# Discovery Announcement of Opportunity (AO) Preproposal Conference Technical, Management and Cost (TMC) Evaluation

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July 1, 2010

# Outline

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II. Evaluation Flow
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# Introduction

**The NASA Science Mission Directorate (SMD) SOMA was established in 1996 to support the Discovery and Explorer Programs, now also supports the New Frontiers (NF), Mars Scout, Earth System Science Pathfinder (ESSP), Living With a Star (LWS) and Solar Terrestrial Probes (STP) programs, and others. The TMC process is a standard process used by SOMA to support all SMD evaluations.**

**The TMC evaluation is to determine, for each Proposal, the level of risk of accomplishing the scientific objectives of the investigation, as proposed, on schedule and within cost.**

**There are three possible Risk Ratings: Low, Medium, and High**

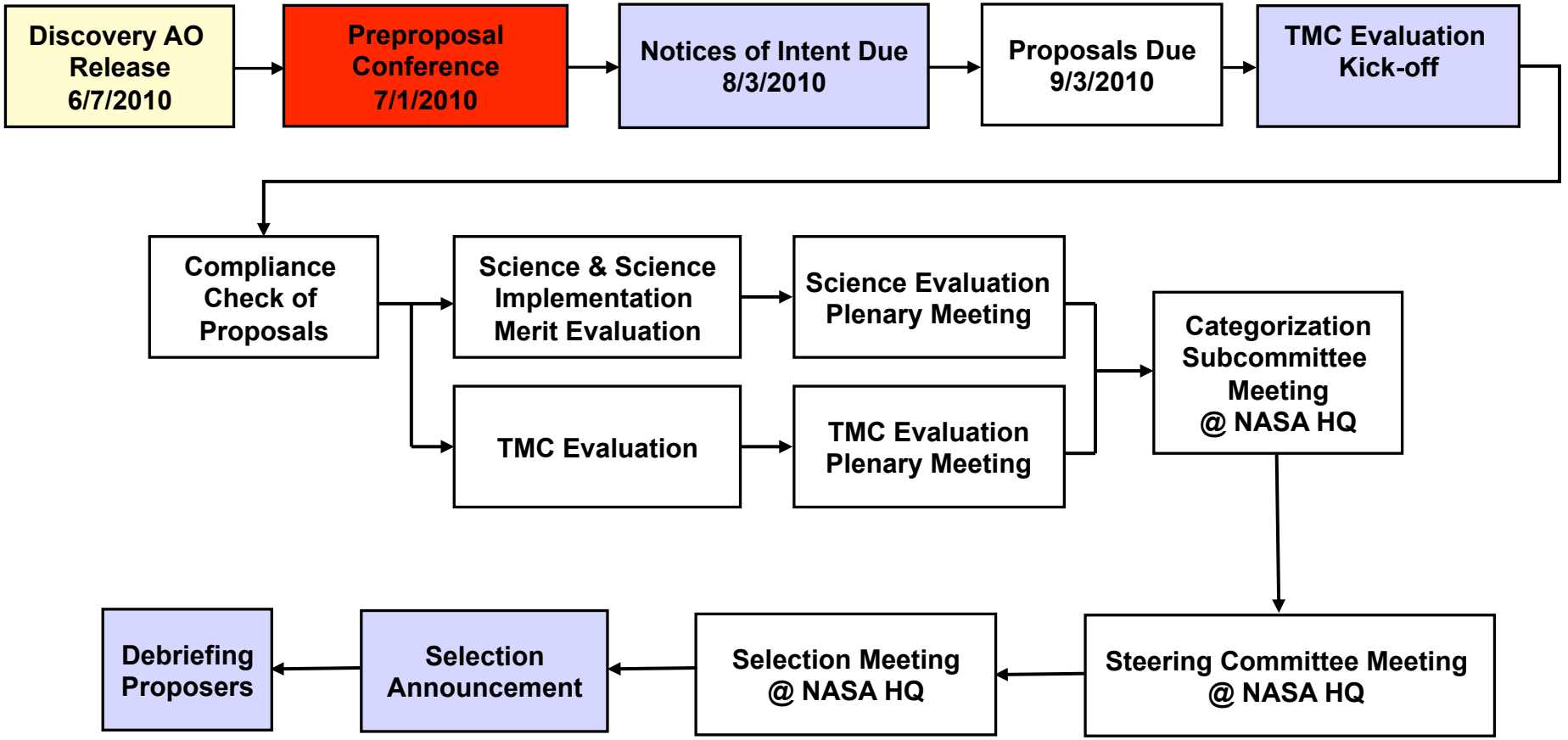
–**Low Risk:** There are no problems evident in the proposal that cannot be normally solved within the time and cost proposed. Problems are not of sufficient magnitude to doubt the Proposer's capability to accomplish the investigation well within the available resources.

