National Aeronautics and Space Administration

Heliophysics Explorers Program (HEP)
2022 Small Explorer (SMEX)
Concept Study Report (CSR): Guidelines and Criteria (G&C) / Technical, Management, and Cost (TMC) Evaluation

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Topics

Guidelines and Criteria for the Phase A Concept Study

The Guidelines and Criteria (G&C) document contains instructions for preparation of the Concept Study Report (CSR).

- A DRAFT version of the Guidelines and Criteria for the Phase A Concept Study document is on the main 2022 Heliophysics Small Explorers page: https://explorers.larc.nasa.gov/HPSMEX22/ *(update will posted after final approval).*
- Requirements are designated as CS-1 to CS-131.
- Note the following language from the document:
  - All program constraints, guidelines, definitions, and requirements specified in the AO are applicable to the CSR (e.g.: Cyber Security, CARA, etc.…).
  - Only new requirements and modified requirements appear in the Guidelines and Criteria for the Phase A Concept Study document.
  - In case of conflict between the SMEX AO and the Guidelines and Criteria document, the Guidelines and Criteria document takes precedence.
  - **Each CSR must be a self-contained document** and must not refer to information contained in the Step 1 proposal.

Guidelines and Criteria for the Phase A Concept Study

All program constraints, guidelines, definitions, and requirements specified in the AO are applicable to the CSR, except as noted within the G&C document; examples of these exceptions include:

- Principal Investigators (PIs) will propose Level 1 requirements in their CSRs, including the criteria for full mission success that satisfy the Baseline Science Mission, and for minimum mission success that satisfy the Threshold Science Mission. (See AO Sections 5.1.5 and 7.4.4).
- The PI-Managed Mission Cost (PIMMC) may not increase by more than 20% from that in the Step-1 proposal to that in the CSR, with adjustments as applicable, and in any case, may not exceed the ($150M FY22$) Cost Cap specified in the AOs. (See AO Sections 4.3.1 and 7.4.4).
- NASA intends down-selected investigations to be implemented as Category 3 projects (per NPR 7120.5) with Class D payloads (per NPR 8705.4, Risk Classification for NASA Payloads). NPR 7120.5 and NPR 8705.4 are available in the Program Library. (See AO Section 4.1.4).
- Heliophysics Explorer missions are required to meet the requirements for safety, reliability, and mission assurance as specified in the Science Mission Directorate (SMD) Policy Document (SPD)-39, SMD Standard Mission Assurance Requirements for Payload Classification D document in the Program Library. (See AO Sections 4.1.2 and 5.2.8).
- The Enhancing TDO incentive will be provided at the beginning of Step 2 and is expected to be approximately $3M FY22$ for the SMEX investigations. (See AO Section 5.2.3).
- Small business subcontracting plans are required, covering Phases B/C/D/E/F.

Guidelines and Criteria for the Phase A Concept Study

- The format of the CSR is specified in Sections A through L.
- The CSR Structure and Page Limits are specified in Table 2 on page 16.
  - 2 pages for Fact Sheet and 6 pages for Executive Summary.
  - 34 pages for Science Investigation (highlight changes from Step 1).
  - Sections E through H: 110 for full mission or 84 for missions of opportunity
  - No page limit for Cost Proposal + Justification and Cost Proposal for optional SEO.
  - + 2 pages for each additional separate, non-identical instrument or flight element
  - + 3 pages for proposals utilizing PI-provided access to space
  - + 10 pages for science enhancement options (SEOs) combined, if proposed
  - + 10 pages for Enhancing Technology Demonstration Opportunities (TDOs) combined, if proposed
  - + 5 pages for Student Collaboration (SC), if proposed
  - + 5 pages for Citizen Science (CS), if proposed
  - No page limit for Section L Appendices
- Appendices shall not be renumbered.

Guidelines and Criteria for the Phase A Concept Study

- All CSR required files must be submitted electronically via NASA box NLT 4 p.m. ET, August 7, 2024. [See CS-5 for details]
- -Electronic CSRs shall be unlocked, bookmarked, and searchable PDF file(s) – limited to the main body of the CSR, all tables and appendices – as well as all other required electronic files as specified in CS-7 (Schedule, MEL, all cost tables, etc.).
- Materials identified as subject to U.S. export laws and regulations, in accordance with the Heliophysics Explorers Program 2022 Small Explorer (SMEX) Announcement of Opportunity (AO) Section 5.8.3 must be marked.

Modified Criterion C Factors

- All of the Technical, Management, and Cost (TMC) Feasibility factors defined in AO Section 7.2.4 apply to the evaluation of the CSR
- All of the AO factors and the updated CSR factors are evaluated to ensure the CSR's technical, management, and cost feasibility are at least at a Phase A level of maturity.
- In the G&C document, changes from the AO are noted in italicized text. Some bullets on the major changes are noted below. More detail on each is provided in the G&C document.
  - ❖ Factor C-1. Adequacy and robustness of the instrument implementation plan
    - Adequacy of backup plans was added
  - ❖ Factor C-2. Adequacy and robustness of the mission design and plan for mission operations.
    - Details for ground systems, operational scenarios and timelines for each mission phase, operations team roles and responsibilities, and navigation/tracking/trajectory analysis are required
    - If proposed, PI provided access to space details are required.

