Small Explorers (SMEX)
and
Missions of Opportunity

Preproposal Conference

Technical, Management, and Cost (TMC) Evaluation

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Technical, Management, and Cost (TMC) Evaluation

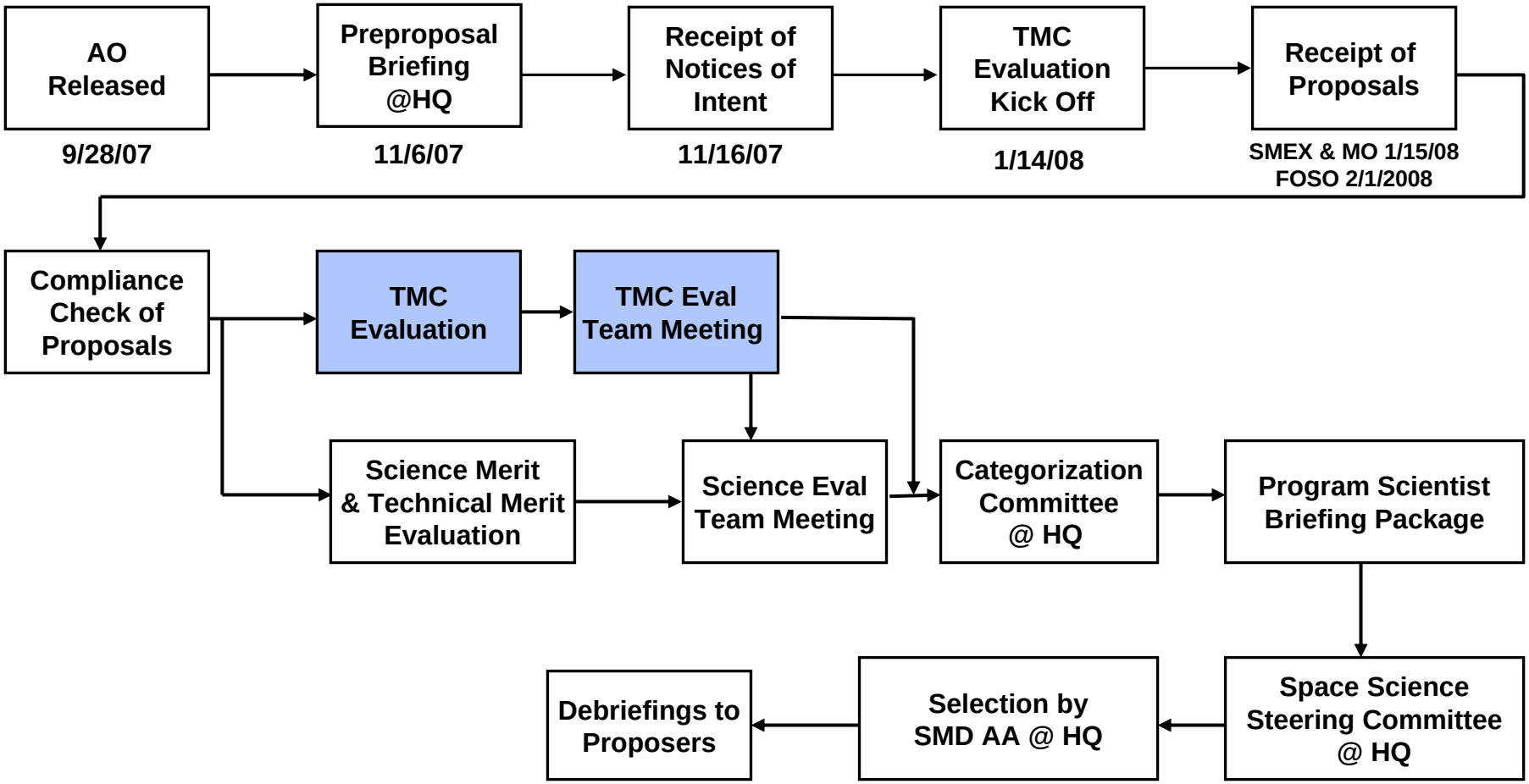
- Outline of TMC Overview
- The TMC evaluation role in the overall evaluation and selection process.
- SMEX AO Highlights related to TMC
- FOSO Amendment Highlights related to TMC
- TMC Evaluation Definitions and Process
- Characteristics of a Low Risk investigation
- Lessons Learned on previous proposals - pitfalls to avoid

Technical, Management, and Cost (TMC) Evaluation

- Three Evaluation Criteria and respective weighting are defined in section 8.2 of the SMEX AO
- The third criteria “Technical, management, and cost feasibility, including cost risk, of the proposed investigation” is generally referred to as “TMC”
- The TMC criteria is “weighted approximately 50%”
- Increased significance of TMC grade in selection.