–**Medium Risk:** Problems have been identified, but are considered within the proposal team's capabilities to correct within available resources with good management and application of effective engineering resources. Mission design may be complex and resources tight.

–**High Risk:** One or more problems are of sufficient magnitude and complexity as to be deemed unsolvable within the available resources.

# Evaluation Flow





# Preliminary Major Weaknesses

- We have allowed more time in the evaluation schedule so we can send proposers the full text of any preliminary Major Weaknesses at the end of the first week of the two-week TMC plenary
- Proposers without any preliminary Major Weaknesses will be notified that is the case
- Responses to preliminary Major Weaknesses will be considered at the beginning of the second week of the TMC plenary
- Proposers will be notified ahead of time when any preliminary Major Weaknesses or the notice that there are none will be sent and when the response is due

# New Technology Policy

- Proposers can chose to use one and only of the new technologies incentivized in AO, if they do
  - NASA is responsible for developing the new technology to TRL 6 by KDP-C (Confirmation), and
  - No backup plan is required
- Proposals with new technology not incentivized in AO must have a
  - Plan to mature the new technology to TRL 6 by KDP-C (Confirmation), and
  - A backup plan in case the new technology cannot be matured

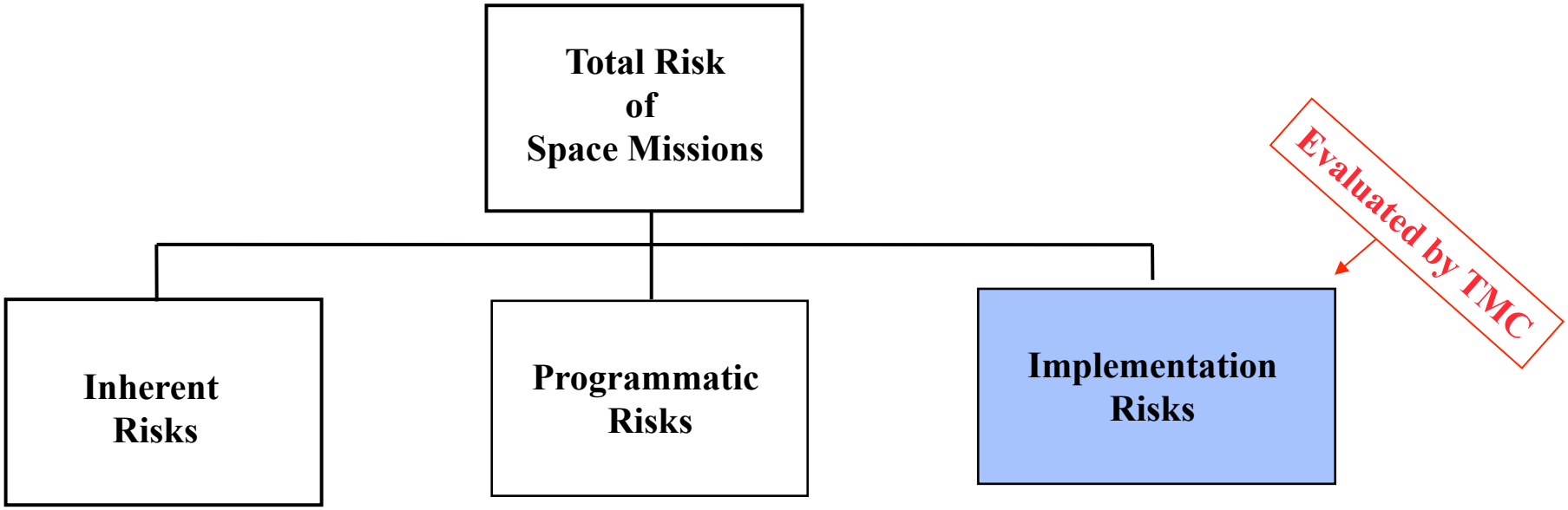
# New Technology Past Preparations

- Reviewed NF evaluation of new technologies incentivized in AO
- Reviewed NF and Discovery AO language and library documents on incentivized new technology
- Participated in NF lessons learned
- Preliminary identification of evaluation team members with expertise in Advanced Stirling Radioisotope Generator (ASRG), Solar Electric Propulsion (SEP), and Aerocapture
- Participated in the ASRG
  - System Requirements Review
  - Requirements Validation Review

# New Technology Future Preparations

- Have program offices developing technologies and tools for NASA
  - Present status to Discovery evaluation team
    - Discuss whether the AO is asking for the information needed and that can be expected from step 1 proposals
    - Discuss the information needed to use the SEP tools provided to the proposers and others
  - Recommend additional reviewers
- Decide whether to propose changes to the:
  - AO
  - Frequently Asked Questions
  - Material in the library

# Risks Evaluated by TMC Process




Risks that are unavoidable to do the investigation:

- Launch environments
- Space environments
- Unknowns
- Etc.