Modified Criterion C Factors

- Factor C-3. Adequacy and robustness of the mission design and plan for mission operations.
  - An assessment of the adequacy of the plans for spacecraft systems engineering, qualification, verification, mission assurance, and launch operations.
  - The adequacy of the plan to mature systems within the proposed cost and schedule, the robustness of those plans, including recognition of risks and mitigation plans for retiring those risks, and the likelihood of success in developing any new technologies will be assessed.
- Factor C-4. Adequacy and robustness of the management approach and schedule including the capability of the management team.
  - Added WBS; project level systems engineering.
  - Added management approach including the roles, commitment, qualifications, and experience of the PI, PM, PSE, and any other named Key Management Team members.
  - Removed risk management aspects and used as basis for new Factor C-6.
  - Added small business subcontracting plan including small disadvantaged businesses.

Modified Criterion C Factors

- Factor C-5. Adequacy and robustness of the cost plan, including cost feasibility and cost risk.
  - Requesting detail on the methods and rationale used to develop the estimated cost.
  - Requesting detail on the proposed cost management tools to be used on the project
  - Added that if the project plans to spend more than 25% of the PI-Managed Mission Cost prior to KDP-C (Confirmation), the rationale/justification for this spending must also be detailed.
- Factor C-6. Adequacy of the risk management plan.
  - Derived from Factor C-4.

Two new factors have been added:

- Factor C-7. Ground Systems.
  - Assessment of the proposed mission operations plans, facilities, hardware and software, processes, and procedures.
- Factor C-8. Approach and feasibility for completing Phase B.
  - Assessment of the completeness of plans
  - Assessment of the adequacy of the approach

Deferred Step 1 Items Required for Step 2 (G&C Table 1)

	SMEX AO Requirement Description	SMEX AO Section	SMEX AO Requirement	Concept Study Reference
1	Independent Verification and Validation (IV&V) of Software	4.6.1	-	-
2	Costing of Conjunction Assessment Risk Analysis	4.6.4	-	Requirement CS-113
3	Planetary protection requirements Note that the baseline Planetary Protection Plan is due at PDR.	5.1.7	15	Requirement CS-124
4	Science Enhancement Option (SEO) or its cost, if proposed	5.1.8	16, 17	Requirement CS-28
5	Enhancing Technology Demonstration Options (TDO)	5.2.3	-	Requirement CS-29
6	PI-Team-Developed Enhancing Technology Demonstration Opportunity or its cost	5.2.3.1	28, 29, 30	-
7	Demonstration of maximum channel bandwidth	5.2.5	37	Requirement CS-40
8	Discussion of critical event coverage capabilities	5.2.6	38	Requirement CS-40
9	Detailed plan for orbital debris and disposal Note that an Orbital Collision Avoidance Plan (OCAP) must be completed by Preliminary Design Review (PDR).	5.2.7	39, B-63 to B-66	Appendix L.9
10	Mission Operations Tools and Services: Non-AMMOS (Advanced Multi Mission Operations System) system use and description	5.2.9	41	Appendix L.25 Requirement CS-129
11	Cybersecurity: Ground system data flow diagram	5.2.11	43	Requirement CS-125
12	Naming of Project Manager (PM) and Project Systems Engineer (PSE)	5.3	47, 49	Requirement CS-56
13	Citizen Science, if proposed	5.4.4	60 (Optional)	Appendix L.14
14	Student Collaborations, if proposed	5.5.2	61, 62, B-53	Requirement CS-94 Requirement CS-95 Requirement CS-96
15	Discussion of cost estimate error and uncertainty	5.6.3	69	Requirement CS-75
16	Requirements for real year dollar costs	5.6.2	B-13, B-51, B-52	Requirement CS-77, Cost templates
17	Institutional Letters of Commitment from major partners	5.8.1.2	88	Appendix L.1
18	AO-Provided Launch Services storage plans and budget	5.9.2.1	103	Requirement CS-73
19	Schedule-based end-to-end Data Management and Archive Plans	-	B-24	Appendix L.5

Career Development

Career Development

- The Science Panel and TMC panel will provide comments to NASA regarding the extent to which the proposed investigation provides career development opportunities to train the next generation of engineering and management leaders.
- While these comments will not be considered in the evaluation, they may be considered during down-selection.

List of Participants and Table of CS Requirements

Requirement CS-11. The Concept Study Team shall provide a list of the individuals who have participated in the Concept Study (e.g., individuals who worked on the CSR, any CSR contributor, Red Team member, reviewer, etc.) and/or whom you are proposing to provide work should the mission be down-selected. Additionally, provide a list of all organizations named in the CSR, or providing developmental or research services, including the lead organization, subcontractors, vendors and contributing organizations who have an interest in the mission. Provide a draft list of the participants as a Microsoft Excel spreadsheet document to the point-of-contact **[Dr. Dan Moses]** (AO Section 6.1.5) **three months** prior [May 7, 2024] to the due date of the CSR [August 7, 2024]. Use the Microsoft Excel spreadsheet template that has been posted to the Program Library. This list is to be updated and a final revision shall be included in a separate electronic file at the time of CSR submission.

Requirement CS-12. The Study Team shall create a separate document that contains a table with all of the requirements (Requirement CS-1 through Requirement CS-131) and the page, section, or table number that is the main place in the CSR where the requirement is addressed. ~~Provide this table to the AO point-of-contact by email no later than seven calendar days after the CSRs are due.~~ ("Provide this table as a PDF document along with the CSR submission." Currently not in the draft but will be in the final G&C document)

Cost Related Items

L.17 Additional Cost Data to Assist Validation (Optional)

In addition to the specific cost table data requested in the Cost Proposal (Section I), investigation teams may also provide any additional costing information/data that they feel will assist NASA to validate the project's proposed costs. Vendor quotes, cost estimates, rationale for design heritage cost savings, are all examples of data that can be included here. Input and output files for any publicly available cost model may be included with each electronic submission, if accompanied by discussion in this appendix.

The information provided may include cost by NASA fiscal year to the lowest level of detail the project is working with, in Microsoft Excel format.

