National Aeronautics and Space Administration

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Amended on January 16, 2015

Announcement of Opportunity

Discovery 2014

Notice of Intent Due Date: **December 05, 2014**
Proposal Due Date: **February ~~16~~ 18, 2015**
[Amended January 16, 2015]

OMB Approval Number 2700-0085

ANNOUNCEMENT OF OPPORTUNITY
DISCOVERY PROGRAM
NNH14ZDA014O

FOREWORD

The National Aeronautics and Space Administration (NASA) Science Mission Directorate (SMD) is releasing this Announcement of Opportunity (AO) to solicit Principal Investigator (PI)-led space science investigations for the Discovery Program.

The AO Cost Cap for a Discovery mission is $450M in Fiscal Year (FY) 2015 dollars for Phases A though D, not including the cost of the Expendable Launch Vehicle (ELV) or the value of any contributions. Any selected mission will launch no later than December 31, 2021.

Proposers should be aware of the following major changes in this AO from previous Discovery Program AOs.

- The value of foreign instrument contributions are now limited to one-third of the PI-Managed Instrument Cost.
- A standard launch capability is offered as GFE. Higher performance or larger fairing will be charged to the PI-Managed Mission Cost. Use of a lower-than-standard performance launch service will result in an increase in the AO Cost Cap.
- Phase E and F costs, *excluding* the development of ground or flight system software and the development, fabrication, or refurbishment of test-beds, which will be considered deferred Phase D work, are no longer under the AO Cost Cap.
- Proposers are now required to use one of two parametric cost models as a benchmarking exercise and to report the input file and results in their submission.
- A variety of NASA-developed technologies are available for infusion into missions.
- Mission of Opportunity investigations are no longer solicited through the Discovery AO.

This AO is based on SMD's Standard PI-led Mission AO. In addition to the changes listed above, proposers should be aware of the following changes in this AO from the language in the Standard PI-led Mission AO.

- Requirement 71 and Requirement B-55 have been added to require provision of parametric cost model input file(s) and results, to provide the opportunity for additional proposed cost information, and to facilitate a more transparent evaluation of proposals.
- Requirement 22, Requirement 23, and Requirement B-26 have been added to accommodate the possible additions of Technology Demonstration Options.
- Requirement 24 and Requirement B-78 have been added to accommodate any required Engineering Science Investigations.
- The value of foreign contributed instruments is now capped at one-third of the sum of the NASA costs for elements 4.0 (Science) and 5.0 (Payload) in the standard Work Breakdown Structure.

In addition to the listed major changes, this AO incorporates a large number of additional changes relative to previous Discovery Program AOs, including both policy changes and changes to proposal submission requirements. All proposers must read this AO carefully, and all

proposals must comply with the requirements, constraints, and guidelines contained within this AO.

On or about January 16, 2015 NASA amended this Announcement of Opportunity as follows:

The deadline for the submission of electronic proposals has been changed to February 18, 2015 due to the observance of the Federal holiday of Washington's Birthday on February 16, 2015. Concomitantly, the deadline for the submission of proposals on CD-ROM has been changed to February 25, 2015.

To ease the identification and, if necessary, the redaction of export controlled information, any such information contained in proposals shall be color-coded: export control information shall be printed in a red font and figure(s) and table(s) containing such information shall be placed in a red-bordered box. Requirement 92 has been updated to reflect this.

To eliminate a conflict between the language of Section 5.1.8 of the final AO, and Requirement B-77, the provision of "[e]stimated … cost … impacts associated with the implementation of the proposed ESI [Engineering Science Investigation]" will not be required. Requirement B-77 has been modified to reflect this.

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1. Description of Opportunity

1.1 Introduction

The National Aeronautics and Space Administration (NASA) issues this Announcement of Opportunity (AO) for the purpose of soliciting proposals for investigations to be implemented through its Discovery Program. All investigations proposed in response to this solicitation must support the goals and objectives of the Discovery Program (Section 2), must be implemented by Principal Investigator (PI) led investigation teams (Section 5.3.1), and must be implemented through the provision of complete spaceflight missions (Section 5.2.1).

Proposed investigations will be evaluated and selected through a two-step competitive process (Section 7). Step-1 is the solicitation, submission, evaluation, and selection of proposals prepared in response to this AO. As the outcome of Step-1, NASA intends to select multiple Step-1 proposals and issue awards (provide funding to NASA Centers and the Jet Propulsion Laboratory (JPL), award contracts to non-NASA institutions, or utilize other funding vehicles as applicable) to the selected proposers to conduct Phase A concept studies and submit Concept Study Reports to NASA. Step-2 is the preparation, submission, evaluation, and continuation decision (downselection) of the Concept Study Reports. As the outcome of Step-2, NASA intends to continue one or more investigation(s) into the subsequent phases of mission development for flight and operations.

This AO, particularly Section 5, presents the requirements and constraints that apply to proposals that are to be submitted in response to this AO. Appendix B contains additional requirements on the format and content of the Step-1 proposal. Appendix D lists the contents of the Program Library while Appendix E.1 lists the Program Library documents that specify requirements for Phase A concept studies, and Appendix E.2 lists the Program Library documents that specify requirements that will apply to subsequent phases of investigations that are selected for implementation. These Program Library documents are intended to provide guidance for investigations selected in Step-1 and Step-2, respectively; they are specifically <u>not</u> intended to impose requirements on Step-1 proposals.

1.2 NASA Safety Priorities

Safety is the freedom from those conditions that can cause death, injury, occupational illness, damage to or loss of equipment or property, or damage to the environment. NASA's safety priority is to protect: (1) the public, (2) astronauts and pilots, (3) the NASA workforce (including NASA employees working under NASA instruments), and (4) high-value equipment and property.

2. AO Objectives

2.1 NASA Strategic Goals

One of NASA's strategic goals is to "Expand the frontiers of knowledge, capability, and opportunity in space." Further information on NASA's strategic goals may be found in NASA Policy Directive (NPD) 1001.0B, *The 2014 NASA Strategic Plan*, available through the Program Library (Appendix D).

The NASA Science Mission Directorate (SMD) is addressing this strategic goal through Strategic Objective 1.5: Ascertain the content, origin, and evolution of the solar system and the potential for life elsewhere.

Further information on the goals and objectives of NASA's Discovery program may be found in the *2014 Science Mission Directorate Science Plan* available at http://science1.nasa.gov/about-us/science-strategy/.

2.2 Discovery Program Goals and Objectives

The goal of NASA's Discovery Program is to provide frequent flight opportunities for high quality, high value, focused, planetary science investigations that can be accomplished under a not-to-exceed cost cap.

By conducting a series of planetary science investigations, NASA will provide a mechanism by which pressing questions in planetary science may be addressed, permitting a steady improvement in our understanding of planetary systems and the processes that affect them. The frequent, steady nature of the investigations will ensure a continuing stream of fresh scientific data to the planetary science community, thus helping to maintain the excellence of the U.S. planetary science program and to inspire the next generation of investigators.

The Discovery Program strives to:

- advance scientific knowledge and exploration of the elements of our Solar System;
- add scientific data, maps, and other products to the Planetary Data System archive for all scientists to access;
- announce scientific progress and results in the peer-reviewed literature, popular media, scholastic curricula, and materials that can be used to inspire and motivate students to pursue careers in science, technology, engineering, and mathematics;
- expand the pool of well-qualified Principal Investigators and Program Managers for implementation of future missions in Discovery and other programs, through current involvement as Co-Investigators and other team members; and
- implement technology advancements proven in related programs.

These goals and objectives are also articulated in the *Discovery Program Plan*, which can be found in the Program Library.

Investigations may target any body in the Solar System except for the Earth and Sun, in order to advance the objectives outlined in Section 2.1. Investigations of extra-solar planets are not solicited in this AO.

2.3 Discovery Program Background

The Discovery Program was initiated in 1992 as a way to ensure frequent access to space for planetary science investigations. Previous Discovery Program AOs were released in 1994, 1996, 1998, 2000, 2004, 2006, and 2010. The completed missions in the Discovery Program are NEAR, Mars Pathfinder, Lunar Prospector, Genesis, Deep Impact, Stardust, Kepler, and GRAIL. CONTOUR was lost shortly after its launch in 2002. The three missions currently in development, operation, or analysis phase are MESSENGER, Dawn, and InSight. Four missions of opportunity, ASPERA-3, Netlander, the Moon Mineralogy Mapper and Strofio, have been selected. Netlander was terminated before launch. Aspera-3 is currently operating on ESA's Mars Express. The Moon Mineralogy Mapper operated on ISRO's Chandrayaan-1. Strofio is currently in development for the joint ESA-JAXA BepiColombo mission. Additionally, three investigations reusing existing spacecraft have completed operations: EPOCh and DIXI were hosted by the Deep Impact spacecraft and were joined to produce the EPOXI mission, and Stardust-NExT was hosted on the Stardust spacecraft. Information about all previous and current Discovery missions may be found at http://discovery.nasa.gov/missions.html.

3. Proposal Opportunity Period and Schedule

This solicitation has a single submission deadline. The following schedule describes the planned major milestones for this AO:

AO Release Date.....November 5, 2014
Preproposal Conference.....November 24, 2014
Notice of Intent to Propose Deadline.....December 5, 2014
[Amended January 16, 2015]
Electronic Proposal Submittal Deadline
at 11:59 p.m. Eastern Time.....February 18, 2015
Letters of Commitment Due (with Proposal).....February 18, 2015
Deadline for Receipt of Proposal on CD-ROMs
at 5:00 p.m. Eastern Time.....February 25, 2015

~~Electronic Proposal Submittal Deadline~~
~~at 11:59 p.m. Eastern Time.....February 16, 2015~~
~~Letters of Commitment Due (with Proposal).....February 16, 2015~~
~~Deadline for Receipt of Proposal on CD-ROMs~~
~~at 5:00 p.m. Eastern Time.....February 23, 2015~~
Step-1 Selections Announced (target) .....June 2015
Initiate Phase A Concept Studies (target).....July 2015
Phase A Concept Study Reports Due (target).....April 2016
Downselection of Investigation(s) for Flight (target).....September 2016
Launch Readiness Date.....NLT December 31, 2021

All proposals must be received before the proposal submittal deadline. Those received after the deadline will be treated in accordance with Appendix A, Section VII.