Risks that are uncertainties due to matters beyond project control:

- Environmental Assessment approvals
- Budgetary uncertainties
- Political impacts
- Etc.

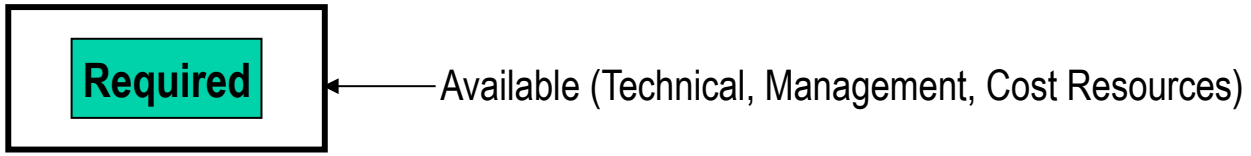
Risks that are associated with implementing the investigation:

- Adequacy of planning
- Adequacy of management
- Adequacy of development approach
- Adequacy of schedule
- Adequacy of funding
- Adequacy of Risk Management (planning for known & unknown)

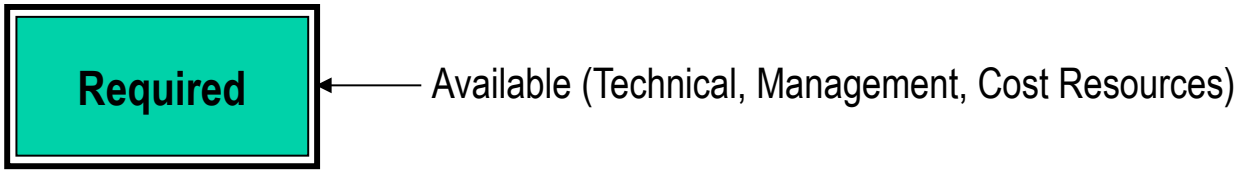
# TMC Envelope Concept

**Envelope:** All TMC Resources available to handle known and unknown development problems that occur. Includes schedule and funding reserves; reserves and margins on physical resources such as mass, power, and data; descope options; fallback plans; and personnel.

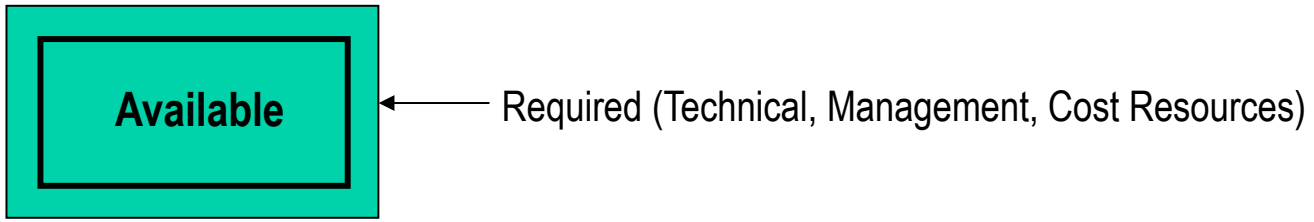
**Low Risk:** Required resources fit well within available resources

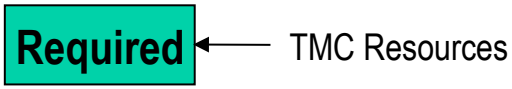


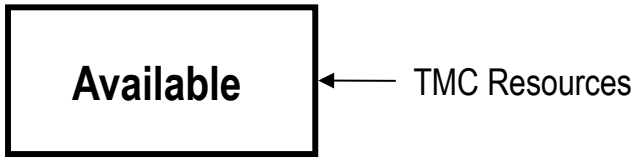

**Medium Risk:** Required resources just barely inside available resources. Tight, but likely doable




**High Risk:** Required resources DO NOT fit inside available resources. Expect project to fail



# Principles of the TMC Evaluation

- **Basic Assumption**: Proposer is the expert on his/her proposal.
  - **TMC:** Task is to try to validate proposer's assertion of Low Risk.
  - **Proposer:** Task is to provide evidence that the project is Low Risk.
  - Proposer given the benefit of the doubt in step one.