TMC Cost Process (Credit to Elisabeth Morse, DYNAMIC Pre-Proposal Conference (PPC) 6/6/23)

We have included a new set of slides (16 slides) in the backup section that will help explain the TMC Cost Analysis process. This has a lot of good information that will help explain:

- Cost Basis of Estimate (BOE)
- Cost Threats related to Weaknesses
- Lessons Learned

Constellation Reliability – Safe Harbor.

Projects proposing multiple spacecraft are expected to show how the proposed mission architecture affects risk to mission success. Additional Step 2 guidance detailing how projects with multiple spacecraft can meet this expectation is available in the Program Library in *Guidance for Distributed Satellite System (DSS) Architectures for Class D Missions*.

The Constellation Reliability safe harbor is increased from 60 percent (Step 1) to 75 percent (Step 2).

TDRSS (Tracking and Data Relay Satellite System)

Proposers should be advised that SCaN intends to migrate away from use of Tracking and Data Relay Satellite Services (TDRSS) and is actively working to validate commercial alternatives. No new mission will be allowed using TDRSS. Missions that are considering proposing specialized services previously offered by TDRSS, such as demand access services, should work with SCaN to understand the potential commercial service alternatives .

From the initial proposals, it did not appear there was anyone planning to use TDRSS.

Conjunction Assessment Risk Analysis (CARA)

NASA Interim Directive (NID) 7120.132 has been superseded by NASA Procedural Requirement (NPR) 8079.1 on June 27, 2023. For this CSR evaluation, NID 7120.132 is still in effect. The official guidance in NPR 8079.1 will be imposed for down-selected missions.

Site Visits

- Site visits with oral briefings will be used to clarify implementation details and commitments.
- Site visits are anticipated ~2-3 months after the CSR due date at location sites to be coordinated between the PI/Proposal Team and NASA HQ/SOMA.
- The Site visit durations will be up to 7 hours plus up to 1 hour for an optional tour/demonstration.
- All site visit presentations/briefings should be in a plenary session with all Evaluation Team members attending - no splinter sessions.
- Written significant weaknesses, questions, and/or requests for information will be provided to the PI/Proposal Team 7 days before the site visit. All teams will have the same lead time.
- Some questions will require an early response, 2 days before the site visit.
- Any additional information provided to NASA by the investigation team at the site visit, in response to the NASA-identified weaknesses and questions, or in response to NASA requests for additional information, will be treated as updates and clarifications to the CSR.

Phase B Plan

- Immediately following the continuation decision (*i.e.*, down-selection), successful teams will be requested to submit a formal cost proposal based upon the Federal Acquisition Regulation (FAR) Part 15. The instruction and format for submission of this formal cost proposal are found in FAR Part 15.403-5 and Table 15.2. Teams will be required to provide cost and pricing data for Phase B that are necessary and required to implement the contract for Phase B. Complete cost and pricing data will be required for each organization participating in Phase B. These data should allocate project costs per the cost categories defined in Table 15-2. See Section I of PART II for additional guidance.

- Once entering Phase B, Explorers projects will be subject to the same requirements as all other NASA missions. Note that the CSR only satisfies some of the KDP-B deliverable requirements, and that the balance will have to be developed early in Phase B (consistent with Section 2.2.7.1 in NPR 7120.5E: "In a two-step AO process, projects are down-selected following evaluation of concept study reports and the down-selection serves as KDP B. Following this selection, the process becomes conventional, with the exception that products normally required at KDP B that require Mission Directorate input or approval will be finished as early in Phase B as feasible.").