Requirement 1. Proposals submitted in response to this solicitation shall be submitted electronically no later than the Electronic Proposal Submittal Deadline.

Requirement 2. In addition to electronic submission, CD-ROMs containing the proposal and relevant files described in Section 6.2.3 must be submitted. Proposals on CD-ROMs submitted in response to this solicitation shall be delivered no later than the Deadline for Receipt of Proposal on CD-ROMs. Proposals shall be delivered to the Addresses for Submittal of Proposals given in Section 6.2.3.

4. **Policies Applicable to this AO**

4.1 NASA Management Policies

The following policies will impose requirements on selected missions, for which planning may need to be considered and described as part of the proposal process. These requirements are not levied on Step-1 proposals.

4.1.1 NASA Flight Program and Project Requirements

Proposals selected in response to this AO will be implemented in accordance with NASA mission management processes. NASA mission management processes, as defined by NASA Procedural Requirements (NPR) 7120.5E, *NASA Space Flight Program and Project Management Requirements*, are Formulation, Approval, Implementation, and Evaluation. The NASA mission management processes are subdivided as follows:

Formulation is divided into:

- Phase A – Mission Concept and Requirements Definition and Technology Development; and
- Phase B – Preliminary Design and Technology Completion.

Approval is the Confirmation process for transitioning into Implementation.

Implementation is divided into:

- Phase C – Final Design and Fabrication;
- Phase D – System Assembly, Integration and Test, and Launch (extending through in-space checkout);
- Phase E – Operations and Sustainment; and
- Phase F – Closeout.

Evaluation is the ongoing independent review and assessment of the project's status during both Formulation and Implementation as described in NPR 7120.5E, which may be found in the Program Library.

A Key Decision Point (KDP) occurs before the project is approved to begin the next phase of development; KDPs are defined in NPR 7120.5E. For missions selected as a result of this AO, KDP-A is the selection of a Step-1 proposal for a Phase A concept study, KDP-B is the downselection of a mission to enter Phase B following evaluation of Concept Study Reports, KDP-C is the culmination of the Confirmation process, KDP-D is a transition that occurs after the Systems Integration Review, KDP-E is the handoff from development to operations, and KDP-F is the decision to terminate operations after completion of the mission. Scientific and other analyses, including data analysis and preliminary analysis of returned samples, may continue under project funding in Phase F. If the decision at downselection is to maintain the selected investigation in an extended Phase A, then a separate KDP-B will be required.

4.1.2 NASA Program Management

Owing to the significant expenditure of Government funds on these space flight investigations, as well as to their expected complexity, NASA intends to maintain an essential degree of insight into mission development; NASA will exercise essential oversight to ensure that the implementation is responsive to NASA requirements and constraints. NASA requirements and constraints are spelled out in the *Discovery Program Safety and Mission Assurance Guidelines and Requirements* document, in NPR 7120.5E, and in other NASA requirements documents available in the Program Library. The Associate Administrator for SMD has established a Discovery Program Office at the NASA Marshall Space Flight Center to be responsible for project oversight. The Discovery Program Manager at the NASA Marshall Space Flight Center reports to the Discovery Program Director at NASA Headquarters. Additional details about the program office staffing, structure, and goals can be found in the *Discovery Program Plan*, available through the Program Library.

NPR 7120.5E defines project management responsibilities, and it presumes that project management is assigned to a NASA Center or JPL. If an organization other than a NASA Center or JPL is proposed and selected to provide project management for an investigation, then the NASA Center's project management responsibilities under NPR 7120.5E will be assigned to the implementing project management organization. That organization must be prepared to carry out these responsibilities. In such cases, the Discovery Program Office at the NASA Marshall Space Flight Center will retain the Technical Authority (TA), as described in NPR 7120.5E, that would otherwise be invested in an implementing Center or JPL.

The *Discovery Program Safety and Mission Assurance Guidelines and Requirements* document, available through the Program Library, will apply to investigations that are selected for Phase A concept studies. Selected investigations that reside at institutions that have NASA-approved safety and mission assurance (S&MA) programs may use their own appropriate institutional practices in lieu of the guidelines and requirements in this document. Although this document may impose requirements on selected investigations, it does not impose requirements, either implicitly or explicitly, on Step-1 proposals.

In addition to its role as the site of the Discovery Program Office, the NASA Marshall Space Flight Center (MSFC) is eligible to submit and participate in proposals in response to this AO. The Discovery Program Office will have access to the AO before it is released; this is necessary so that the Discovery Program Office can review the AO and ensure that it correctly

describes the postselection project management processes. Other than that, the Discovery Program Office plays no role in the AO process; specifically they play no role in defining the scientific scope of the AO, writing the AO, evaluating proposals, or selecting proposals. The Science Mission Directorate at NASA Headquarters will manage the evaluation and selection process. In order to manage MSFC's two roles, SMD has established functional and organizational firewalls between the Discovery Program Office and those parts of MSFC that might participate in proposals. These firewalls ensure that personnel identified as supporting the Discovery Program Office and the AO process will protect all nonpublic information from all proposers, including those at MSFC, and will be free of financial and other conflicts of interest with proposers.

Similarly, a firewall has been put in place for the NASA Langley Research Center from which selected personnel are supporting the development of this AO and the evaluation of proposed investigations.

4.1.3 NASA Center Role in Public Affairs and Outreach

Successful media relations activities require close cooperation between NASA and the selected investigations. NASA Centers and JPL have specific expertise in media relations and/or public affairs, especially as they pertain to Earth and space science missions. All selected investigations will coordinate media relations and/or public affairs with a NASA Center or JPL. If a selected investigation does not include a NASA Center or JPL as part of their investigation team, the investigation will utilize the public affairs guidance and resources of the Discovery Program Office at the NASA Marshall Space Flight Center.

NASA is to be informed in a timely manner of any newsworthy mission event or issue before public release of information. Strategies for using new and social media also will be developed collaboratively to ensure that common and consistent messaging will occur in a timely manner. NASA and the selected investigation will establish and maintain a detailed coordination media relations plan and communications process.

Selected PIs also must work with NASA to ensure their mission website follows NASA requirements for incorporating content for the agency's primary public website at http://www.nasa.gov/. NASA, and through NASA the selected investigation, is required under the Information Quality Act (44 U.S.C. 3504(d)(1) and 3516) and associated guidelines to maximize the quality, objectivity, utility, and integrity of information and services provided to the public.

4.1.4 Remediation, Termination, or Cancellation

Any alteration of a mission that renders it unable to accomplish one or more of its baseline science objectives will be regarded as a descope of the investigation. NASA will review any such descoped set of achievable science objectives to ensure that the investigation remains at or above the Threshold Science Mission (see Section 5.1.3 of this AO). A descope made necessary by the PI's inability to remain within budget or schedule, or failure at any time during formulation and implementation to maintain a level of science return at or above the

Threshold Science Mission, can result in mission cancellation accompanied by appropriate contract action, which may involve termination.

During Phase A, each selected PI will conduct a concept study. The Phase A Concept Study Report must include a commitment by the PI for the PI-Managed Mission Cost, schedule, and scientific performance of the investigation. If, at any time, the cost, schedule, or scientific performance commitments made in the Phase A Concept Study Report appear to be in peril, the investigation will be subject to termination or cancellation.

During Phase B, each selected PI will work with NASA to develop top-level science and technical performance requirements. Each PI will also work with NASA to establish a set of performance metrics for project evaluation with NASA. These will include cost, schedule, and others, as appropriate.

Once an investigation has been confirmed for implementation, failure of the PI to maintain reasonable progress within committed schedule and cost, and/or failure to operate within other applicable constraints, may be cause for NASA to convene a termination review. The Associate Administrator (AA) for the Science Mission Directorate may also call for a termination review any time an excursion above the agreed upon mission cost in Phase C through Phase E occurs, or is projected to occur, by the PI, the implementing organization, or NASA. The objective of such a review is to determine whether remedial actions, including changes in management structure and/or Key Management Team members, would better enable the project to operate within established cost, schedule, and/or technical constraints. If a termination review determines that no remedy is likely to improve matters, NASA may consider mission cancellation and/or contract termination. NASA may cancel a mission and/or terminate a contract notwithstanding any international or domestic partnerships established to enable the mission.

4.2 Participation Policies

4.2.1 Eligibility to Participate in this AO

Prospective investigators from any category of organizations or institutions, U.S or non-U.S., are welcome to respond to this solicitation. However, proposals may not include any bilateral participation from China or any Chinese-owned company or entity (see Section 4.2.2). Specific categories of organizations and institutions that are welcome to respond include, but are not limited to, educational, industrial, and not-for-profit organizations, Federally Funded Research and Development Centers (FFRDCs), University Affiliated Research Centers (UARCs), NASA Centers, the Jet Propulsion Laboratory (JPL), and other Government agencies.

There is no restriction on the number of proposals that an organization may submit to this solicitation or on the teaming arrangements for any one proposal, including teaming with NASA Centers and JPL. However, each proposal must be a separate, stand-alone, complete document for evaluation purposes.

NASA contracts for the services of outside, non-Governmental organizations for support in evaluating proposals (see Section 7.1.1). Organizational conflicts of interest between proposing, evaluating, and executing organizations must be avoided. The approach to avoiding

organizational conflicts of interest depends on the unique characteristics and roles of each evaluating organization. For non-Governmental organizations, this requires limiting the extent to which the outside evaluating organizations can participate in proposal development and/or execution of the work proposed. NASA has two general classes of limitation for organizations.

Full Limitation: The NASA contract with the outside organization for evaluation support under this AO creates an unmitigatable organizational conflict of interest for the evaluating organization in the event that any business unit of the organization has a proposed role as prime contractor, subcontractor, or participating organization. Because of this organizational conflict of interest, the evaluating organization is precluded from participating in any capacity in support of a respondent under this AO.