- **All Proposals will be reviewed to identical standards.**
  - All proposals receive same evaluation treatment in all areas.
  - Proposals are not compared to each other.

- **TMC Panel is made up of evaluators that are experts in the areas of the proposals that they evaluate.**

- **TMC Panel develops findings for each proposal that is the consensus of the entire TMC panel.**
  - Findings: As expected (no finding), above expectations (strengths), below expectations (weaknesses).
  - Only Major Strengths and Major Weaknesses are considered in determining the overall Risk rating.
- The final TMC evaluation product is an Evaluation Form.

# TMC Evaluation Factors and Sub-Factors

**Generally, the degree to which Proposals address the following factors directly relates to the grade of Low, Medium, or High Risk:**

- Instrument
  - Instrument design, accommodation, and interface
  - Design heritage
  - Environment concerns
  - Technology readiness
  - Instrument systems engineering
- Mission Design and Operations
  - Launch mass margin
  - Delta-V and propellant margins
  - Trajectory analysis
  - Launch services
  - Concept of mission operations
  - Ground facilities – new/existing
  - Telecom
  - Planetary protection
- Flight Systems
  - Hardware/software design
  - Design heritage
  - Spacecraft systems engineering
  - Design margins (excluding launch mass)
  - Qualification and verification
  - Assembly, test, and launch operations
  - Mission assurance
  - Development of new technology
  - Entry, descent, and landing
- Management and Schedule
  - Roles and responsibilities
  - Team experience and key individuals' qualifications
  - Project management and systems engineering
  - Organizational structure and Work Breakdown Schedule (WBS)
  - International participation
  - Risk management, including descope plan and decision milestones
  - Project-level schedule
  - Small Disadvantaged Business (SDB) participation
- Cost
  - Basis of Estimate (BOE)
  - Cost realism and completeness
  - Cost reserves by phase
  - Comparison with TMC estimates (including parametric models and/or analogies)