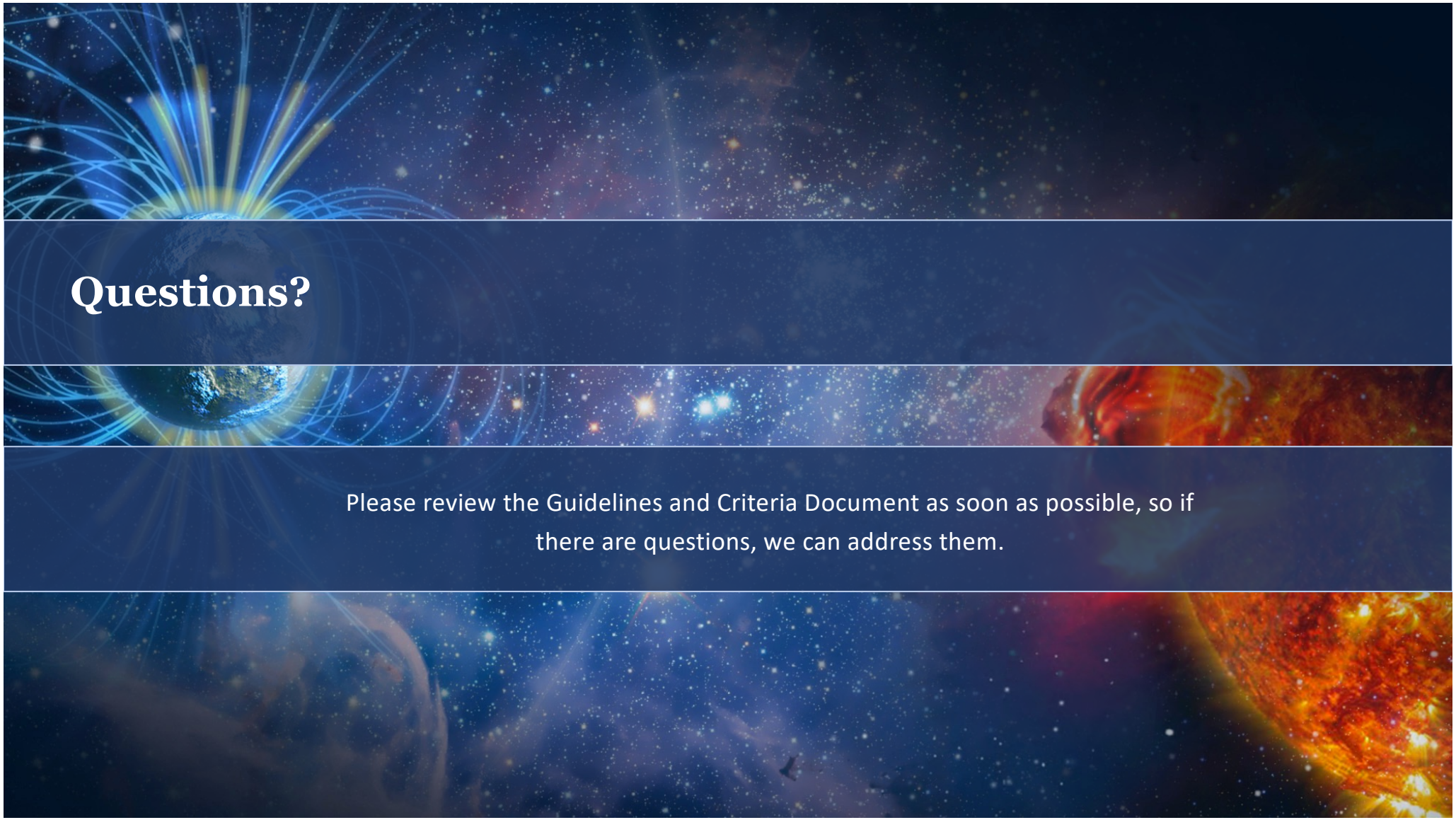
Additional and Updated Documents

Updated:

- DRAFT Guidelines and Criteria for the Phase A Concept Study, dated November 7, 2023 in https://explorers.larc.nasa.gov/HPSMEX22/

Additional documents in the Program Library:

- Space Systems Protection documents FIPS PUB 140-2, NASA-STD-1006, and FAQ
- Sample of International Agreement examples for Juno and MSL
- Program Level Requirements Appendix (PLRA) examples for TESS and ICON
- Mission Definition Requirements Agreement (MDRA) examples for ICON
- Level 1/Level 2 Requirements Presentation from PI Forum
- FY 20 NASA Inflation Tables for FY22
- CSR Conflicted Party List Template
- Microsoft Excel versions of the Step 2 cost template tables in the G&C



Questions?

Please review the Guidelines and Criteria Document as soon as possible, so if there are questions, we can address them.

Points of Contact

- Launch Services Program (LSP) and Rideshare Contact:
  Shaun Daly
  shaun.m.daly@nasa.gov
  321-867-8400

- Conjunction Analysis Risk Assessment (CARA):
  Alinda Mashiku
  alinda.k.mashiku@nasa.gov
  301-286-6248

- Multimission Automated Deepspace Conjunction Assessment Process (MADCAP)
  David Berry
  david.s.berry@jpl.nasa.gov
  818 354 0764

- Cyber Security
  Dr. Reynaldo Anzaldua , SMD Information Security Executive, E-mail:
  reynaldo.anzaldua@nasa.gov.

Points of Contact

All further questions pertaining to the SMEX AO MUST be addressed by email to:

Dr. Dan Moses
Heliophysics Explorers Program Scientist
Science Mission Directorate
NASA Headquarters
Washington, DC 20546
dan.moses@nasa.gov

(subject line to read “SMEX AO")

References

HE22 SMEX Acquisition Page

The HE22 SMEX acquisition home page is available at https://explorers.larc.nasa.gov/HPSMEX22/

The contents of the web site include the following:

- Links to SMEX webpages
- 2022 Heliophysics SMEX news
- Preproposal conference
- Community announcements
- SAM.gov links
- SMEX Q&As
- Teaming interest