Partial Limitation: The NASA contract with the outside organization for evaluation support under this Announcement of Opportunity creates an organizational conflict of interest for the evaluating organization in the event that any business unit of the organization has a proposed role as prime contractor, subcontractor, or participating organization. Because of this organizational conflict of interest, the evaluating organization is precluded from responding to this AO, from participating as a member of any proposal performance team, and from being proposed as the recipient of any work awarded under this AO. Under appropriate circumstances, respondents to this AO may contract with the evaluating organization for supporting analysis services, including cost analysis, engineering analysis, and resource analysis, if it is deemed in the best interest of the Government and only under the following conditions.

(i) The evaluating organization is precluded from responding to this AO, from participating as a member of any proposal performance team, and from being proposed as the recipient of any work awarded under this AO. The evaluating organization is precluded from providing or developing hardware, including any elements or components, that will be proposed for any work awarded under this AO. The evaluating organization should not be referenced in the proposal, nor should the evaluating organization's analysis be identified in the proposal.

(ii) The evaluating organization has established firewalls within the organization to prevent conflicts of interest between organizational units and employees supporting NASA's evaluation of proposals and organizational units and employees supporting proposal efforts. Any supporting analysis services, including supporting cost analysis and supporting engineering analysis, provided to a proposal team must comply with the firewall that has been established by the evaluating organization and is described in a NASA approved Organizational Conflict of Interest Avoidance Plan.

(iii) The proposer shall fully describe in a memorandum submitted to NASA at the same time as the proposal all of the supporting analysis services provided by the evaluating organization to the proposing team. The memorandum must be signed by the proposing organization and must be concurred on by the evaluating organization. The memorandum shall not be bound into the proposal itself, but must be a separate document. This memorandum must describe all of the work provided by the evaluating organization, must identify any work products of the evaluating organization that are included in the proposal or its appendices, and must list all employees of the evaluating organization who participated in the work.

For this opportunity, two outside evaluating organizations may be used. In this case, their participation in proposed investigations is thus limited, as follows:

- Cornell Technical Services (CTS) will be subject to the "Full Limitation" described above. The NASA Evaluations, Assessments, Studies, Services, and Support (EASSS) contract with CTS creates an unmitigatable organizational conflict of interest for CTS in the event that any business unit of CTS has a proposed role as prime contractor, subcontractor, or participating organization. Because of this organizational conflict of interest, CTS is precluded from participating in any capacity in support of a respondent under this AO.
- The Aerospace Corporation is subject to no limitation. The Aerospace Corporation, as the Federally Funded Research and Development Center (FFRDC) for space systems acquisition, is available to the U.S. Government and other organizations under the terms of its sponsoring agreement with the U.S. Air Force. The Aerospace Corporation has no limitation and is permitted to participate fully in all proposal activities.

4.2.2 Restrictions Involving China

Proposals must not include bilateral participation, collaboration, or coordination with China or any Chinese-owned company or entity, whether funded or performed under a no-exchange-of-funds arrangement.

In accordance with Public Law 112-55, Section 539(a), NASA is restricted from funding any NASA contract, grant, or cooperative agreement action that involves bilateral participation, collaboration, or coordination with China or any Chinese-owned company or entity, whether funded or performed under a no-exchange-of-funds arrangement.

<u>Requirement 3.</u> Proposals must not include bilateral participation, collaboration, or coordination with China or any Chinese-owned company or entity, whether funded or performed under a no-exchange-of-funds arrangement. NFS 1852.225-71 and NFS 1852.225-72 are hereby included by reference.

4.2.3 Constraints on Investigations that are Candidates for Selection

Only those investigations that propose to meet cost, schedule, and launch vehicle requirements that do not exceed the constraints identified in this AO and that demonstrate sufficient margins, reserves, and resiliency to ensure mission success within committed cost and schedule, will be considered for selection.

4.2.4 Responsibility of Principal Investigator for Implementation

The primary responsibility for implementing and executing selected investigations rests with the PI, who will have latitude to accomplish the proposed objectives within committed schedule and financial constraints. This responsibility, however, will be exercised with essential NASA oversight to ensure that the implementation is responsive to the requirements and constraints of the Discovery Program.

4.2.5 NASA Concurrence for Replacement(s) of Key Management Team Members

Any replacement of Key Management Team members (as defined in Section 5.3.5) requires concurrence by NASA.

4.3 Cost Policies

4.3.1 PI-Managed Mission Cost

PI-Managed Mission Cost is defined as the cost proposed by the PI's implementation team to be funded by the Discovery Program for the development and execution of the proposed project, Phases A through F. It includes any reserves applied to the development and operation of the mission as well. The Phase A-D portion of the PI-Managed Mission Cost is capped at the AO Cost Cap (see Section 5.6.1).

Examples of costs to be included in the PI-Managed Mission Cost, unless contributed, are: development activities (*e.g.*, instrument development, spacecraft development, management, software, testing); launch services outside of the standard services provided by NASA; Student Collaborations in excess of the student collaboration incentive (see Section 5.5.3); subcontracting costs, including fees; science Co-Is and all other personnel required to conduct the investigation, analyze data and publish results, and deliver data in an acceptable format to an approved archive; insurance; any program/project-specific costs (*e.g.*, curation of returned samples); and all labor, including contractor and Civil Servant (NASA and non-NASA).

4.3.2 Total Mission Cost

Total Mission Cost is defined as the PI-Managed Mission Cost (see Section 4.3.1), plus any Student Collaboration costs up to the student collaboration incentive (see Section 5.5.3), plus any additional costs that are contributed or provided in any way other than through the Discovery Program (see Section 5.6.7). The Total Mission Cost will define the total value of the baseline investigation, not including the cost of standard launch vehicle and launch services.

4.3.3 Enhanced PI-Managed Mission Cost

Enhanced PI-Managed Mission Cost is defined as the funding that the Discovery Program will be expected to provide to the PI's implementation team for the development and execution of the proposed project, plus the optional components such as any Student Collaboration costs up to the student collaboration incentive (see Section 5.5.3), Engineering Science Investigation (see Section 5.1.8), Science Enhancement option (see Section 5.1.6), Technology Demonstration Opportunity (see Section 5.1.7), or any incentives for the use of NASA-developed technologies (see Table 4).

4.3.4 Mission Funding Profile

The Discovery Program's planning budget can accommodate a selection at the AO Cost Cap with a typical funding profile over a nominal four-year development period. Proposers should propose a funding profile that is appropriate for their investigation and is consistent with the selection and launch readiness dates in Section 3 of this AO. Proposers must not assume that NASA can or will accommodate proposals whose requested funding profile differs significantly from the Discovery Program's planning budget for this AO. While NASA will

consider whether a different funding profile can be accommodated, NASA cannot guarantee that the proposed funding profile will be acceptable. The inability of NASA to accommodate the requested funding profile may be a reason for nonselection of a proposal. A final funding profile for the selected mission will be negotiated.

4.3.5 Availability of Appropriated Funds

Prospective proposers to this AO are advised that funds are not in general available for awards at the time of its release. The Government's obligation to make awards is contingent upon the availability of sufficient appropriated funds from which payment can be made and the receipt of proposals that NASA determines are acceptable for award under this AO.

4.4 Data Policies

4.4.1 Data Analysis

The PI will be responsible for analysis of the mission data (including returned samples) necessary to complete the proposed science objectives and for timely publication of initial scientific results in refereed scientific journals, as part of their mission operations (Phase E) or postmission (Phase F) activities. Data analysis and preliminary analysis of returned samples may be continued during Phase F.

4.4.2 Data Rights

By NASA policy, all science data returned from NASA missions are immediately in the public domain. A short period of exclusive access may be proposed for data radiometric and geometric calibration and validation, but a compelling justification for it must be demonstrated. Any period of exclusive access should be the minimum that is consistent with optimizing science return from the mission. Barring exceptional circumstances, it may not exceed six months.

4.4.3 Delivery of Data to Archive

Mission data will be made fully available to the public by the investigator team through a NASA-approved data archive (*e.g.*, the Planetary Data System, Atmospheric Data Center, High Energy Astrophysics Science Archive Research Center, Space Physics Data Facility, *etc.*), in a readily usable form, in the minimum time necessary but, barring exceptional circumstances, within six months following its collection. The PI will be responsible for collecting the scientific, engineering, and ancillary information necessary to validate and calibrate the data prior to delivery to the archive.

Archival data products will include preflight and in-flight radiometric and geometric calibration data, ancillary and/or engineering data needed or simply useful for the full understanding of the experiment, observation geometry data (such as that supplied by valid SPICE kernels), and complete documentation of the experiment, the instrument and the archived data. If derived data products such as maps are to be considered a result of the proposed experiment, these must also be archived with suitable documentation. In some cases the inclusion of software in an archive may be appropriate, although this can present special problems and should be discussed with the relevant archive.

The PI will be responsible for generating data products that are documented, validated, and calibrated in physical units that are readily usable by the scientific community at large.

International coordinate system and nomenclature standards are required to be used when archiving data and products into the PDS (http://pds.nasa.gov/documents/sr/Chapter02.pdf). Additionally, data archived in the PDS must be compliant with the PDS's "PDS4" archive standards (which have been also adopted by the International Planetary Data Alliance).

The International Astronomical Union (IAU) approves international standards for coordinate systems and nomenclature. Appropriate working groups and their contact information can be found by following links from astrogeology.usgs.gov/groups. NASA's Planetary Cartography Program maintains the core software infrastructure for cartographic processing of a variety of planetary data sets but does not fund mission-specific applications needed to utilize this infrastructure. More information on this software is available from isis.astrogeology.usgs.gov. If proposing to produce geologic maps, extensive guidelines and other materials are available through the NASA/USGS Planetary Geologic Mapping Program (http://planetarymapping.wr.usgs.gov). NASA funds open facilities for producing stereogrammetric and radargrammetric topography and geographical information system products. Information on the capabilities of these facilities and contact information for their leads can be found at astrogeology.usgs.gov/facilities/photogrammetry-guest-facility and astrogeology.usgs.gov/facilities/mrctr. The photogrammetry guest facility also provides limited support for investigators wishing to make use of similar mapping hardware/software systems at their home institutions.