SMEX 2007 Proposal Evaluation Process

SMEX Preproposal Conference



TMC Evaluation Criteria Section 8.2.4

"Each proposed investigation will be evaluated for its technical, management, and cost feasibility, including cost risk, as expressed in terms of specific major and minor strengths and weaknesses. The technical and management approaches will be evaluated to assess the likelihood that the investigation can be implemented as proposed. This includes an assessment of risk of completing the investigation within the proposed cost. The evaluation will consider implementation factors such as the overall mission design (i.e., "mission architecture"); spacecraft design and design margins; communication and navigation/tracking; and the proposers' understanding of the processes, products, and activities required to accomplish development and integration of all elements (flight systems, ground and data systems, etc.). This assessment will also consider the adequacy of the proposed organizational structure, the roles and experience of the known partners, the management approach, the commitments of partners and contributors, and the team's understanding of the scope of work (covering all elements of the mission, including contributions). The relationship of the work to the project schedule, the project element interdependencies, and associated schedule margins will also be evaluated."

TMC Evaluation Criteria Section 8.2.4

"For SMEX space flight investigations, this will also include an assessment of the likelihood of launching by the proposed launch date. Since it is recognized that teaming arrangements for implementing the mission may not be complete before the proposal closing date, proposers will not be penalized if the proposal indicates only candidate (but credible) implementation approaches for the spacecraft, launch vehicle, communications, and ground systems that should reasonably allow successful implementation of the mission. Mission resiliency (the flexibility to recover from problems) will also be evaluated. For SMEX missions, this will include an assessment of the approach to descoping the Baseline Mission to the Minimum Mission in the event that development problems force reductions in scope. Investigations proposing new technology, i.e., technologies having a Technology Readiness Level (TRL) less than 6 (see *TRL Definitions* in the EPL), will be penalized for risk if adequate backup plans to ensure success of the mission are not described**."**

TMC Evaluation Criteria Section 8.2.4

"The methods and rationale used to develop the estimated cost, and the discussion of cost risks, will be assessed. Mission proposals will be evaluated for the adequacy of the cost reserves; proposals with inadequate cost reserves, and those that do not demonstrate a thorough understanding of the cost risks, will be penalized. The single biggest item that reduces cost risk is complete and detailed basis of estimate, including complete cost model input data, vendor quotes, comparisons to similar analogous missions, etc.

The risk management approach the project team intends to use will be assessed, as will any risk mitigation plans for new technologies, any long-lead items, and the adequacy and availability of any required manufacturing, test, or other facilities.

The role, qualifications, and experience of the PI will be assessed, as will the commitment, spaceflight experience, and past performance of the PI and his/her implementing institution, against the needs of the investigation.

The role, qualifications, and experience of the PM will be assessed, as will the commitment and past performance of the PM and his/her implementing institution, against the needs of the investigation."

TMC Evaluation Criteria Section 8.2.4

"The plans for managing the risk of contributed critical goods and services will be assessed including the commitment of every partner as documented in letters of commitment and the adequacy of contingency plans for coping with the failure of a proposed cooperative arrangement.

Since partner MO investigations fly on non-SMD missions, factors involving spacecraft and launch vehicle capabilities will be considered in the evaluation only as appropriate. This evaluation will result in narrative text, as well as an appropriate adjectival rating."

The TMC will provide evaluation comments on portions of the SC criteria defined in section 8.2.5

"Student Collaboration (SC) elements are encouraged. SC elements will be evaluated for overall merit. Overall merit of an SC is a combination of 1) the science/engineering merit of the proposed SC investigation; **2) implementation merit of the SC based on technical, management, and cost feasibility of the SC, including cost risk, as expressed in terms of specific major and minor strengths and weaknesses;** and 3) and educational merit of the SC. These three factors are of equal value. **The SC must be non-impact to the rest of the mission, not add risk to the success of the primary mission, and be shown as clearly separable from the primary mission** as discussed in Section 4.8.2. **In order to achieve the SC objectives, inherently higher cost risk, schedule risk, or technical risk of the SC will be tolerated if and only if the SC is shown to be clearly separable from the primary mission.**

What is an SC?

"The SC may involve **development of an instrument**, investigation of scientific questions, **data analysis** or modeling, **development of supporting hardware or software, and/or other aspects of the mission. The activities may involve flight or ground systems.** For example, the Student Dust Counter aboard the New Horizons spacecraft was provided by a student team and included the students in the full spaceflight instrument experience while creating a real-world vehicle for teaching other students. SC elements involving only analysis of archival data are not allowed." Section 4.8.2

If a SC is proposed, **the proposal must provide details of the development schedule of the SC, including decision points for determining SC readiness for flight.** An SC may, but is not required to, have the potential to add value to the science or engineering of the mission. ***The proposer must describe how the SC can be incorporated into the mission on a non-impact basis. That is the SC may not increase the mission development risk or impact the development or performance of the baseline science investigation in any way that would cause the baseline mission to be compromised in the event that the SC component is not funded, encounters technical, schedule, or cost problems, or fails in flight. The SC must be shown to be clearly separable from the rest of the proposed effort. The inclusion of an adequate plan for the mentoring and oversight of students*** to maximize the opportunity for teaching, learning, and success in contributing to the mission is strongly encouraged."