SMEX Reference Material

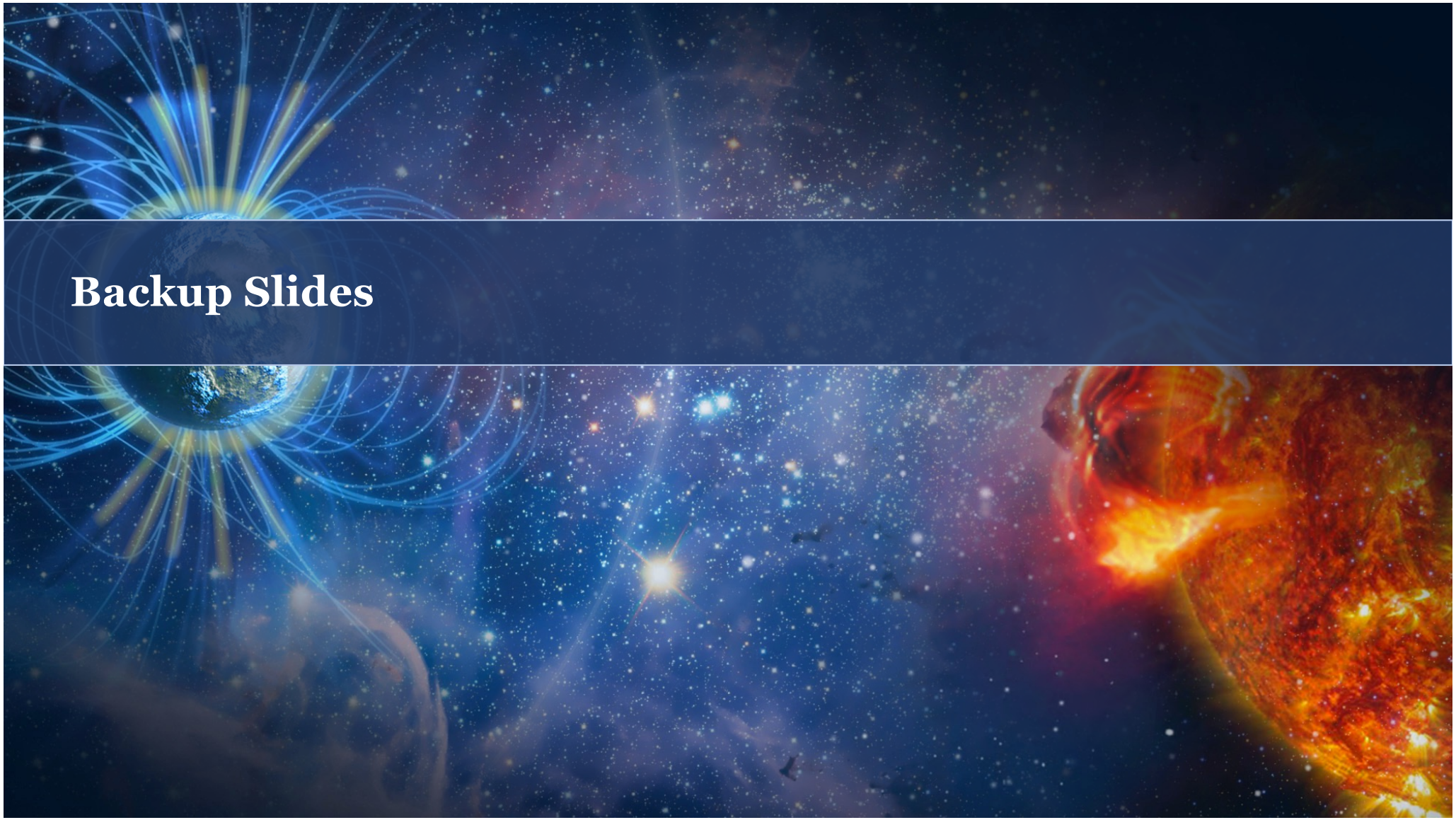
HE22 SMEX Acquisition Home Page

- The HE22 SMEX Acquisition Home Page available at https://explorers.larc.nasa.gov/HPSMEX22/SMEX/index.html, will provide updates and any addenda during the solicitation process. The contents of the SMEX acquisition page include the following:
  - Links to the NSPIRES for access to the solicitation
  - Program library
  - Evaluation plan
  - Q&A
  - SAM Announcement

HE22 SMEX Program Library

- The Program Library provides additional regulations, policies, and background information, and is accessible at https://explorers.larc.nasa.gov/HPSMEX22/SMEX/programlibrary.html
- It is incumbent upon the proposer to ensure that the documents used in proposal preparation are of the date and/or revision available in the Program Library
- A detailed Change Log has been implemented and will document all updates to the Program Library


NASA



Backup Slides

TMC Cost Analysis

Cost Analysis Overview

- Cost is one important element of Technical, Management and Cost (TMC).
- Initial cost analyses are performed on the basis of information provided in the proposals
  (*e.g.*, technical baseline, schedule, WBS, cost consistency and completeness, basis of estimate, contributions, use of full cost accounting)
- Cost models for TMC Base Independent Cost Estimates ("base ICE")
  - Two or more cost models are used to validate the proposed cost for Phases B-D. One or more for Phase E.
  - Cost Models are chosen to be complementary to each other when possible, *i.e.,* different modeling approaches.
  - For Step 2 evaluations, more cost models may be used.
  - Cost model inputs are obtained from the information in the Proposal in order to develop the TMC ICE for the project "as proposed".
- The TMC identifies implementation threats (weaknesses) and assigns Cost Threats where applicable.
  - Cost Threats are estimates of the cost to mitigate the identified threat and the likelihood that the mitigation will be needed. The total of all Cost Threats above a selected threshold are compared to the proposed unencumbered reserves.
- The entire panel participates in Cost deliberations. All information from the entire evaluation process is considered in the final cost assessment.

Decoding Cost Validation MW

- A cost validation Major Weakness can take the following form:

A sum of cost elements over which the selected cost model(s) are validated against actuals.
Typically can be:
- WBS 1+2+3
- WBS 5
- WBS 6+10
- Total Phases B-D
- Total Phase E

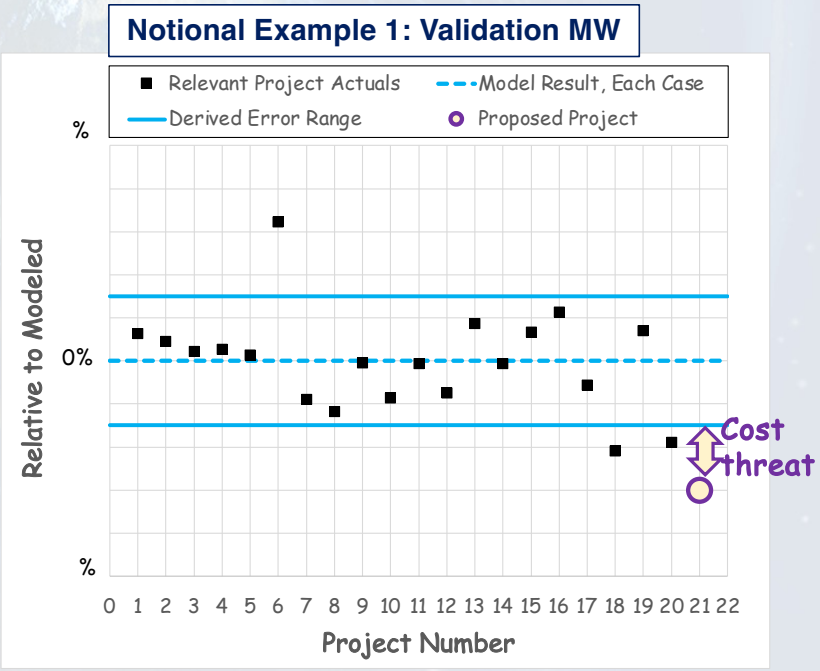
The proposed costs for WBS X.XX cannot be validated, as the TMC Base Independent Cost Estimate exceeds the proposed cost by more than the error range.