All archive submissions must go through a peer review organized by the archiving organization. Each data provider must participate in the peer review and will be responsible for correcting any liens identified. Data will not be considered submitted to an archive until the peer review is completed and any liens have been addressed and accepted by the archive. Depending on the length of the mission there could be a single peer review at the end of the mission, or more likely, a series of peer reviews at regular intervals throughout the life of the mission–typically every three months.

NASA data archives have budgets to support core activities, including the basic ingestion and review of new data. Proposed mission data archiving plans and budgets must be consistent with the policies and practices of the appropriate NASA, or NASA-approved, data archive. For the Planetary Data System (PDS), guides to the archiving process and tools for data archive preparation may be downloaded from the PDS website (http://pds.nasa.gov/tools/index.shtml). Information on SPICE kernels may be found at the Navigation and Ancillary Information Facility (NAIF) of the PDS (http://naif.jpl.nasa.gov/naif/). For other archives, proposers should contact the archive directly to obtain information regarding the appropriate policies and practices.

Proposals may include funding for up to one year after end-of-operations for the generation and archiving of derived data products. The mission's archive plan must clearly indicate any

plans for such work, including details about what will be archived and the schedule for providing the derived data products to the archive.

4.5 Project Management Policies

4.5.1 Independent Verification and Validation of Software

The NASA Chief Safety and Mission Assurance Officer has the authority to select software projects to which Independent Verification and Validation (IV&V) is to be applied, as defined in NASA-STD-8739.8, *Standard for Software Assurance*, and NPR 7150.2A, *NASA Software Engineering Requirements*. Per NPR 7150.2A, all Category 1 and Category 2 missions with a Payload Classification A or B require IV&V. Since past Discovery missions have been determined to be Category 2 missions (per NPR 7120.5E) with Class B or Class C payloads (per NPR 8705.4) it should be expected that proposed missions will be required to support independent verification and validation of software. The costs for IV&V will be outside of the AO Cost Cap.

See Section 5.2.8 for a discussion of the mission category and payload risk classification of missions proposed to this AO.

4.5.2 Earned Value Management Plan

For government entities, the earned value management (EVM) requirements are listed in NPR 7120.5E. For entities receiving contracts, the EVM requirements are listed in NFS 1834.203-70.

4.5.3 Cost Analysis Data Requirement (CADRe)

NASA has established a Cost Analysis Data Requirement (CADRe) in NPR 7120.5E, Section 4.5.2.c(3), that will apply to investigations selected through this AO. Support contractors funded directly by NASA Headquarters will perform the actual development of the CADRe; the costs for these services need not be included in the proposed PI-Managed Mission Cost. Selected investigations will have to spend project funds only to collect existing documentation and transmit it to the CADRe support contractor at selected major milestones and then to review the completed CADRe for completeness and accuracy.

4.5.4 Conjunction Assessment Risk Analysis

NASA has established a Conjunction Assessment Risk Analysis (CARA) requirement in NPR 8715.6A that will apply to investigations selected through this AO. A CARA team at NASA Goddard Space Flight Center is funded directly by NASA Headquarters to perform the actual analysis and risk assessment; the costs for these services need not be included in the proposed PI-Managed Mission Cost. Investigations to which NPR 8715.6A6A is applicable will have to spend project funds to establish a working interface between the Flight Operations Team and the CARA team to routinely share orbital ephemeris data and maneuver plans, and to perform any maneuver planning activities required for collision avoidance once on orbit. Estimates of how many maneuver planning events may be required in a particular orbit regime are available from the CARA team. The interface between the mission and CARA should be agreed-to and documented one year prior to launch.

For additional information, proposers may contact the Ms. Lauri Newman (Telephone: 301-286-3155; E-mail: lauri.k.newman@nasa.gov).

For information regarding CARA for the Moon and Mars, please contact Mr. Roby Wilson (Telephone: 818-393-5301; E-mail: roby.s.wilson@jpl.nasa.gov).

5. Requirements and Constraints

This section provides general requirements on Step-1 proposals. Supplemental requirements on standard proposal content and format are provided in Appendix B.

5.1 Science Requirements

5.1.1 Scope of Proposed Investigation

A goal is understood to have a broad scope (*e.g.*, discover whether life exists elsewhere in the Universe; discover how and why the Earth's climate and the environment are changing), while an objective is understood as a more narrowly focused part of a strategy to achieve a goal (*e.g.*, identify specific chemical, mineralogical, or morphological features on Mars that provide evidence of past or present life there; understand and improve predictive capability for changes in the ozone layer, climate forcing, and air quality associated with changes in atmospheric composition). Proposed investigations must achieve their proposed objectives; however, the investigation might only make progress toward a goal without fully achieving it.

Requirement 4. Proposals shall describe a science investigation with goals and objectives that address the program science objectives described in Section 2.

Requirement 5. Proposals shall demonstrate how the proposed investigation will fully achieve the proposed objectives.

5.1.2 Traceability of Proposed Investigation

The Discovery Program is intended to perform focused science investigations that conclude with papers published in peer-reviewed archival journals, as well as deposition of appropriately reduced and calibrated data and derived products in designated data archives (see Section 4.4.3)

Requirement 6. Proposals shall clearly state the relationship between the science objectives, the data to be returned, and the instrument complement to be used in obtaining the required data (see Appendix B, Section D, for additional detail).

Requirement 7. Proposals shall include a plan to calibrate radiometrically and geometrically (both preflight and inflight), analyze, publish, and archive the data returned, and shall demonstrate, analytically or otherwise, that sufficient resources have been allocated to carry out that plan within the proposed mission cost. The data plan shall discuss and justify any period of exclusive access to data or data latency period (see Appendix B, Section E, for additional detail).

5.1.3 Mission Science Objectives and Requirements

The ability to determine whether a proposed mission can successfully carry out the proposed science investigation depends on a well-formulated articulation of the proposed science objectives, the information and steps needed to bring closure to the objectives, and the measurements that must be obtained while conducting the mission. The proposed mission is evaluated against the standard of successfully delivering the required measurements.

Requirement 8. Proposals shall state the specific science objectives and their required measurements at a level of detail sufficient to allow an assessment of the capability of the proposed mission to make those specific measurements and whether the resulting data will permit achievement of these objectives (see Appendix B, Sections D and E, for additional detail).

Requirement 9. Proposals shall describe the proposed instrumentation, including a discussion of each instrument and the rationale for its inclusion in the proposed investigation.

5.1.4 Baseline and Threshold Science Missions

The Baseline Science Mission and the Threshold Science Mission are defined to be consistent with NPR 7120.5E as follows:

> The "Baseline Science Mission" is the mission that, if fully implemented, would fulfill the Baseline Science Requirements, which are the performance requirements necessary to achieve the full science objectives of the mission.
>
> The "Threshold Science Mission" is a descoped Baseline Science Mission that would fulfill the Threshold Science Requirements, which are the performance requirements necessary to achieve the minimum science acceptable for the investment.

The differences between the Baseline Science Mission and the Threshold Science Mission provide resiliency to potential cost and schedule growth in the proposed formulation and implementation plan. Any alteration of a mission's implementation that renders the mission unable to accomplish one or more of the Threshold Science Mission objectives is unacceptable, and will result in a Termination Review.

NASA recognizes that, in some circumstances, the Threshold Science Mission may be identical to the Baseline Science Mission.

Requirement 10. Proposals shall specify only one Baseline Science Mission and only one Threshold Science Mission.

Requirement 11. Proposals shall not identify any descopes or other risk mitigation actions that result in the mission being unable to achieve the Threshold Science Mission objectives.

5.1.5 Planetary Protection and Sample Return Policies

5.1.5.1 Planetary Protection

Investigations are subject to the established NASA policies and procedures that address forward contamination (transmittal from Earth to a targeted solar system body) and backward contamination (transmittal to Earth from the targeted body) with respect to other solar system bodies (see NPD 8020.7G, *Biological Contamination Control for Outbound and Inbound Planetary Spacecraft;* NPR 8020.12D, *Planetary Protection Provisions for Robotic Extraterrestrial Missions*; and NASA-HDBK-6022, *NASA Handbook for the Microbiological Examination of Space Hardware (DRAFT),* in the Program Library). Note that forward contamination is of particular concern for Mars and for possible liquid water bodies within icy satellites.

Return of samples from certain target bodies may be subjected to rigorous containment and biohazard testing protocols in accordance with NASA planetary protection policy (see NPR 8020.12D, *Planetary Protection Provisions for Robotic Extraterrestrial Missions* and NASA/CP-2002-211842, *A Draft Test Protocol for Detecting Possible Biohazards in Martian Samples Returned to Earth*, in the Program Library).

Although not formally a part of planetary protection requirements, it is suggested that proposers request a preliminary planetary protection categorization of their mission from the Planetary Protection Officer (PPO) during the early stages of planning — even before proposal submission. Prior to a written request, the project is encouraged to communicate informally with the PPO.

For additional information, proposers may contact the NASA Planetary Protection Officer, Dr. Catharine A. Conley (Telephone: 202-358-3912; E-mail: cassie.conley@nasa.gov).

Requirement 12. Proposals that include an encounter with another solar system body, via flyby, orbiter, lander, or end of mission impact shall address plans for contamination control, as required by NPD 8020.7G and NPR 8020.12D; such investigations shall bear all additional costs generated by any special planetary protection requirements.

Requirement 13. Proposals that include the return of extraterrestrial samples shall address plans to comply with planetary protection requirements as required by NPD 8020.7G and NPR 8020.12D; such investigations shall bear all additional costs generated by any special planetary protection requirements.

See Appendix B, Section J.6.A, for additional detail.