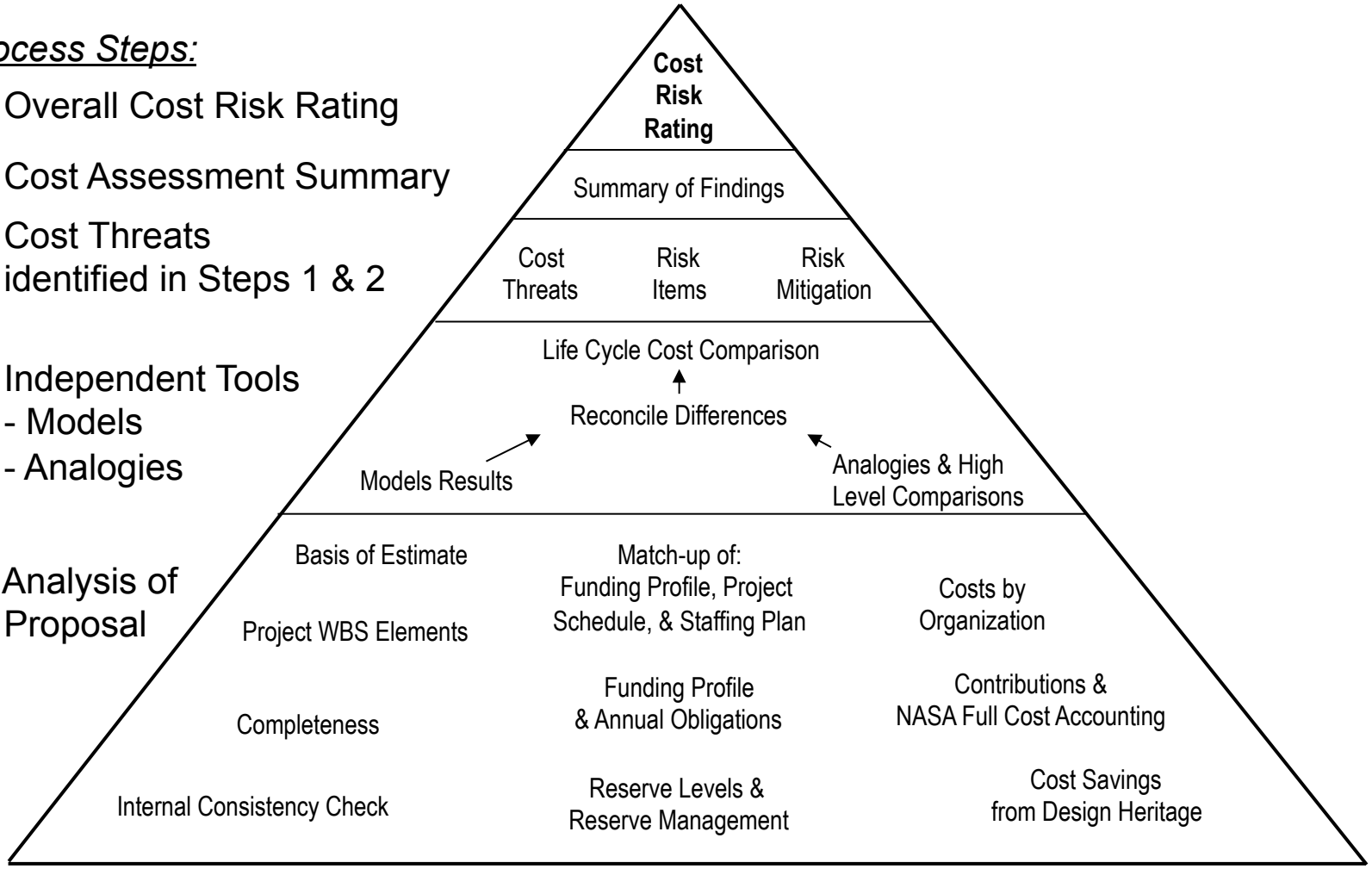
# Cost Evaluation Process

- Cost evaluation of Investigations will be accomplished using the same methodology.
- Cost analysis is accomplished based on information in the proposals (consistency, completeness, proposed basis of estimate, contributions, use of full cost accounting, maintenance of reserve levels, and cost management, etc.).
- Cost Realism is based on Models, Analogies, Heritage, and Grass Roots information in the proposals.
- Several independent cost models are used to analyze proposed cost.
- The cost threats, risks, and risk mitigation approach will be analyzed.
- Entire TMC Panel will participate in Cost deliberations and votes on Cost Risk.
- Cost Risk is reported in one of the following 5 categories: 1) Low Risk, 2) Medium-Low Risk, 3) Medium Risk, 4) Medium-High Risk, and 5) High Risk.
- The Cost Assessment and Cost Risk **are folded into the overall TMC Assessment and TMC Risk**.

# TMC Cost Assessment Pyramid

*Process Steps:*

5. Overall Cost Risk Rating
4. Cost Assessment Summary
3. Cost Threats identified in Steps 1 & 2
2. Independent Tools
   - Models
   - Analogies
1. Analysis of Proposal



# Typical TMC Questions to be Answered

- Will overall investigation approach allow successful implementation as proposed?
- If not, are there sufficient resources to correct identified problems?
- Does proposed design/development approach allow the investigation to have a reasonable probability of accomplishing its objectives and include all needed tools?
- Are requirements within existing capabilities or are advances required?
- Does the proposal accommodate sufficient resiliency in appropriate resources (e.g., money, mass, power) to accommodate development uncertainties?
- Is there a Risk Management approach adequate to identify problems with sufficient warning to allow for mitigation without impacting the investigation's objectives?
- Does the proposer understand the known risks and are there adequate fallback plans to mitigate them, including risk of using new developments, to assure that investigation can be completed as proposed?
- Is the schedule doable?
- Does it reflect an understanding of work to be done and time it takes to do it?

# Typical TMC Questions to be Answered (cont.)

- Is there a reasonable probability of delivering the investigation on time to meet Project Schedules?
- Does it include schedule margin?
- Will proposed management approach (e.g., institutions and personnel, as known, organization, roles and responsibilities, experience, commitment, performance measurement tools, decision process, etc) allow successful completion of investigation? Is the role, qualifications, and experience of the Management Team commensurate with the technical and managerial needs of the investigation?
- Does the investigation, as proposed, have a reasonable chance of being accomplished within proposed cost?
- Are proposed costs within appropriate caps and profiles and does cost estimate cover all costs including full-cost accounting for NASA Centers?
- Are costs phased reasonably?
- Is there evidence in the proposal to give confidence in the proposed cost?
- Does the proposer recognize all potential risks/threats for additional costs or cost growth (e.g., late deliveries of components)?