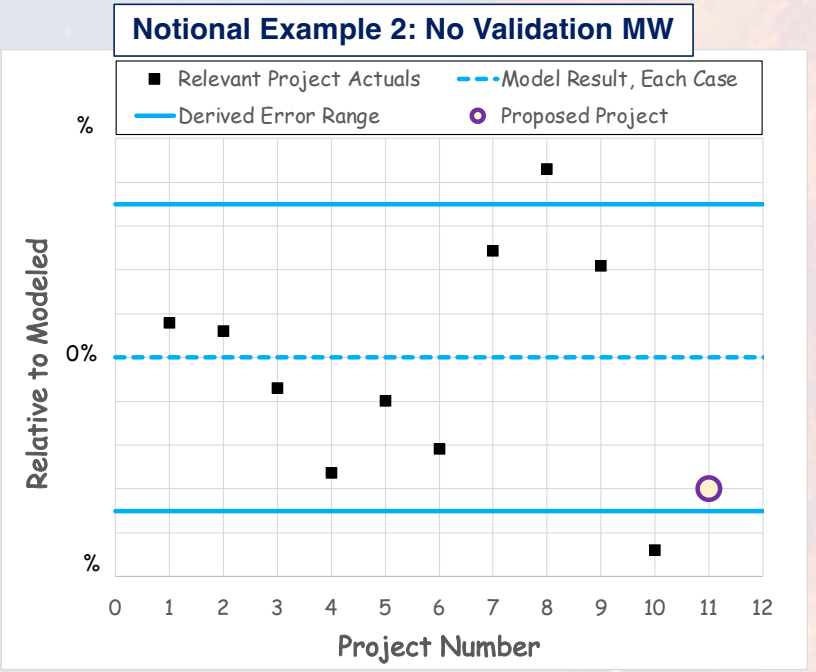
The TMC Base ICE:
- combines the results of the models used (no reserves)
- is performed with the best performing models selected after testing several models against past actuals relevant to this acquisition
- follows the same process, for all proposals in this acquisition
- uses inputs that are based exactly on information in the proposal (*incl.* MEL, schedule, heritage, TRL, cost BOE, *etc.*)

A specific error range is:
- defined prior to the start of proposal evaluations
- derived for this acquisition and each WBS group
- applied to the TMC Base ICE
- based on the combined performance of the selected models on past actuals relevant to this acquisition

Notional Validation Error Bar Example

- How large a difference from the cost model is needed to trigger a validation finding?
- It depends on how well the chosen cost model combination validates against actuals of relevance, statistically.

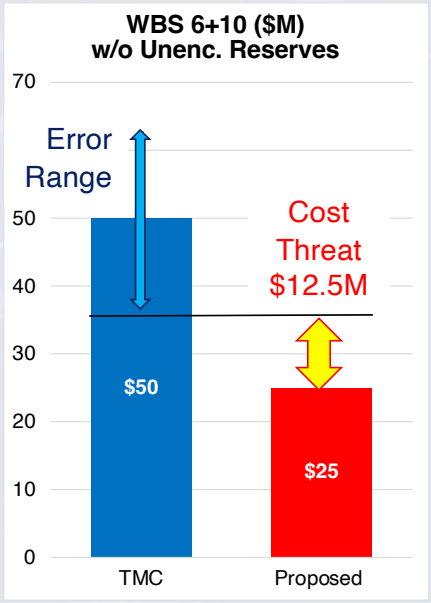




Decoding Cost Validation MW: Example

Notional Proposal A: validates

Notional Proposal B: does not validate



- The situation shown in notional example A would not result in a validation finding.
- The situation shown in notional example B would result in the following finding:

"The proposed costs for the sum of WBS 6 and 10 cannot be validated, as the TMC Base Independent Cost Estimate exceeds the proposed cost by more than the error range. "

…followed by a cost threat statement.

Cost Threat Matrix

- The likelihood and cost impact, if any, of each weakness is estimated then stated in terms of Likelihood and Impact categories
  - The **likelihood** is the probability range that the cost impact will materialize.
  - The **cost impact** is the current best estimate of the range of costs to mitigate the threat.
- The cost threat matrix defines the adjectives that describe the likelihood and cost impact.
- The minimum cost threat is $1M for Phases B/C/D *and $250K for Phase E*.