5.1.5.2 Curation of Returned Samples

All samples of extraterrestrial planetary materials returned by NASA missions are NASA property (see NPD 7100.10E, *Curation of Extraterrestrial Materials*, in the Program Library). They shall be delivered to, and processed by, the NASA Astromaterials Curatorial Facility located at the NASA Johnson Space Center (JSC); contact the Manager, Astromaterials Acquisition and Curation Office at the Johnson Space Center: Dr. Cindy Evans,

cindy.evans-1@nasa.gov, 281-483-0519; (http://curator.jsc.nasa.gov/). The Curator will assist proposers in designing a curation plan that meets their mission's requirements for sample preservation and use as well as providing cost estimates for sample curation. The actual costs for all aspects of curation, from planning through distribution and storage, including all required laboratory construction or modification, shall be borne by the mission from inception to two years following sample return.

Requirement 14. Proposals that include the return of extraterrestrial samples shall provide a Sample Curation Plan. See Appendix B, Section J.6.B, for details.

Requirement 15. Proposals that include the return of extraterrestrial samples shall allocate funding for use of the JSC Curatorial Facility, including all aspects of curation.

5.1.5.3 Allocation of Returned Samples to Non-U.S. Partners

As a proportionate return for investment by non-U.S. partners in a mission that returns extraterrestrial materials, a fraction of the total returned sample may be forwarded to the national curatorial facility of the contributing country within six months after delivery to the NASA Astromaterials Curatorial Facility. The amount of samples so transferred must be no more than 25% of the total. Any material allocated to non-U.S. partners during the preliminary examination period must be included in this 25% limitation and the amount of material contributed by the non-U.S. partner to the preliminary examination must be in proportion to the contribution from that partner to the Total Mission Cost minus any Student Collaboration incentive.

Requirement 16. Proposals that include the return of extraterrestrial samples shall specify the terms and conditions of selection of a sample fraction proportional to contributions, but no greater than 25% for transmission to the contributing country, as appropriate.

In the event that the investigation is selected, the final arrangements for the transfer of a fraction of the sample to the contributing country must be established through an international agreement between NASA (with the approval of the Astromaterials Curator) and the contributing non-U.S. partner. NASA will negotiate the terms and conditions of the agreement.

5.1.5.4 Curation of Space-Exposed Hardware

It is the policy of the Discovery Program that any space-exposed hardware returned to Earth will be made available to the science and engineering community for study. Such hardware must be delivered to and processed by the NASA Astromaterials Curatorial Facility located at the NASA Johnson Space Center (JSC). The Astromaterials Curator at the Johnson Space Center is responsible for the physical security, documentation, inventory accountability, environmental preservation, and distribution of any space-exposed hardware delivered to the Curatorial Facility. The Curator will assist proposers in designing a curation plan for returned space-exposed hardware. The actual costs for all aspects of curation, from planning through distribution and storage, including all required laboratory construction or modification, shall be borne by the mission from inception to two years following sample return.

Requirement 17. Proposals that include the return of space-exposed hardware shall include the curation of this hardware in their Sample Curation Plan. See Appendix B, Section J.6.B, for details.

Requirement 18. Proposals that include the return of space-exposed hardware shall allocate funding for use of the JSC Curatorial Facility to document, store and distribute hardware samples, including all aspects of curation.

5.1.6 Science Enhancement Options

Activities such as extended missions, guest investigator programs, general observer programs, participating scientist programs, and/or interdisciplinary scientist programs where appropriate, have the potential to broaden the scientific impact of investigations. Such optional activities may be proposed as Science Enhancement Options (SEOs). Flight hardware may not be proposed as SEOs.

NASA considers any proposed SEO activities as optional. Inclusion of such optional activities in a proposal does not imply a commitment from NASA to fund them, even if the baseline investigation is selected. NASA reserves the right to accept or decline proposed SEO activities at any time during the mission; in particular, the decision may not be made at the time the baseline investigation is selected for flight. The process for deciding on SEO activities may involve further reviews (*e.g.*, a "Senior Review" for extended missions). NASA reserves the right to solicit and select all participants (*e.g.*, guest investigators and participating scientists) in such programs.

Costs for proposed SEO activities must be defined, but will not count against the PI-Managed Mission Cost. Funding requested for SEO activities prior to Phase E should be minimized. As these proposed activities are optional and are not included within the cost capped baseline investigation, the science enabled by SEO activities is not considered as part of the scientific merit of the proposed investigation.

Requirement 19. If SEO activities are proposed, the proposal shall define and describe the proposed activities and their costs.

Requirement 20. If SEO activities are proposed, they shall be clearly separable from the Baseline Science Mission and Threshold Science Mission investigations.

Requirement 21. If an extended mission SEO is proposed, it shall conform to the guidelines provided in the *SMD Mission Extension Paradigm* document found in the Program Library.

See Appendix B, Section E, for additional detail.

5.1.7 Technology Demonstration Options

The Discovery Program recognizes that it would be desirable for Discovery missions to introduce new technologies in order to enable new scientific investigations or enhance the investigation's science return. Demonstration of NASA-developed technologies is described in Section 5.9.3. Proposers may also choose to define a Technology Demonstration Opportunity

(TDO) that may be a non-NASA-developed instrument, investigation, new technology, hardware or software that may be demonstrated on either the flight system or ground system.

Any TDO must use innovative technological approaches that may have continuing applicability to future SMD missions. The constraints on the proposed TDO are that it may not include the demonstration of a radioisotope power system, and it must be clearly separable from the proposed baseline and threshold science investigations to the extent that it will not impact either the Baseline or Threshold Mission if the TDO development has technical, schedule or cost problems and is deleted from the mission, or if the TDO fails in flight.

The proposer must clearly identify the proposed TDO and describe the innovative technology and/or the enhanced science return. If proposed, the proposer must clearly identify the development schedule of the TDO and describe how it can be developed so as to be separable from the proposed baseline science investigation and performance floor science investigation. Review and decision points for determining the TDO readiness for flight must be identified. Backup plans for the TDO technology, if any, should be explained. There will be no penalty assessed for any inherent higher technical risk of the TDO itself.

TDOs will be evaluated as described in Section 7.2. The cost of the TDO must be identified separately from the proposed investigation and will not count against the PI-Managed Mission Cost. If NASA selects the proposed mission, NASA may or may not choose to select the TDO.

Requirement 22. If TDO activities are proposed, the proposal shall define and describe the proposed activities and their costs.

Requirement 23. If TDO activities are proposed, they shall be clearly separable from the Baseline Science Mission and Threshold Science Mission investigations.

5.1.8 Engineering Science Investigation (ESI)

Discovery Program investigations involving entry, descent, and landing (EDL) into the atmosphere of a Solar System object (including the Earth) shall include an Engineering Science Investigation, to be funded outside of the AO Cost Cap, to obtain diagnostic and technical data about vehicle performance and entry environments. Details of the goals and objectives of this activity are available on the Discovery Program Acquisition Website (discovery.larc.nasa.gov) in the Program Library. An estimated cost for the ESI will *not* be required. Details of the ESI will be negotiated with selected investigations during Phase A.

Questions about this ESI may be directed to Ms. Michelle Munk, EDL Principal Investigator for the Space Technology Mission Directorate, michelle.m.munk@nasa.gov or 757-864-2314.

Requirement 24. If an entry, descent, and/or landing into any atmosphere is proposed, a campaign to obtain diagnostic and technical data about vehicle performance and entry environments shall be described in proposal appendix J.14 (see Appendix B, Section J.14).

5.2 Technical Requirements

5.2.1 Complete Spaceflight Missions

The term "complete" encompasses all appropriate mission phases (see Section 4.1.1) from project initiation (Phase A) through mission operations (Phase E), which must include analysis and publication of data in the peer reviewed scientific literature, delivery of the data to an appropriate NASA data archive, preliminary analysis of returned samples, and, if applicable, extended mission operations or other science enhancements (see Section 5.1.6), and closeout (Phase F). The term "spaceflight missions" is defined as Earth orbital and deep-space missions; it specifically excludes suborbital missions (*e.g.*, via sounding rockets, balloons, and aircraft).

Requirement 25. Proposals submitted in response to this AO shall be for complete science investigations requiring a spaceflight mission.

Requirement 26. Proposals shall describe the proposed mission architecture and the rationale for each mission element.

Requirement 27. Proposals shall describe the proposed mission design and mission operations concept.

Requirement 28. Proposals shall describe the proposed flight system concept, including the spacecraft bus and its major subsystems.

Requirement 29. Proposals shall describe the development approach for implementing the proposed mission within schedule and cost constraints, including a project schedule covering Phases A-F.

Proposals traditionally considered as "data buys" are not permitted in response to this AO.

See Appendix B, Section F, for additional detail.

5.2.2 Accepted Management Processes and Practices

The document NPR 7120.5E, *NASA Space Flight Program and Project Management Processes and Requirements*, delineates activities, milestones, and products typically associated with Formulation and Implementation of projects; it should be used as a reference in defining an investigation team's management approach. The implementing organizations are free to propose their own processes, procedures, and methods for managing their missions; however, they must be consistent with the principles of NPR 7120.5E. Any deviations from NPR 7120.5E will require a waiver during formulation.

Requirement 30. Proposals shall describe the investigation's proposed management approach, including the management organization and decision-making process, the teaming arrangement, the responsibilities of the PI and other team members, and the risk management and risk mitigation plans (see Appendix B, Section G, for additional detail).

The document NPR 7123.1B, *NASA Systems Engineering Processes and Requirements*, clearly articulates and establishes the requirements on the implementing organization for performing, supporting, and evaluating systems engineering. This systems approach is applied to all elements of a system and all hierarchical levels of a system over the complete project life cycle. NPR 7123.1B should be used in defining the Investigation Team's systems engineering approach. The implementing organizations are free to propose their own processes, procedures, and methods for systems engineering; however, they must be consistent with NPR 7123.1B.

Requirement 31. Proposals shall describe the investigation's proposed systems engineering approach, including plans, tools, and processes for requirements, interfaces, and configuration management. (see Appendix B, Section F, for additional detail).