"Although the cost of the SC must be included within the PI Mission Cost cap, **the cost of the SC must be identified separately from the proposed investigation**. If NASA selects the proposed mission, NASA may or may not fund the SC."

Section 4.8.2

To address SC implementation merit the **proposer must describe the SC unique instrumentation and/or data analysis. Each necessary individual of the SC team and their roles and responsibilities must be identified. The capabilities and experience of all members of the proposed SC team must be described. In addition, if an instrument is proposed, the description must identify the SC instruments and instrument systems, including their characteristics and requirements, and indicate items that are proposed to be developed, as well as any existing instrumentation or design/flight heritage. The SC payload observing profile and the SC data reduction and analysis plan must also be discussed, including the method and format of the data reduction, data validation, and preliminary analysis.** Section 8.2.5

How will the TMC evaluate student collaborations (SC)?
-The TMC will evaluate the student collaboration by applying its traditional criteria to determine technical, management and cost risk as appropriate (depending on what the student collaboration). This will result in the TMC risk rating of Low, Medium or High Risk to each proposed SC.
-The TMC will also comment on whether the SC is “clearly separable from the primary mission” given the guidance in section 4.8.2

-If the proposed SC is not separable from the baseline mission, then it will effect the baseline mission investigation TMC Risk rating.

-Make sure the SC is separable from the baseline mission. Provide separate cost and follow guidance in section 4.8.2

-If the AA does not select the SC, it should not affect your baseline mission proposal.

SMEX AO Highlights related to the TMC evaluation

"As part of their funded Phase E activities, investigation teams must include an appropriate period for data analysis independent of archiving activities. The proposal must explicitly demonstrate, analytically or otherwise, that sufficient resources have been allocated to insure that data will be calibrated, analyzed, published, and archived within the proposed mission cost." Section 4.3.1

Phase E – Operations and Sustainment - "Phase E is to include analysis and publication of data in the peer reviewed scientific literature and delivery of the data to an appropriate NASA data archive." Section 1.1

The TMC will have a finding on the adequacy of the proposed funding for MODA.

SMEX AO Highlights related to the TMC evaluation

Space Operations and Communication
"Common elements for the mission operations of Explorers include spacecraft command uplink and data downlink, radiometric tracking, mission control centers, orbit and attitude determination and level-0 data processing. NASA centers offer many services which may be available and cost-effective to proposing missions. Proposers are free to propose the use of services from sources other than those offered through NASA.
Costs for such services, whether obtained from NASA or other sources, must be included in the cost estimate. The proposal must include a letter of commitment from the service provider…Proposals to this AO **involving the use of SCaN services shall have a preliminary Project Service Level Agreement which will serve as the required letter of commitment** from the respective service commitment office(s) as to the nature and level of service that may be provided within the capacity of the applicable network." Section 4.4.3

SMEX AO Highlights related to the TMC evaluation

"All **contributions of critical goods and services must be described, the risks of these contributions must be described, and adequate contingency plans for coping with the failure of a proposed cooperative arrangement must be described**. "Section 4.5.5 Contributions, particularly non-U.S. contributions, offer benefits but also represent complexity and risk to a project. Therefore, **U.S. proposers must discuss mitigation plans, where possible, for the failure of funding or contributions to materialize when they are outside the control of the PI.**
Mitigation may include, but is not limited to, descoping the contributed items and/or **holding reserves to develop the contribution directly**. **Note that reserves held for this purpose will be considered by NASA to be encumbered. Section 4.7.6**

SMEX AO Highlights related to the TMC evaluation

Cost Reserve

"All **contributions of critical goods and services must be described, the risks of these contributions must be described, and adequate contingency plans for coping with the failure of a proposed cooperative arrangement must be described**. "Section 4.5.5

"mission proposals that are unable to show an adequate unencumbered reserve are likely to be judged a high cost risk and not selected. … an **adequate unencumbered reserve on the PI Mission Cost is measured against the cost to complete through Phases A/B/C/D/E/F and is a minimum of 30% including funded schedule reserve.** Adequate unencumbered reserves must be demonstrated in the proposal, in the Phase A Concept Study Report (i.e., at the end of Phase A), and at Confirmation (i.e., at the end of Phase B). Section 4.6.4

Note: For equation see Q&A50 under draft SMEX AO FAQ

Appendix B - Guidelines for Proposal Preparation

Appendix B provides instructions on what information must or should be provided.

If this information is not provided, a weakness may be noted in the evaluation.

Specific Topics areas with page limits are described in Table on B-2 and Appendix B text.

- Discuss the Small Disadvantage Business (SDB) subcontracting plan- Appendix B Sec H

--Within the page limit (see chart in this Appendix) and consistent with the specific guidance given in Sections 4.9 of this AO and Paragraph XIII of Appendix A, respectively, discuss the proposed Small Business Plan.

-Proposals must provide the information requested in Appendix B and must be compliant with all constraints, guidelines and requirements in AO.

If there is a conflict between AO and Appendix B and or Library documents, the AO takes precedence.