Normal black text shows the Phases B/C/D version of the CTM
Italics blue text shows the Phase E version of the CTM

			Cost Impact (CI) % of PI-Managed Mission Cost to complete Phases B/C/D or *% of Phase E* not including unencumbered cost reserves or contributions					
	Likelihood of Occurrence	**Weakness**	**Very Minimal** 0.5% < CI ≤ 2.5% ($xM < CI ≤ $xM) *1% < CI ≤ 2.5% ($xM < CI ≤ $xM)*	**Minimal** 2.5% < CI ≤ 5% ($xM < CI ≤ $xM) *2.5% < CI ≤ 5% ($xM < CI ≤ $xM)*	**Limited** 5% < CI ≤ 10% ($xM < CI ≤ $xM) *5% < CI ≤ 10% ($xM < CI ≤ $xM)*	**Moderate** 10% < CI ≤ 15% ($xM < CI ≤ $xM) *10% < CI ≤ 15% ($xM < CI ≤ $xM)*	**Significant** 15% < CI ≤ 20% ($xM < CI ≤ $xM) *15% < CI ≤ 20% ($xM < CI ≤ $xM)*	**Very Significant** CI > 20% (CI > $xM) *CI > 20% (CI > $xM)*
Likelihood (L, %)	Almost Certain (L > 80%)							
	Very Likely (60% < L ≤ 80%)							
	Likely (40% < L ≤ 60%)							
	Possible (20% < L ≤ 40%)							
	Unlikely (L ≤ 20%)							

Note: Each "$xM" is converted to dollars according to the associated percentage depending on the proposed PIMMC.

Decoding Cost Threat Statement

- When a Cost Threat is associated with a Major Weakness, the cost threat statement takes the following form:

Estimated likelihood of the cost threat being realized:
- Unlikely: < 20% (weight 10%)
- Possible: 20% - 40% (weight 30%)
- Likely: 40% - 60% (weight 50%)
- Very Likely: 60% - 80% (weight 70%)
- Almost Certain: > 80% (weight 90%)

Estimated magnitude of the cost threat relative to the proposed cost (PIMMC in that phase):
- Very minimal: 0.5% – 2.5% (subject to lower $ threshold)
- Minimal: 2.5% - 5%
- Limited: 5% - 10%
- Moderate: 10% - 15%
- Significant: 15% - 20%
- Very Significant: > 20%

(Can be a specific estimate or middle of the range)

This finding represents a cost threat assessed to have a [LIKELIHOOD] likelihood of a [IMPACT] cost impact being realized during development and/or operations, which results in a reduction from the proposed unencumbered cost reserves.

Phase affected by cost threat
- Cost threat impact ranges established separately for Phases B-D and Phase E
- Cost threats evaluated separately against Phases B-D and Phase E
- Impact of cost threats on reserves applied separately to Phases B-D reserves and to Phase E reserves

If realized, cost threats would consume unencumbered cost reserves
- By definition, TMC-identified cost threats are above and beyond the proposed cost basis and the proposed encumbered cost reserves

Decoding Cost Threat Statement: Examples

Example of cost threat statement 1: cost validation Major Weakness

- The cost validation process results in a cost threat of $12.5M for WBS 6+10. The notional example PIMMC for Phases B-D is $100M.
- The TMC ponders the case made in the proposal for cost-reducing paradigm and gives further benefit of the doubt to the proposer. The likelihood of this cost threat is estimated in the range 20%-40%.
- The TMC appends the following statement to the cost validation MW:

> *This finding represents a cost threat assessed to have a **Possible** likelihood of a **Moderate** cost impact being realized during **development**, which results in a reduction from the proposed unencumbered cost reserves.*

Example of cost threat statement 2: technical Major Weakness

- The TMC considers that the Technology Readiness Level (TRL) is overstated and that it is likely that a TRL development plan will be required before KDP-C. The notional example PIMMC for Phases B-D is $100M.
- The TMC estimates that the cost for an adequate TRL development plan would be in the range of $2.5M to $5M
- The TMC writes the technical MW and appends the following statement:

> *This finding represents a cost threat assessed to have a **Likely** likelihood of a **Minimal** cost impact being realized during **development**, which results in a reduction from the proposed unencumbered cost reserves.*

Decoding Summary Statement

Cumulative impact of cost threats

- The Form C "Overall Evaluation/Rationale" Summary could include a statement of the following form.
- When present, this statement informs the risk rating, together with all of the Major Findings. This statement alone does not automatically result in any specific rating.

Example (could also be Phase E)

Subtract total from the total proposed unencumbered cost reserves in that phase

Applies to unencumbered only. (Encumbered reserves are already assigned to other, specific risks.)

The TMC-identified cost threats reduce the Phases B–D unencumbered cost reserves below the 25% required by the AO.

Total of all identified threats
- weigh impact by likelihood
- add %unencumbered reserves required by the AO (25% for Phases B-D, 15% for Phase E)

TMC compares remaining to AO-required %
- An informational statement
- TMC also assesses the appropriateness of the proposed %unencumbered cost reserves for the specific proposed scope, as justified by the proposal

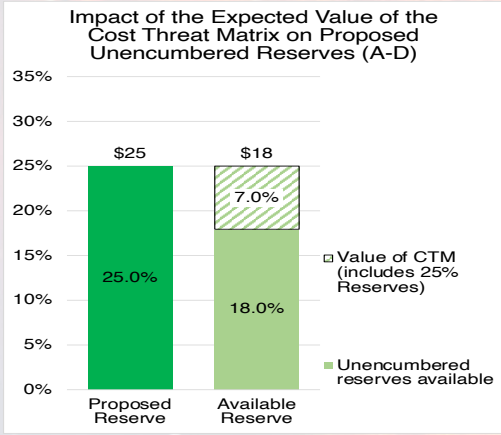
Decoding Summary Statement: Example

Example of cumulative impact (notional)

- The cumulative impact of the cost threats for this notional example brings the unencumbered cost reserves level from the proposed level of 25% down to 18%.