# What Low Risk Proposals have in Common

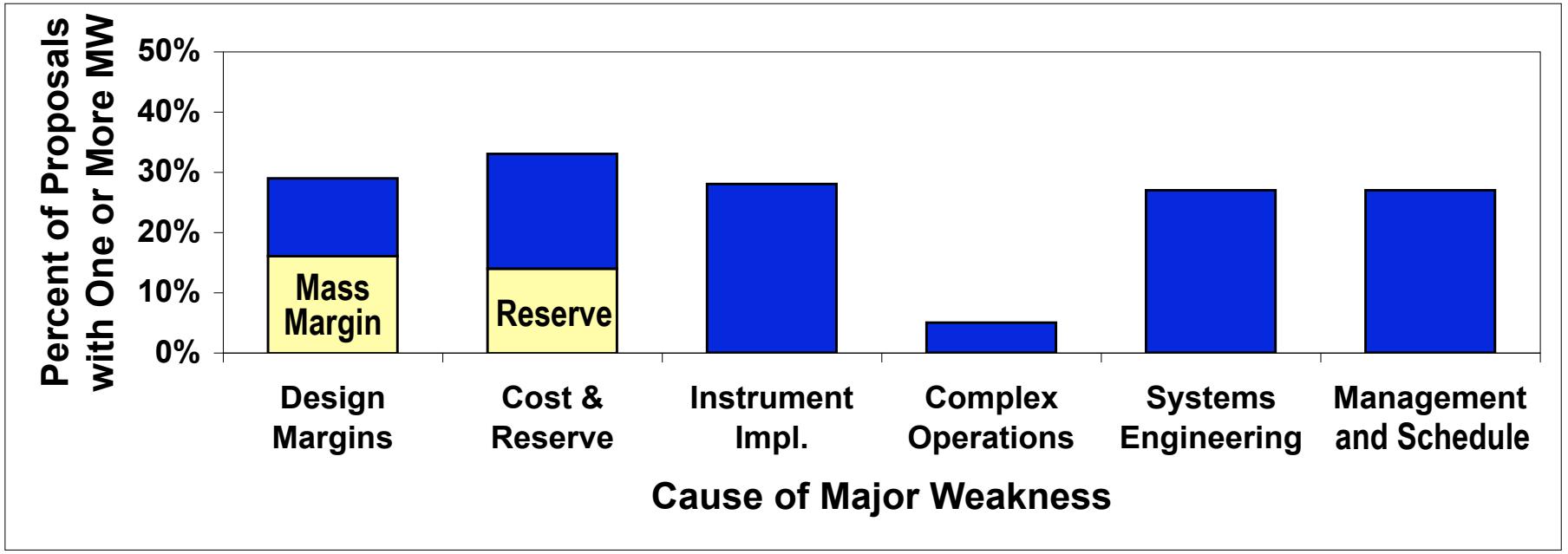
- All risks for the project have been/are being identified and managed by the team, with plans to reduce or retire the risk before launch.
- There is either a workaround planned for all risks or a very sound plan to develop and qualify the risk item for flight.
- The proposed project team and each of its critical participants are competent, qualified, and committed to execute the project.
- The project will be self managed to a successful conclusion while providing reasonable visibility to NASA for oversight.
- The team has thoroughly analyzed all project requirements, and the resulting resources proposed are adequate to cover the projected needs, including an additional percentage for growth during the design and development, and additional margin for unforeseen difficulties.
- Reserve time is included in the schedule to find and fix problems that may arise.
- Any contributed assets for the project are backed by letters of commitment.
- The team understands the seriousness of failing to meet technical, schedule, or cost commitments for the project in today's environment.

# Lessons Learned from TMC Reviews

Recommend reviewing causes of Major Weaknesses in paper on “Lessons Learned from Technical, Management, and Cost Review of Proposals” that is available through the SOMA website: http://soma.larc.nasa.gov

# Introduction

- Common causes for Major Weaknesses can be categorized in six areas noted below.
- The figure also shows the percentage of Step 1 proposals with one or more identified Major Weaknesses in each of these categories.
- Two issues, mass margin and cost reserve, are highlighted for special attention since they are prominent as sources of many Major Weakness findings.



# Common Causes of Major Weaknesses

- Technical Design Margins (Mass, Power, etc.)
  - Insufficient data provided from which to independently verify the margins.
  - No margin provided or conflicting data provided.
  - Margin provided deemed too low based on the maturity of the design.
- Cost
  - Concerns relating to cost reserve (Below AO requirement, too low based on liens/ threats, phasing inconsistent with anticipated needs).
  - Unable to validate proposed cost
- Instrument Implementation
  - Heritage claims not substantiated/development risks not adequately addressed.
  - Inadequate/inconsistent description and detail.
  - Inconsistencies between instrument requirements and bus capabilities.
- Complex Operations
  - More common in payloads containing multiple instrument that required tight scheduling/ sequential operations.
  - Inadequately addressing the challenges inherent in lander operations.