FOSO Amendment Highlights related to TMC

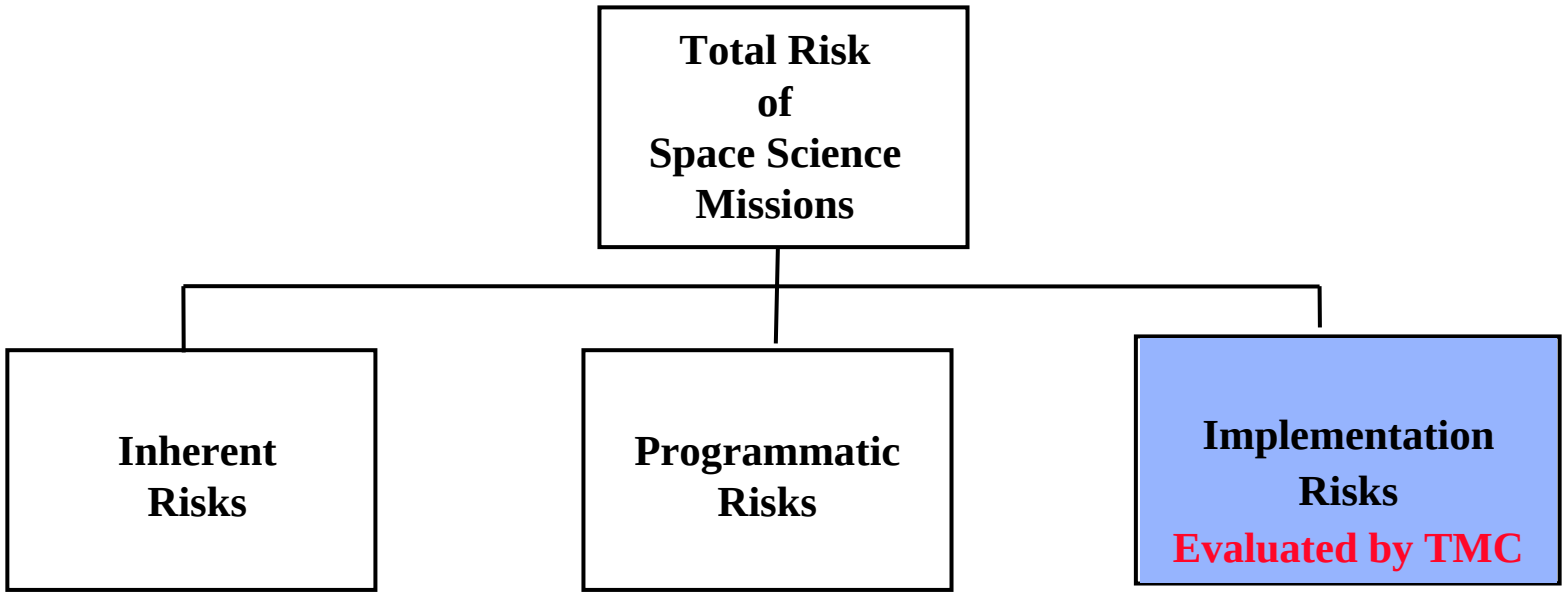
FOSO investigations will be evaluated against the criteria described in Section 8.2 of this SMEX AO.
These evaluation criteria are:

- Scientific merit of the proposed investigation;
- Scientific implementation merit of the proposed investigation; and
- **Technical, management, and cost feasibility, including cost risk, of the proposed investigation.**

In addition to the evaluation factors given in Section 8.2 of this SMEX AO, the evaluation of technical, management, and cost feasibility also includes the following factors:

- The extent to which the proposed instruments and sensors can be achieved within the resources available to Solar Orbiter instruments;
- The demonstration of a realistic plan to carry out all of the management responsibilities.
- The demonstration of a thorough understanding of the accommodation and environmental challenges for the Solar Orbiter mission; and
- The demonstration of a realistic cost and adequate reserves for all phases of the investigation.

Risks for Space Science Missions



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 Evaluation Objective

- **The TMC evaluation is to determine, for each Proposal, the level of risk of accomplishing the scientific objectives of the investigation, as proposed, on time and within cost.**
- **There are three possible Risk Levels: Low, Medium, and High**
  - **Low Risk:** There are no problems 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.
  - **Medium Risk:** Problems have been identified, but are considered within the proposal team's capabilities to correct with good management and application of effective engineering resources. Mission design may be complex and resources tight.
  - **High Risk:** Problems are of sufficient magnitude such that failure is highly probable.

TMC Principles for 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.
- **All Proposals will be reviewed to identical standards.**
  - Science Support Office established in 1996 by OSS to support Discovery and Explorer, now also supports New Frontiers, Mars Scout, and others.
  - The TMC process is used by SSO to support all SMD evaluations with a standard process.
  - All proposals receive same evaluation treatment in all areas.
- **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).