		Cost Impact (CI) % of Baseline Mission Cost to complete Phases B-D not including unencumbered cost reserves or contributions					
Likelihood of Occurrence	**Weakness**	**Very Minimal** $1.0M<CI≤2.5% ($1M<CI≤$2.5M)	**Minimal** 2.5%<CI≤5% ($2.5M<CI≤$5M)	**Limited** 5%<CI≤10% ($5M<CI≤$10M)	**Moderate** 10%<CI≤15% ($10M<CI≤$15M)	**Significant** 15%<CI≤20% ($15M<CI≤$20M)	**Very Significant** CI>20% (CI>$20M)
AlmostCertain (L>80%)							
VeryLikely (60%<L≤80%)							
Likely (40%<L≤60%)	**TRL Maturation**		**$1.9**				
Possible (20%<L≤40%)	**Cost Validation**		*$3.75M x 50% = $1.9M*		**$3.7**		
Unlikely (L≤20%)							

Example for Phases B/D	
PIMMC without unenc. reserves	$100.0
Proposed unenc. reserves %	25%
Proposed unenc. reserves	$25.0
Total expected cost threat impact	$5.6
Reserves % on cost threats	25%
Total impact of cost threats	$7.0
Proposed unenc. reserves minus expected cost threats	$18.0
Proposed unenc. reserves minus expected cost threats %	18.0%



Clarification of Cost PMWs

The Clarification process offers a chance for updating cost information

Information from proposers provided during clarifications may be relevant to cost threat statements associated with PMWs.

For example, the following types of information may be folded into the cost analysis even after the clarifications.

- Past actuals for efforts justified as being similar or otherwise relevant.
- References to past efforts justified as being similar, for which past actuals in CADRe exist.
- Further basis of estimate details, for the specific area(s) identified in the PMW.
- Resolution of inconsistencies or clarification of any misunderstanding affecting cost model inputs.

Benefit of the Doubt in Cost Validation

The TMC Cost Validation process has been geared in several ways towards providing proposers the benefit of the doubt.

1. The inputs to the cost models are derived directly from the descriptions in the proposal, "as proposed"
   - This includes all heritage and TRL level claims.
   - TMC's independent assessment of technical parameters, if it differs from that of the proposal, is not factored into the Base ICE. It would be reflected in separate findings, with associated cost threats if applicable.
2. Validation error bars are derived specifically for each solicitation. They reflect how well the selected cost model combination performs against actuals of relevance to the solicitation.
   - A cost validation finding major weakness is written only if the proposed cost is outside that error bar.
3. The validation cost threat impact only reflects excursions outside of the error bar (not the full delta between modeled and proposed).
4. The validation cost threat impact is weighted by the cost threat likelihood.
5. Proposal and clarification content can affect the likelihood of the validation cost threat.

Evaluation of the Cost Basis of Estimate

- SMEX AO Req. B-49 describes requirement for the Basis of Estimate (BOE):
  - Traceable to the WBS of Table B3,
  - Description of the methodologies and assumptions used to develop the proposed cost estimate,
  - Description of cost reserves that provides insight into their adequacy and robustness,
  - Any additional BOE data to assist the validation of the cost estimates.
- The type of data useful to support a BOE depends on the method used for the cost estimate
  - Example if based on analogy: list heritage cost and rationale for adjustments
  - Example if using parametric model: model name and version, key inputs used with rationale
  - Example if using bottom-up estimates: breakout of labor vs material, FTEs and/or WYEs and average labor rates, list of significant hardware with date and importance to investigation.
- No external independent cost validation estimates are expected in the proposal, nor are they evaluated or considered if submitted.
- TMC's evaluation of the quality of the proposer's basis of estimate is separate from TMC's ICE analysis.
- Different findings can result from the BOE and from the ICE. If the findings are Major, they are both considered during polling for the final risk rating.

Cost Validation Lessons Learned

Proposal teams who do the following tend to better support their proposed cost

- Estimate both schedule and cost iteratively, starting early in proposal development; let that inform the proposed scope.
- Estimate both schedule and cost conservatively by accounting for remaining unknowns and for expected cost growth during proposal development and during Phase A.
- Identify cost-driving parameters clearly and consistently (including TRL, modifications from heritage, engineering models & spares, *etc.*)
- Use NASA Standard WBS definitions and terminology.

Cost Threats Lessons Learned

Proposal teams who do the following tend to better support their proposed reserves posture

- Apply risk management process early; plan mitigations appropriate for the proposed project class.
- Encumber appropriate amounts of cost reserves against those risks that could impact schedule and/or cost.
- Determine the levels of funded schedule reserve and of unencumbered cost reserves that would be adequate and robust for the proposed project –as well as their phasing.
  - Unencumbered cost reserves higher than the minimum AO requirement, and funded schedule reserves higher than typical practices, may be necessary for some elements of some projects, such as those requiring specific technology maturation.
  - Remember to also carry unencumbered cost reserves against the encumbered cost reserves; encumbered cost reserves are part of the base PIMMC.
- Remember that appropriate cost reserves could be either the minimum required by the AO, or higher as assessed by the TMC evaluation panel based on the justification provided by the proposal.

Additional Information on Cost Estimation

- NASA WBS Handbook in the Program Library
  https://soma.larc.nasa.gov/STP/DYNAMIC/pdf_files/NASA%20SP%2020210023927%20WBS_Handbook.pdf

- NASA Cost Estimating Handbook: https://www.nasa.gov/content/cost-estimating-handbook

- Note that several NASA cost models that may be relevant to some projects are free to proposers and do not require cost expert training (spreadsheet-based and compatible with Mac and PC). These include:
  - Project Cost Estimating Capability (PCEC)
  - NASA Instrument Cost Model (NICM)
  - Mission Operations Cost Model (MOCET)

  Access can be requested at https://software.nasa.gov/software/category/all/aw/1/cost.

  Use of these models is not a requirement nor an expectation.