Requirement 32. Proposals shall describe any deviations from NPR 7120.5E, NPR 7123.1B, or other NASA procedural requirements that will require a waiver during formulation.

5.2.3 New Technologies/Advanced Engineering Developments

This AO solicits flight missions, not technology or advanced engineering development projects. Proposed investigations are generally expected to have mature technologies, with systems at a Technology Readiness Level (TRL) of six or higher. For the purpose of TRL assessment, "systems" are defined as level three WBS payload developments (i.e., individual instruments) and level three WBS spacecraft elements (e.g., electrical power system); see Figure 3-7 of the *NASA WBS Handbook*, NASA/SP-2010-3404, which can be found in the Program Library. TRLs are defined in NPR 7123.1B *NASA Systems Engineering Processes and Requirements*, Appendix E, which can be found in the Program Library as well.

Proposals with a limited number of less mature technologies and/or advanced engineering developments are permitted as long as they contain a plan for maturing these systems to TRL six (see NASA/SP-2007-6105 Rev 1, *NASA Systems Engineering Handbook*) by no later than PDR and adequate backup plans that will provide mitigation in the event that the systems cannot be matured as planned. An independent team will validate the technological maturity of these systems at PDR.

Section 5.9.3 of this AO provides guidelines for infusion of NASA-developed technologies. NASA assumes the responsibility for maturing these technologies to TRL six. Therefore, proposals that include utilization of these NASA-developed technologies will not be required to include a maturation plan for them. Proposals will, however, be required to include a plan for the infusion of these technologies (see Appendix B, Section J.13).

Requirement 33. Proposals that use systems currently at less than TRL six shall include a plan for system maturation to TRL six by no later than PDR and a backup plan in the event that the proposed systems cannot be matured as planned (see Appendix B, Section F, for additional detail). For any system that includes NASA-developed technologies described in Section 5.9.3, this requirement only applies to the balance of the system.

5.2.4 Environmental Review and Launch Approval

The process by which the environmental review and launch approval (if applicable) requirements are satisfied is referred to as "launch approval engineering." Multiple organizations within NASA, and possibly outside of NASA, participate in this process. Although it is the responsibility of NASA to ensure that all such requirements are satisfied, missions will have to allocate resources to provide inputs into the process, participate in the development and implementation of any contingency plans or risk communication plans, and participate in launch approval reviews. Additionally, spacecraft and mission designs will have to take into account risk reduction and range safety issues.

5.2.4.1 Environmental Review and Launch Approval

The *National Environmental Policy Act* (NEPA) *of 1969*, as amended (42 USC 4321 *et seq*.), is the nation's policy for the protection, maintenance, and enhancement of the environment. It requires NASA decision-makers to take environmental factors into account during the decision-making process. NASA is required to comply with NEPA for activities involving research and development, space flight activities, and program management. NASA implements NEPA using 14 CFR Part 1216.3, *Procedures for Implementing the National Environmental Policy Act*, NPR 8580.1, *Implementing the National Environmental Policy Act and Executive Order* 12114, and the Council on Environmental Quality (CEQ) *Regulations for Implementing the Procedural Provisions of NEPA* (40 CFR Parts 1500-1508).

NASA is responsible for determining the proper level of NEPA and related documentation required for a mission and ensuring that the process is completed during the preliminary design and technology development phase of a mission (per NPR 7120.5E, Section 4.5.2(2)). Depending on the potential environmental impacts of a selected mission, one of three levels of NEPA documentation will be required:

- Record of Environmental Consideration and a NASA Routine Payload (NRP) Checklist;
- Preparation of a mission unique Environmental Assessment (EA); or
- Preparation of a mission unique Environmental Impact Statement (EIS).

Questions concerning environmental review requirements or NEPA may be addressed to Ms. Tina Norwood, the NASA NEPA Program Manager, at (202) 358-7324 or by E-mail at tina.norwood-1@nasa.gov.

5.2.4.2 Use of Radioactive Material

The proposed use of radioactive materials of any quantity and any isotope, including radioisotope heater units or radiological sources for science instruments, will require review for environmental impact and nuclear launch safety approval (NLSA). The NLSA requirements are specified in NPR 8715.3C, *NASA General Safety Program Requirements*, Chapter 6: "Nuclear Safety for Launching of Radioactive Materials." The effort required for NLSA varies between a concurrence from the NASA Office of Safety and Mission Assurance for low-level radioactive sources (*i.e.*, with an A2 mission multiple less than ten, as defined in NPR 8715.3C, Chapter 6 and Appendix D) to a full interagency review and approval from the Executive Office of the President for radioisotope power sources or radioisotope heater units.

Requirement 34. If use of radioactive materials of any quantity and any isotope is proposed (including radioisotope heater units or radiological sources for science instruments), the proposal shall include a listing of the estimated radioactive materials to be used (isotope, form, quantity). The proposal shall provide a rationale for the use of radioactive materials and reasonable, nonnuclear alternatives.

This AO allows for missions to baseline use of minor radiological sources for science instrumentation and radioisotope heater units (RHUs). If RHUs are to be used in a mission proposed for this AO, NASA, under an agreement with the Department of Energy (DOE), will provide these, as well as the services associated with their provisioning on space missions. However, the use of RHUs is not without costs charged against the PI-Managed Mission Cost; missions will have to fund the environmental and nuclear launch safety review processes (see Sections 5.2.4.1, 5.2.4.2, and 5.2.4.4). For questions concerning RHUs, contact Mr. Carl Sandifer, Radioisotope Power Systems Program Office, at (216) 433-8727 or by E-mail at carl.e.sandifer@nasa.gov.

Requirement 35. The costs of services associated with the use of RHUs and any minor sources shall be included within the PI-Managed Mission Cost (see the *Lightweight Radioisotope Heater Unit Information Summary* document in the Program Library).

Launch processing of a mission that uses radioisotope heater units is a nonstandard launch service that carries an additional cost against the PI Managed Mission Cost (see Section 5.9.2).

Questions concerning the NLSA process may be addressed to Ms. Suzanne Aleman, NASA Coordinator for Nuclear Safety, Office of Safety and Mission Assurance, at (202) 358-1745 or by E-mail at suzanne.m.aleman@nasa.gov.

5.2.4.3 Restricted Sample Return

If a mission plans on returning samples to the Earth from a Solar System body deemed by scientific opinion to potentially harbor indigenous life, a safety approval process with the Executive Office of the President will be necessary (see NPR 8020.12D). Specific planetary protection requirements for each planned mission will be determined by the NASA Planetary Protection Officer, in accordance NPR 8020.12D, and consistent with the policy and guidelines of the Committee on Space Research (COSPAR), recommendations of the Space Studies Board of the National Research Council (NRC), and advice from the NASA Advisory Council. The direct or indirect environmental effects that may be associated with sample return will have to be documented and the decision to approve the sample return will rest with the NASA Administrator and the Director of the Office of Science and Technology Policy (OSTP). Proposers are encouraged to review the *Sample Return Primer and Handbook,* found in the Program Library, which contains procedures for Unrestricted Earth Return. Additional constraints on Restricted Earth Return missions are outlined in NPR 8020.12D

5.2.4.4 Accommodating Environmental Review and Launch Approval Requirements

The costs associated with satisfying the requirements of the NEPA and NLSA are borne by a range of organizations. The launch of radioactive materials entails "nonstandard launch services" which are detailed in the *Launch Services Information Summary* document in the Program Library. The costs for these services, distinct from the costs associated with the development of NEPA and NLSA documents, must be included in the PI-Managed Mission Cost. The cost associated with the launch of radioactive materials (including RHUs) is $11M for non-standard launch services.

The costs for the development of some NEPA and NLSA documents will also be considered part of the PI-Managed Mission Cost. These last costs vary depending on the attributes of the proposed mission, as shown in Table 1; the costs in Table 1 are to be used for proposal preparation and are firm, fixed costs; proposals should not add margin onto them. There is no need to identify which year the costs will be expended or to convert the costs into real year dollars.

Also shown in Table 1 are the key milestones that missions will have to accommodate in their scheduling. The proposed mission must provide only portions of the documents required to meet these milestones; NASA, DOE, and their contractors will produce the majority of them. Proposed missions, however, must be cognizant of the environmental review and launch approval schedule constraints imposed by NASA's processes.

Table 1: Key milestones and costs for launch approval processes in FY15 dollars. Costs for nonstandard launch services are not included.

Mission Attributes				
RHUs?	**Sample Return?**	**A2 Mission Multiple[§]**	**Cost**	**Key Milestones**
No	No	Less than 10	$100K	Final NEPA Document: by PDR
No	No	Between 10 and 500	$800K	Final NEPA Document: by PDR OSMA Nuclear Safety Review Document: 5 months before launch
No	No	Between 500 and 1000	$9M	NEPA Notice of Intent: 19 months before CDR Representative Databook: 26 months before CDR Final NEPA Document: 1 month before CDR Safety Analysis Summary to OSMA: 5 months before launch Final Risk Communication Plan: 1 month before PDR
No	Unrestricted	Less than 10	$500K	Final NEPA Document: by PDR
No	Unrestricted	Between 10 and 500	$800K	Final NEPA Document: by PDR OSMA Nuclear Safety Review Document: 5 months before launch
No	Unrestricted	Between 500 and 1000	$9M	NEPA Notice of Intent: 19 months before CDR Representative Databook: 26 months before CDR Final NEPA Document: 1 month before CDR Safety Analysis Summary to OSMA: 5 months before launch Final Risk Communication Plan: 1 month before PDR

Mission Attributes				
RHUs?	**Sample Return?**	**A2 Mission Multiple[§]**	**Cost**	**Key Milestones**
No	Restricted	Any	$7M*	NEPA Notice of Intent: 19 months before CDR Final NEPA Document: 1 month before CDR Final Risk Communication Plan: 1 month before PDR
Yes	No	Any	$25M[†]	NEPA Notice of Intent: 19 months before CDR Representative Databook: 26 months before CDR Final NEPA Document: 1 month before CDR SAR Launch Vehicle Databook: 3 years before launch OSTP Request for Launch Approval: 6 months before launch Final Risk Communication Plan: 1 month before PDR
Yes	Unrestricted	Any	$28M[†]	NEPA Notice of Intent: 19 months before CDR Representative Databook: 26 months before CDR Final NEPA Document: 1 month before CDR SAR Launch Vehicle Databook: 3 years before launch OSTP Request for Launch Approval: 6 months before launch Final Risk Communication Plan: 1 month before PDR
Yes	Restricted	Any	$35M*[†]	NEPA Notice of Intent: 19 months before CDR Representative Databook: 26 months before CDR Final NEPA Document: 1 month before CDR SAR Launch Vehicle Databook: 3 years before launch OSTP Request for Launch Approval: 6 months before launch Final Risk Communication Plan: 1 month before PDR

[§]For a definition of the A2 mission multiple, see NPR 8715.3C, Appendix D.
*This does not include environmental documentation that may be required to cover any use/modification/development of a sample receiving facility.
[†] Use of RHUs will also incur a cost of $11M for non-standard launch services.