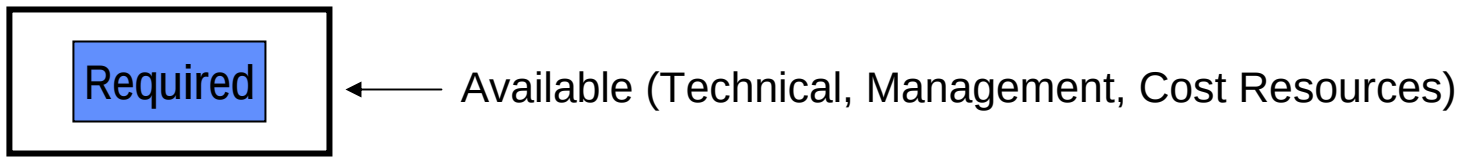
TMC Principles for Evaluation

- **AO Proposal Risk Assessment:**
  - The TMC Risk Assessment is based on a *preliminary concept*
  - The Cost Analysis is done without Proposer feedback and is integrated into overall risk.
- The final TMC evaluation product is an Evaluation Form with a Risk Rating as either Low, Medium, or High Risk.
- Only Major Strengths and Major Weaknesses are considered in determining the overall TMC Risk Rating.

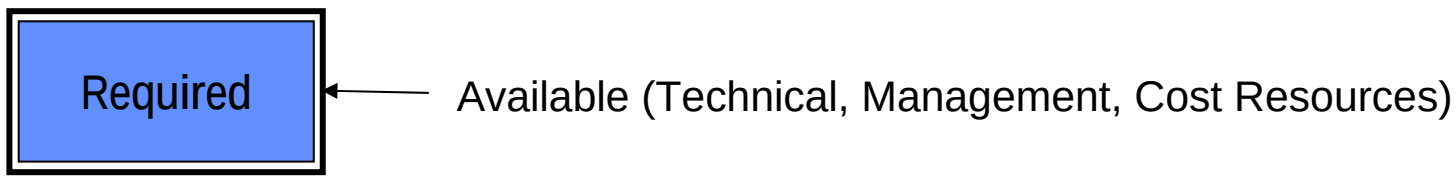
TMC Envelope Concept

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

TMC Evaluation Factors and Sub-Factors
SMEX Mission Investigation Proposals

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 (N/A for MO's)
  - Mass Margins
  - Trajectory Analysis
  - Launch Services
  - Concept of Mission Operations
  - Ground Facilities – New/Existing
  - Telecom
- Flight Systems
  - Hardware/Software Design
  - Design Heritage
  - Spacecraft Systems Design
  - Design Margins (Excluding mass)
  - Qualification and Verification
  - Assembly, Test, and Launch Operations
  - Mission Assurance
  - Development of New Technology
- Management and Schedule
  - Roles and Responsibilities
  - Team Experience and Key Individuals Qualification
  - 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
  - Proposed Subcontracting Plans and SDB Participation.
- Cost
  - Basis of Estimate (BOE)
  - Cost Realism and Completeness
  - Cost Reserves by Phase
  - Comparison with TMC Estimates (Including
  - Parametric Models/Analogies)

