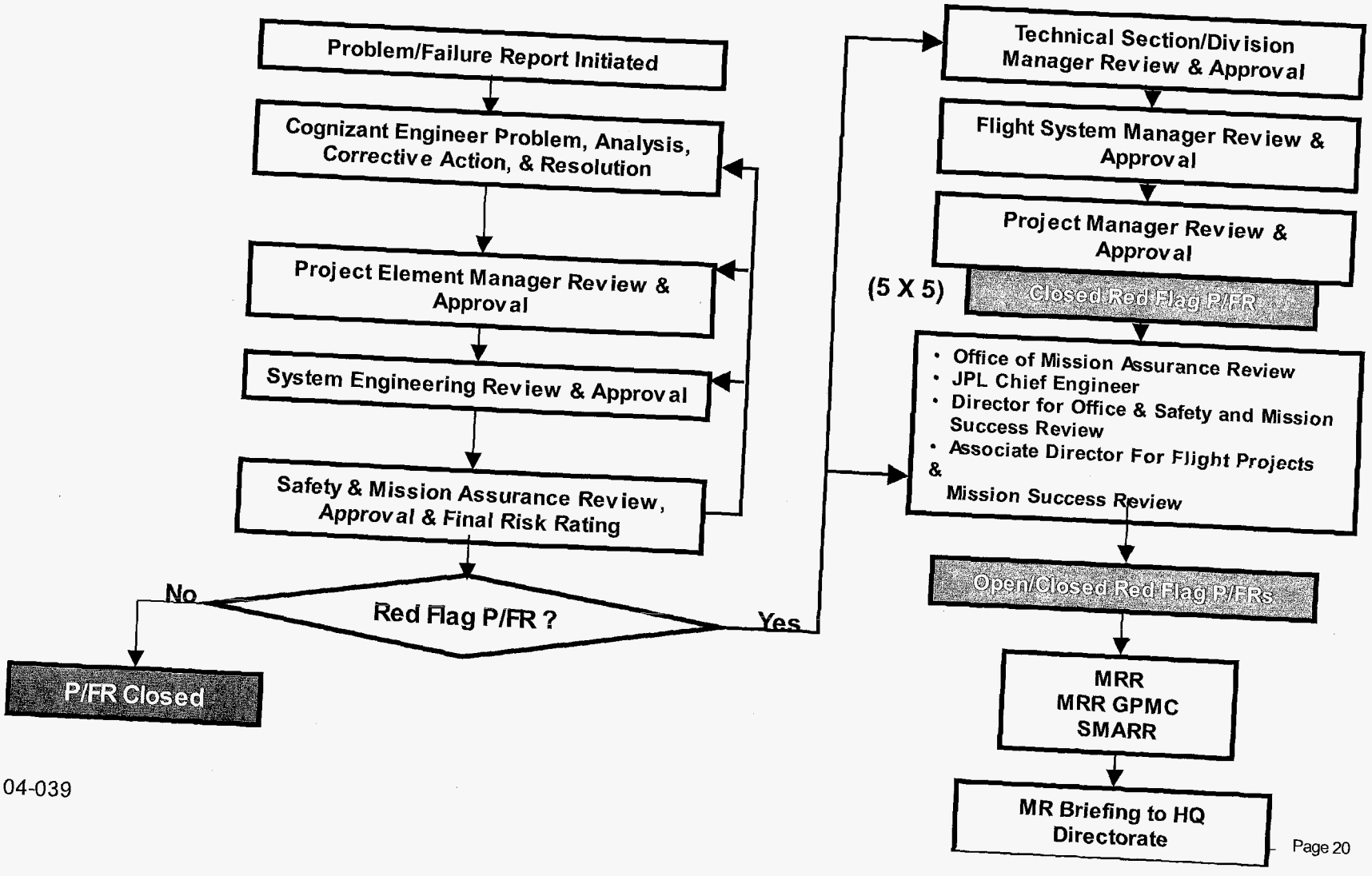
- MA-assigned managers meet monthly with senior MA managers to discuss/assess the risk status each Project (Fever Charts) covering all safety and mission assurance disciplines.

- The results of the monthly reviews are documented and reviewed with the OSMS Director and provided to project managers and JPL Senior Management.

Examples of Key Mission Assurance Processes

- Anomaly Reporting
- Monthly Fever Chart Report
- NASA 5X5 Risk Matrix

Problem / Failure (P/FR) Process



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Name of Project
Name of MAM

OSMS (51X)	MAM	SAFETY	QA	SQA	Config. Mgmt.	Reliability / Env.	Elect. Parts	Mat'ls/ Proc	Flight Ops	IV&V	Cont. Control
Y	Y					Y	R				

- **Issue (For Yellow or Red Risk Rating):**

- **Open date:**

- **Resolution Plan:**

- **Status:**

- **Expected Closure:**

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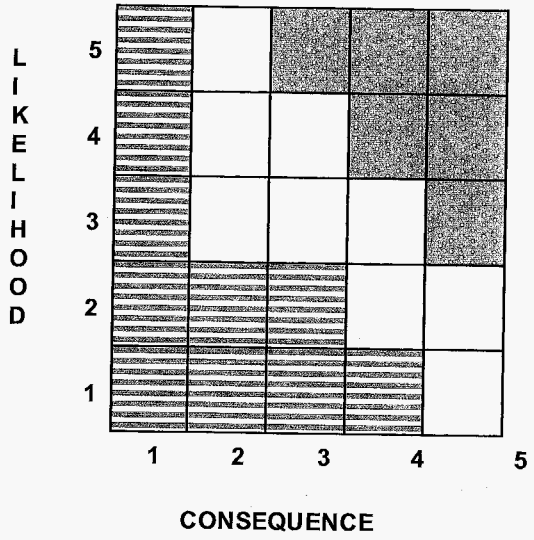
NASA 5X5 Risk Matrix

Risk Matrix



Risk Assessment Criteria for Consequence and Likelihood

Risk Type (either or both may apply to each risk)

Mission Risk

Consequence of Occurrence

Level Mission risk Level Definitions

5 Mission Catastrophic – no data return
4 Significant reduction in mission return (cannot meet minimum mission success)
3 Moderate reduction in mission return (cannot meet full mission success)
2 Small reduction in mission return
1 Minimal (or no) impact to mission

Likelihood of Occurrence

Level Likelihood Level Definition
5 Very High - almost certain
4 High - more likely than not
3 Moderate - significant likelihood
2 Low - unlikely
1 Very Low - very unlikely

MA Principal Documents

- JPL Flight Project Practices
- JPL Design, Verification/Validation and Operations Principles for Flight Systems
- Standard for Anomaly Resolution
- JPL Project Reviews
- Mission Assurance Principles
- Mission Assurance Manager Handbook
- Risk Management for JPL Projects
- Annual Operating Agreement(AOA) with NASA Office of Safety and Mission Assurance(OSMA)

Summary

Based on the JPL experience, a technically strong, independent MA organization is fundamental to enable mission success and doing it safely.