Requirement 36. The costs of environmental review and launch approval shall be included in the PI-Managed Mission Cost. The key milestones for environmental review and launch approval shall be accounted for in the proposed schedule.

5.2.5 Telecommunications, Tracking, and Navigation

Use of NASA's Near-Earth Network, Space Network, or Deep Space Network (DSN) may be proposed, as appropriate. Points of contact and cost information for these services may be found in the *NASA's Mission Operations and Communications Services* document in the Program Library.

Proposers should consult the DSN Future Missions Planning Office website (http://deepspace.jpl.nasa.gov/advmiss/) for information about the capabilities of the DSN. For assistance, contact the persons named on the website. In the past, proposers to Discovery AO were required to provide cost estimates for DSN Aperture Fees and include those estimates in the PI-Managed Mission Cost. Proposers should compute the estimated DSN Aperture Fees and report this in their proposal as a means of assessing the reasonableness of the proposed DSN use. DSN Aperture Fees should *not* be included in the PI-Managed Mission Cost nor should they appear in any cost table.

When the use of non-NASA communication services is proposed, NASA reserves the option of contracting for those services directly through its Space Communication and Navigation (SCaN) office. Further information may be obtained from the point of contact in the *NASA's Mission Operations and Communications Services* document. NASA funds may not be used for the construction of new facilities for non-NASA communications services.

Requirement 37. Proposals shall include mission requirements for telecommunications, tracking, and navigation; proposals shall also include a plan for meeting those requirements. If non-NASA networks are used, a cost plan for the use of services must also be included in the PI-Managed Mission Cost.

Requirement 38. If use of NASA's network services is proposed, costs for services, as described in the NASA's Mission Operations and Communications Services document, including the cost of any development but excluding DSN Aperture Fees, must be included in the PI-Managed Mission Cost and the proposal's cost plan. Cost estimates for DSN Aperture Fees shall be included in the proposal, but not in any cost table.

Requirement 39. Proposals shall include a discussion of their use of NASA telecommunications, tracking, and navigation services, if used, demonstrating that the plan for use makes efficient use of NASA assets.

Where the use of NASA's network services is clearly within the capabilities and capacities described in the *NASA's Mission Operations and Communications Services* document, no Letter of Commitment is required from the NASA network provider.

Where the use of NASA's network services may not be within the capabilities and capacities described in the *NASA's Mission Operations and Communications Services* document, discussions should be initiated with the Point of Contact (POC) named in that document. In this case, a Letter of Commitment is required from the NASA network provider describing the network's ability to deliver the required capabilities and capacities and the cost for doing so.

It is SMD policy that only one DSN 34 meter antenna will be scheduled at the same time during normal operations of the selected Discovery mission. It is SMD policy that none of the DSN 70 meter antennas may be proposed to support normal operations of the selected Discovery mission. These restrictions do not apply to station hand-offs, critical event coverage, emergency services, radio science measurements, or navigation observations (*e.g.*, delta differential one-way ranging or delta-DOR).

NASA intends to transition all deep-space missions launched after 2016 to the use of Ka-band for science data return (telemetry, tracking, and commanding (TT&C) data may still be transmitted using X-band). In order to better manage the Agency's transition to Ka-band service, proposed investigations shall baseline the use of Ka-band for science data return. The Space Frequency Coordination Group (SFCG) has recommended (Recommendation 23-1, available at https://www.sfcgonline.org/) that X-band users be limited to using 12 MHz of spectrum in deep space and 8 MHz at Mars (where there are multiple missions). Where appropriate, these limits will be imposed on missions proposed to this AO.

Requirement 40. If use of NASA's network services beyond the capabilities and capacities described in the *NASA's Mission Operations and Communications Services* document is proposed, the proposal shall include a Letter of Commitment from the NASA network provider; the Letter should confirm the ability of the network to provide the required capabilities and capacities and should include an estimate of the additional costs for these capabilities and capacities.

Requirement 41. Proposals shall baseline the use of Ka-band for science data return. If the use of Ka-band is inappropriate for the proposed investigation (based on the SFCG recommendations), then the proposal shall contain a justification for the use of an alternative communications approach.

Requirement 42. Proposals that propose the use of the DSN shall baseline the use of only one DSN 34 meter antenna at any time for normal operations (not including periods of station hand-off, emergencies, DDOR measurements, *etc.*).

5.2.6 Critical Event Coverage

Critical events in the operation of a spacecraft are defined as those that must be executed successfully, usually in a single opportunity, as failure could lead to early loss or significant degradation of the mission if not executed successfully or recovered from quickly in the event of a problem.

NPR 8705.4, *Risk Classification for NASA Payloads*, requires that critical event telemetry be recovered for reconstruction of an anomaly, should one occur. Telemetry coverage is required during all mission critical events to assure data is available for critical anomaly investigations to prevent future recurrence. NPR 8705.4 provides examples of critical events. Critical event coverage may be provided in any fashion that is deemed appropriate for the proposed investigation.

Requirement 43. Proposals shall specify all critical events for the proposed mission and shall discuss the technical approach, required resources, and implementation concepts for providing critical event telemetry.

5.2.7 End-of-Mission Spacecraft Disposal Requirement

NPR 8715.6A, *NASA Procedural Requirements for Limiting Orbital Debris*, specifies that spacecraft are to limit the generation of orbital debris during operations and spacecraft disposal requirements for all Earth- and Moon-orbiting spacecraft. Earth-orbiting spacecraft must be passivated at the end of the mission prior to disposal and be deorbited within 25 years of end-of-mission (or 30 years after launch, whichever comes first), or be placed in a disposal orbit above 2000 km but not within 300 km of geosynchronous orbit (GEO). Lunar missions must address disposal to avoid increasing the hazard to other spacecraft. Please note that NASA prefers powered controlled reentries for disposal.

Requirement 44. As applicable for Earth and Moon orbiters, proposals shall demonstrate satisfaction of the orbit disposal requirement by providing a mission lifetime analysis and

indicating whether disposal is in orbit or with a reentry, either controlled or uncontrolled (see Appendix B, Section J.7, for additional detail).

5.2.8 Mission Category and Payload Risk Classification

NPR 7120.5E, *NASA Space Flight Program and Project Management Requirements*, establishes guidelines for categorizing NASA missions based on the estimated total mission cost and mission priority level. The mission categorization guidelines are given in Section 2.1.4 and Table 2-1 of NPR 7120.5E.

NPR 8705.4, *Risk Classification for NASA Payloads*, establishes baseline criteria that enable a definition of the risk classification level for NASA payloads. It defines four payload risk levels or classes, A through D, and provides guidance for programmatic options during development based on this class. The requirements for each class are specified in Appendix B of NPR 8705.4.

Historically, Discovery missions have been determined to be Category 2 missions (per NPR 7120.5E) with Class B or Class C payloads (per NPR 8705.4). Investigations using nuclear power sources, however, are Category 1 missions by regulation (see NPR 7120.5E).

Requirement 45. Based on the criteria for mission categorization in NPR 7120.5E and risk classification in NPR 8705.4, proposers shall propose a mission categorization and risk classification for their proposed mission. Proposers shall incorporate appropriate work effort and support in their proposals accordingly.

Proposed categorization and risk classification will be confirmed or modified by the NASA Decision Authority at selection points KDP-A and KDP-B.

5.2.9 Deviations from Recommended Payload Requirements

Discovery missions are required to meet the requirements for safety, reliability, and mission assurance in the *Discovery Program Safety and Mission Assurance Guidelines and Requirements* document (see Program Library).

Requirement 46. Proposals shall indicate any expected deviations from the recommended requirements in the *Discovery Program Safety and Mission Assurance Guidelines and Requirements* document and in Appendix B of NPR 8705.4 for the payload class specified in Section 5.2.8.

5.2.10 Mission Operations Tools and Services

NASA's Advanced Multi‑ Mission Operating System (AMMOS) comprises a set of tools and services that support the operations of robotic flight missions (see the AMMOS catalog at ammos.jpl.nasa.gov). AMMOS tools and services and their long-term sustaining engineering are fully funded by NASA, and are provided by NASA free of charge to all missions. Missions must fund only mission-unique adaptations to the AMMOS. Use of applicable AMMOS tools is expected, *although not required*. A point of contact and costing information for these

services may be found in the *NASA's Mission Operations and Communications Services* document in the Program Library.

It is expected that any mission operations tools or services to be developed by the investigation, and their sustaining engineering, will be described and budgeted in the proposal.

Requirement 47. If a ground/operations system solution other than the AMMOS is proposed, a justification must be provided for this choice (see Appendix B, Section J.15).)

5.3 Management Requirements

See Appendix B, Section G, for additional detail.

5.3.1 Principal Investigator

The Principal Investigator (PI) is accountable to NASA for the success of the investigation, with full responsibility for its scientific integrity and for its execution within committed cost and schedule. Designation of a deputy PI is recommended, but not required.

The PI must be prepared to recommend project termination when, in her/his judgment, the minimum subset of science objectives identified in the proposal as the Threshold Science Mission (Section 5.1.4) is not likely to be achieved within the committed cost and schedule.