Cost Evaluation

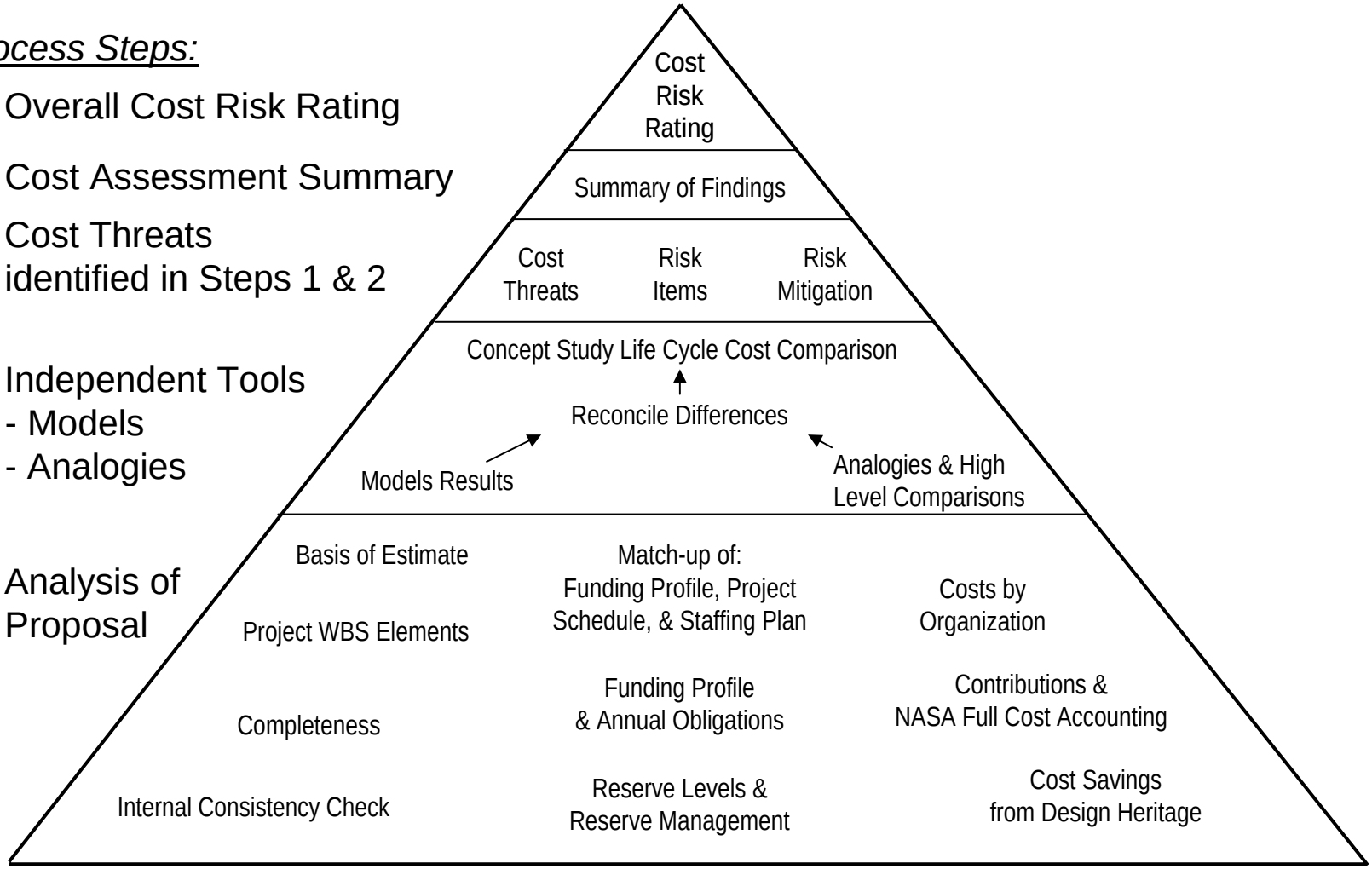
- Cost evaluation of Full Missions and MO's will be accomplished using the same methodology.
- Cost analysis is accomplished based on information in the proposals (consistency, completeness, proposed basis of estimate, contributions, use of full cost accounting, maintenance of reserve levels, and cost 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 analysis will be analyzed.
- Entire TMC Panel will participate in Cost deliberations and works to achieve consensus for 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 Independent Cost Assessment Pyramid

"The 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 Evaluation Questions to be Answered

- Will overall investigation approach allow successful implementation as proposed?
- If not, are there sufficient resources (time & $) to correct identified problems?
- Does proposed design/development 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?

Typical TMC Evaluation Questions to be Answered (cont'd)

- Is the schedule doable?
- Does it reflect an understanding of work to be done and time it takes to do it?
- 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 PM 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)?

Some Characteristics Applicable to a Low Risk Rating

- 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.
- No risk exists for which there is neither a workaround planned, nor 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 then a margin on top of that for unforeseen difficulties.
- Reserve time exists in the schedule to find and fix problems if things do not go according to plan.
- 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.

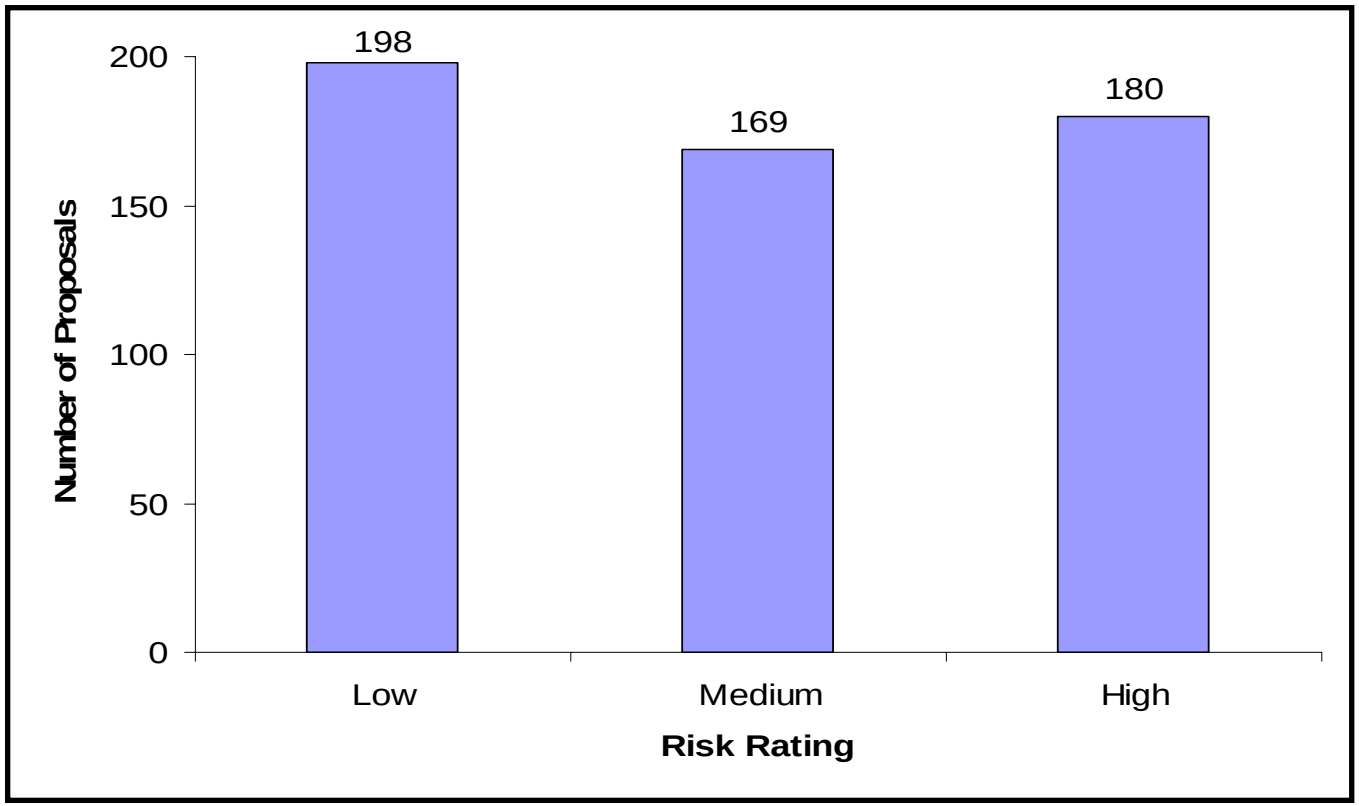
• Recommend reviewing causes of Major Weaknesses in paper on “Lessons Learned from Technical, Management, and Cost Review of Proposals” is available through the SMEX Library website section 7 Explorer Program Background.