# Common Causes of Major Weaknesses (cont.)

- Systems Engineering
  - Incomplete flow-down of science requirements to payload/flight system accommodations.
  - Incomplete description of how the systems engineering function will be executed.
  - Inadequate resources allocated to accomplish this function.
- Management Plans
  - Confusing/conflicting organizational roles and responsibilities.
  - Lack of demonstrated organizational/individual expertise for specified role.
  - Insufficient time commitments for key personnel.
- Schedules
  - Insufficient detail from which to perform an independent assessment.
  - Inadequate/no schedule reserve identified.
  - Overly ambitious schedules that are not consistent with recent experiences.

# Mass and Power Margins

**Mass and power margins** were the most prevalent areas of concern:

Mass: Common reasons for Major Weaknesses:

1. Unable to verify the margin.
2. No mass margin was identified or the proposal contained conflicting statements.
3. Mass margins were too low based on the maturity of the proposed design, or required elements were omitted.
4. Confusion between mass contingency and mass margin.

Power: Common reasons for Major Weaknesses:

1. Margins were not calculated against the most critical or demanding operating mode.
2. Maneuver impulse budgets and propellant requirements could not be verified.
3. Could not verify and assess suitability of stated margins for both high-thrust and low-thrust propulsion systems.

The TMC review teams look for a competent engineering design that includes appropriate levels of contingency *and* margin, along with suitable rationale for the size of both.

# Common Causes of Cost Major Weaknesses

There are three common reasons why proposals received a cost Major Weakness:

1. Cost Reserve is too low.
   - A reserve level (percent of cost-to-go) is below the stated AO requirement.
   - Liens already identified against the reserves.
   - Reserves are too low to cover cost threats identified during evaluation.
   - Phasing of reserves in the funding profile is too late to be useful.
2. Basis of Estimate is flawed: Rationale and method is unconvincing or deficient.
3. Unable to validate proposer's cost estimate:
   - Multiple independent cost analyses are developed for each proposal.
   - A large uncertainty bar is added giving the benefit of doubt to the proposer.
   - A proposed cost that falls outside this cost range is likely to be flagged as a Major Weakness.

# Instrument Implementation

Areas of concern that produce Major Weaknesses include:

1. Complex new designs for which the development risks are not adequately addressed.
2. Inadequate or inconsistent description and detail that preclude a reasonable TMC evaluation.
3. Weak heritage claims.
4. Inconsistencies between instrument requirements and the spacecraft instrument accommodation capabilities.
5. Insufficient integration and test program including an end-to-end verification test.
6. Issues with pointing performance (knowledge, accuracy, etc.) and potential for detector contamination during flight.

# Complex Operations

Major Weaknesses related to the complexity of the proposed operations included:

1. Complex observing sequences for instruments:
   - For payloads consisting of several instruments that must be operated sequentially.
   - Where many critical events must occur in a short period of time.
2. Proposed landers that present additional operational challenges that may not be adequately planned.
3. Concept of operations not clearly defined and inadequate or incomplete explanation of how the operations planning will be developed and tested.

# Systems Engineering

Major Weaknesses for Systems Engineering seem to occur more often in earlier proposals. Recent experience seems to indicate an improvement in the number of Major Weaknesses in this area, perhaps in response to firm AO requirements for a traceability matrix to flow down science requirements to instruments, payload accommodations and flight systems.

More recent concerns that continue to produce Major Weaknesses in systems engineering are:

1. Incomplete or unconvincing plan for how systems engineering responsibilities will be executed across the entire project.
2. Implementation plan not providing for adequate resources for all participating organizations to successfully accomplish this function.
3. Underestimates of the cost of this function.

# Management and Schedule

The common causes of Major Weaknesses in project management are as follows.

1. Confusing organizational roles and responsibilities for the participating institutions or key individuals.
2. Unclear lines of authority within the project, or between the project and the participating institutions.
3. Lack of demonstrated organization or individual expertise for the specific role identified.
4. Low time commitments for essential members of the core management team.
5. Missing letters of commitment or endorsement from partners, as required by AO.

The common causes for Major Weakness in schedule are as follows:

1. Insufficient detail from which to perform a reasonable assessment of whether the proposer understands how all of the work will be accomplished in time.
2. The master schedule shows inadequate or no margin to address potential delays.
3. TMC assesses whether the proposed schedule reflects realistic expectations based on recent experiences in flight system and payload development. An area that receives special consideration is the plan for Assembly, Test, and Launch Operations (ATLO).