Supplemental Information

Lessons Learned Summary
Historical Risk Ratings

A **Low Risk** proposal is one that TMC reviewers expect will accomplish its goals within the schedule and cost proposed.

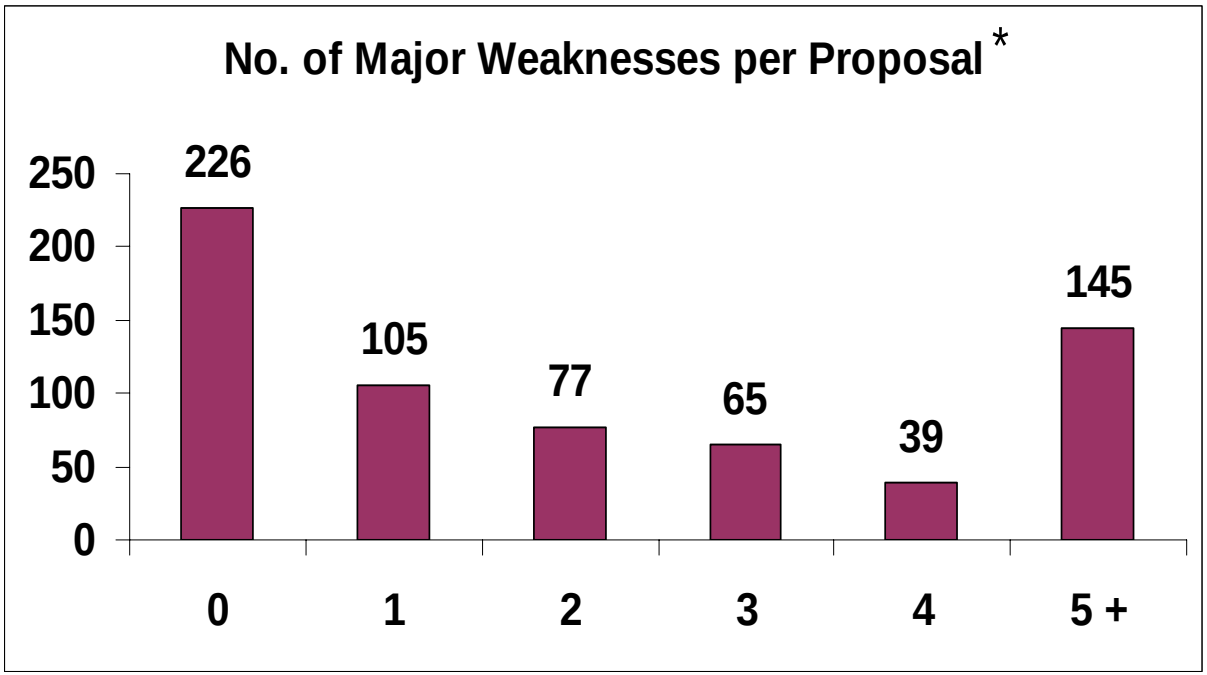
- Of the 547 proposals given a Risk Rating, only 198 (36%) received a Low Risk Rating.
- No full missions rated as High Risk by TMC have been selected for implementation.



Summary of Risk Ratings for Step 1 Proposals

Lessons Learned Summary
Major Weaknesses per Proposal

- Only 34% of proposals reviewed were judged to have no Major Weaknesses.
- The number and severity of Major Weaknesses directly affect the overall implementation Risk Rating.

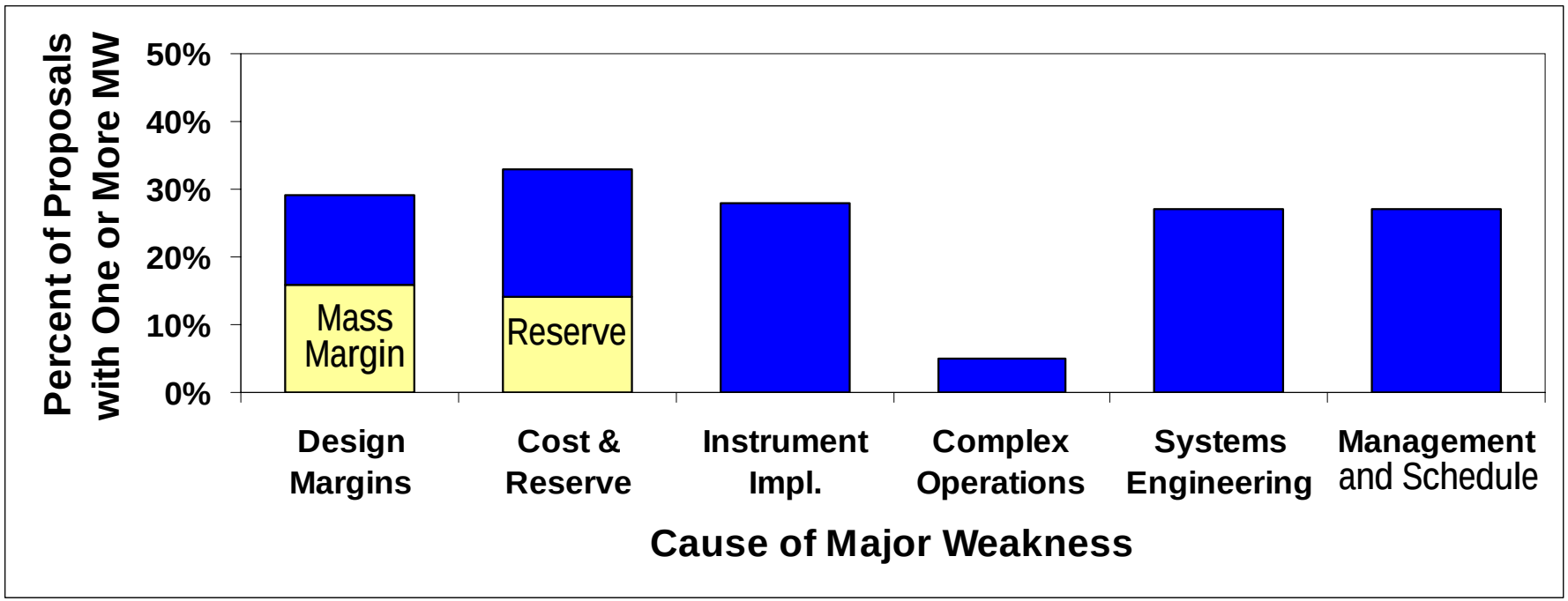


History of Major Weaknesses per Proposal Evaluated

* This chart includes 657 proposals. This number is greater than the 547 proposals as noted on the previous slide, since not all evaluations resulted in a TMC Risk Rating.

Lessons Learned Summary
Common Causes of Major Weaknesses

- 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.



Lessons Learned Summary from TMC Reviews (cont'd)

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.

Lessons Learned Summary from TMC Reviews (cont'd)

Common Causes of Major Weaknesses (cont'd):

- 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.

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

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 • 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. • The proposed cost reserve is adequate to address cost threats identified by TMC, and to fund unexpected needs. • The resource management plan indicates strong, active management of resources throughout implementation.
MEDIUM-LOW	Cost Envelope is somewhat tight, but project should succeed. • 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. • TMC independent analysis verifies proposer's cost.
MEDIUM	Cost Envelope is tight. Success requires diligent oversight of resources. • 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. • TMC independent analysis could not verify significant elements of the proposer's costs.
MEDIUM-HIGH	Cost Envelope is very tight. It is likely the project will require more funding.. • 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. • TMC independent analysis could not verify significant elements of proposer's costs.
HIGH	Project exceeds Cost Envelope and is expected to require substantially more funding. • 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 resources to cover them. Threats are not acknowledged, or are underestimated by proposer. • TMC independent analysis could not verify proposer's costs.

Common Causes of Major Weaknesses Design 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.

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.

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.

Common Causes of Major Weaknesses
Cost and Reserves

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.

Common Causes of Major Weaknesses 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.

Common Causes of Major Weaknesses 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.

Common Causes of Major Weaknesses 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.

Common Causes of Major Weaknesses 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 instruction.

Common Causes of Major Weaknesses Management and Schedule (concluded)

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 no margin or inadequate 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 SSO 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 SSO 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.