# Summary

- The results presented were derived from an analysis of all TMC proposal evaluation activity conducted by the SOMA during the period 1996-2005.
- The TMC review team looks for evidence of thorough designs and robust plans in all aspects of the proposed technical, management, and cost considerations. The final judgment of how well the proposal meets this expectation is the Implementation Risk Rating, which is summarized as Low, Medium, or High Risk.
- The primary consideration that raises a proposal's Risk Rating from Low to Medium or High is the Major Weaknesses identified during the Step 1 proposal review. Not all Major Weaknesses are of equal importance: One serious issue may be enough to convince the TMC review team that Risk Rating is High.
- Review of the 10-year history of proposal evaluations conducted by the SOMA identified six areas that are common causes of Major Weaknesses: 1) Design margins, 2) Cost issues, 3) Instrument implementation, 4) Complex operations, 5) Systems engineering, and 6) Management and Schedule Plans.

The goal of proposers should be to eliminate Major Weaknesses from their proposals.

# Supplemental Information

# TMC Key Technical Definitions

- **Contingency (or Reserve):** When added to a resource, results in the maximum expected value for that resource. Percent contingency is the proposed value of the contingency divided by the maximum expected value of the resource minus the contingency.

- **Margin:** The difference between the maximum possible value of a resource (the physical limit or the agreed-to limit) and the maximum expected value for a resource. Percent margin for a resource is the margin divided by the maximum possible value minus the margin.

- **Example 1:** A payload in the design phase has an estimated mass of 115 kg including a proposed mass reserve of 15 kg. There is no other payload on the ELV and the ELV provider plans to allot the full capability of the vehicle, if needed. The ELV capability is 200 kg. The mass reserve is 15/100 = 15% and the mass margin is 85 kg or 85/115 = 74%

- **Example 2:** The end-of-mission life capability of a spacecraft power system is 200 watts. The proposed instrument is expected to use 40 watts, and a 25% contingency is planned. If 75 watts is allotted by the satellite provider, the reserve is 10 watts and the margin is 25 watts, or 25/50 = 50%

# TMC Cost Risk Definitions

**TMC Cost Risk addresses the following questions:**

***1. Does the project have enough resources to perform the job they propose?***

***2. Are reserves adequate to cover threats, and still leave enough for typical unexpected problems?***

***3. Will resources be managed effectively?***

| Cost Risk | Definition |
|---|---|
| LOW | **Cost Envelope is adequate-expect success.**<br>• The proposer's estimate (with reserves) agrees closely with the work, staffing, and schedule proposed, fits within the program cap and any other budget constraints, and is verified by TMC independent analysis.<br>• The proposed cost reserve is adequate to address cost threats identified by TMC, and to fund unexpected needs.<br>• The resource management plan indicates strong, active management of resources throughout implementation. |
| MEDUIM-Low | **Cost Envelope is somewhat tight, but project should succeed.**<br>• TMC identified one or more significant cost threats or weaknesses with regard to the proposer's estimate, cost reserves, and/or resource management. Overall impact of identified threats and weaknesses should be manageable.<br>• TMC independent analysis verifies proposer's costs. |
| MEDIUM | **Cost Envelope is tight. Success requires diligent oversight of resources.**<br>• TMC identified one or more significant cost threats or weaknesses with regard to the proposer's estimate, cost reserves, and/or resource management. Cost impact of threats may be underestimated by proposer. Overall impact of identified threats and weaknesses should be manageable.<br>• TMC independent analysis verifies some or most of proposer's costs. |
| Medium High | **Cost Envelope is very tight. It is likely the project will require more funding.**<br>• TMC identified one or more major cost threats or weaknesses with regard to the proposer's estimate, cost reserves, and/or resource management. Cost impact of threats appears underestimated by proposer. Overall impact of identified threats and weaknesses will be challenging to manage within funding and/or schedule constraints.<br>• TMC independent analysis could not verify significant elements of proposer's costs. |
| HIGH | **Project exceeds the Cost Envelope and is expected to require substantially more funding.**<br>• TMC identified one or more major cost threats or weaknesses in the proposer's estimate, cost reserves, and/or resource management. Overall impact of identified threats and weaknesses exceeds proposed resources and/or available resources to cover them. Threats are not acknowledged, or are underestimated by proposer.<br>• TMC independent analysis could not verify proposer's costs. |