Requirement 48. A proposal shall identify and designate one, and only one, PI as the individual in charge of the proposed investigation.

5.3.2 Project Manager

The Project Manager (PM) oversees the technical and programmatic implementation of the project. The PM works closely with the PI in order to ensure that the mission meets its objectives within the resources outlined in the proposal.

Proposals may designate a Project Manager Alternate. At selection and subject to the approval of NASA, the Alternate may be named as the PM. The qualifications of both the PM and the PM Alternate will be evaluated.

NASA will approve the PM at each transition to the next Phase of implementation as part of the KDP approval process.

Requirement 49. A proposal shall identify and designate one, and only one, PM as the individual charged with the responsibility for overseeing the technical and programmatic implementation of the proposed project. Proposals may optionally name a single Project Manager Alternate.

5.3.3 Project Systems Engineer

The Project Systems Engineer (PSE) is responsible for the systems engineering management of the project.

Requirement 50. A proposal shall identify and designate, one and only one, PSE as the individual responsible for the systems engineering process implementation of the proposed project.

5.3.4 PI, PM, AND PSE Roles

Requirement 51. Proposals shall clearly define the respective roles of the PI and PM, and PSE.

5.3.5 Management and Organization Experience and Expertise

The qualifications and experience of the PI, PM, Project Systems Engineer (PSE), Project Scientist (PS) (if named), Project Manager Alternate (if named), and other Key Management Team members of the PI-led investigation team must be commensurate with the technical and managerial needs of the proposed investigation.

The implementing institutions, selected and overseen by the PI, have the responsibility to ensure that the mission meets schedule and cost constraints. It is the PM and the implementing institutions' responsibility to provide the quality personnel and resources necessary to meet the technical and managerial needs of the mission. The commitment, spaceflight experience, and prior experience of the key members of the PI-led investigation team and of the implementing institutions will be assessed against the needs of the investigation.

Proposals shall identify the management positions that will be filled by Key Management Team members. These positions shall include, as a minimum, the PI, PM, PSE, Project Manager Alternate (if named), and, where appropriate, the PS and partner leads for substantial efforts. For management positions for which Key Management Team members are named (PI, PM, and PSE per Requirement 48, Requirement 49, and Requirement 50), proposals shall describe the qualifications and experience of those team members who occupy those positions. For management positions for which Key Management Team members are not named, proposals shall describe the qualifications and experience required of any candidate to occupy those positions. For all positions that will be filled by Key Management Team members, proposals shall demonstrate that the described qualifications and experience are commensurate with the technical and managerial needs of the proposed investigation.

Requirement 52. Proposals shall describe the qualifications and experience of the primary implementing institutions and demonstrate that they are commensurate with the technical and managerial needs of the proposed investigation.

5.3.6 Risk Management

Proposers must demonstrate clear understanding of specific risks inherent in the formulation and implementation of their proposed investigation and must discuss their approaches to mitigating these risks. Examples of such risks that must be discussed in the proposal are: any new technologies/advanced engineering developments, or any nontrivial modifications or upgrades of existing technologies, proposed for the investigation; any validation of heritage technology for the mission context; any manufacturing, test, or other facilities needed to ensure successful completion of the proposed investigation; any need for long-lead items that must be

placed on contract before the beginning of Phase C to ensure timely delivery; and any contributions that are critical to the success of the mission.

Requirement 53. Proposals shall define and discuss the major risks to the formulation and implementation of the proposed investigation.

Requirement 54. Proposals shall discuss management approaches to mitigate risks to ensure successful achievement of the investigation objectives within the committed cost and schedule.

The differences between the Baseline Science Mission and the Threshold Science Mission (see Section 5.1.4) may provide some resiliency to potential cost and/or schedule growth in the proposed formulation and implementation of the investigation. One method of responding to such growth is to reduce the capabilities of the mission (to "descope" the mission). Any set of descopes, which still allows the investigation to satisfy the objectives of the Threshold Science Mission, may be proposed.

Requirement 55. If the proposed risk management approach includes potential descoping of mission capabilities, the proposal shall include a discussion of the approach to such descopes, including savings of resources (mass, power, dollars, schedule, etc.) by implementing descopes, and the decision milestone(s) for implementing descopes, and the scientific impact of individual, as well as combined, descopes.

Requirement 56. Proposals that include international participation shall address the risk resulting from any international contributions to the proposed mission (see Section 5.6.7 and Section 5.7).

5.3.7 Compliance with Procurement Regulations by NASA PI Proposals

Proposals submitted by NASA Centers are required to comply with regulations governing proposals submitted by NASA PIs (NASA FAR Supplement (NFS) 1872.308). Additional instructions may be found in Procurement Information Circular (PIC) 05-15 (available in the Program Library).

Requirement 57. Proposals submitted by NASA Centers shall contain any descriptions, justifications, representations, indications, statements, and/or explanations that are required by the regulations in NFS 1872.308 (see Appendix B, Section J.8, for additional detail).

5.4 Science Team, Co-Investigators, and Collaborators

5.4.1 Science Team

Requirement 58. Proposals shall clearly define the science team necessary to successfully conduct the science investigation.

5.4.2 Co-Investigators

A Co-Investigator (Co-I) is defined as an investigator who plays a necessary role in the proposed investigation and whose services are either funded by NASA or are contributed by his/her employer.

Every Co-I must have a role that is required for the successful implementation of the mission, and the necessity of that role must be justified. The identification of any unjustified Co-Is may result in the downgrading of an investigation and/or the offer of only a partial selection by NASA.

Requirement 59. Proposals shall designate all Co-Is, describe the role of each Co-I in the development of the mission, and justify the necessary nature of the role.

Requirement 60. Proposals shall identify the funding source for each Co-I. If funded by NASA, costs shall be included in the PI-Managed Mission Cost. If contributed, the costs shall be included in the Total Mission Cost.

5.4.3 Collaborators

A collaborator is an individual who is less critical to the successful development of the mission than a Co-I. A collaborator must not be funded through the proposal. A collaborator may be committed to provide a focused contribution to the project for a specific task, such as data analysis. If funding support is requested in the proposal for an individual, that individual must not be identified as a collaborator, but must be identified as a Co-Investigator or another category of team member.

Requirement 61. Proposals shall identify and designate all collaborators.

5.5 Small Business Participation and Education and Communications

5.5.1 Small Business Participation

It is the policy of the Government when contracts are issued to emphasize subcontracting opportunities for small businesses. Offerors are advised that NASA is subject to statutory goals to allocate a fair portion of its contract dollars to small businesses, small disadvantaged business (SDB) concerns, Historically Black Colleges and Universities (HBCUs), and Other Minority Institutions (OMIs), as these entities are defined in Federal Acquisition Regulations (FAR) 52.219-8 and 52.226-2. Offerors are encouraged to assist NASA in achieving these goals by using best efforts to involve these entities as subcontractors to the fullest extent consistent with efficient performance of their investigations.

Offerors are advised that, by law, for NASA prime contracts resulting from this solicitation which offer subcontracting possibilities, exceed $650,000, and are with organizations other than small business concerns, the clause at FAR 52.219-9 will apply. Offerors other than small businesses submitting a proposal are advised that a small business subcontracting plan is required with goals for subcontracting with small business (SB), small disadvantaged business (SDB), veteran-owned small business (VOSB), service-disabled veteran-owned small business (SDVOSB), Historically Underutilized Business Zone (HUBZone) small business (HBZ),

women-owned small business (WOSB), HBCU, and OMI entities to the maximum practicable extent. Failure to submit a required subcontracting plan will make the offeror ineligible for selection. The subcontracting plans will be evaluated on the participation goals and quality and level of work performed by small business concerns overall, as well as that performed by the various categories of small business concerns listed in FAR 52.219-9.

However: proposals are not required to include small business subcontracting plans, but selected investigations will be required to provide them prior to negotiation and award (see Section 7.4.3). Failure to submit a subcontracting plan after selection will make the offeror ineligible for award of a contract. The subcontracting plans will be evaluated on the participation goals and quality and level of work performed by small business concerns overall, as well as that performed by the various categories of small business concerns listed in FAR 52.219-9.

At the time the Phase A concept study report is delivered, regardless of whether subcontracting plans are submitted with the Step-1 proposal, offerors other than small business concerns are required to submit small business subcontracting plans, covering Phases B/C/D/E/F. Failure to submit a subcontracting plan will make the offeror ineligible for subsequent implementation and operation phases. As part of the Step-2 continuation (downselect) decision process, these subcontracting plans will be evaluated on the participation goals and quality and level of work performed by small business concerns overall, as well as that performed by the various categories of small business concerns listed in FAR 52.219-9, except for SDBs. Offerors will separately identify and will be evaluated on participation targets of SDBs in North American Industry Classification System (NAICS) codes determined by the Department of Commerce to be underrepresented industry sectors.

5.5.2 Education and Communication (E&C) Program

Among NASA's strategic goals is to communicate the results of its efforts to the American public and to enhance the science and technical education of the next generation of Americans. However, E&C plans are not needed at this time. NASA may impose E&C requirements during or subsequent to the Phase A concept study phase and will negotiate any additional funding necessary to meet these requirements.

5.5.3 Student Collaborations

Proposals may define a Student Collaboration (SC) that is a separate part of the proposed investigation. A SC can take the form of an instrument development, an investigation of scientific questions, analysis and display of data, development of supporting hardware or software, or other aspects of the investigation. The SC must be incorporated into the mission on a nonimpact 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. A SC must be dependent upon the proposed mission being implemented, *e.g.*, require the provision of flight elements and/or access to science/engineering data generated by the mission. SC elements that involve only analysis of archival data may not be proposed. A SC may, but is not required to, have the potential to add value to the science or engineering of the mission. A SC must include

appropriate plans for the mentoring and oversight of students to maximize the opportunity for teaching, learning, and success in contributing to the mission.

There is no minimum and no maximum allowable cost for a SC. NASA is providing a student collaboration incentive that is defined to be 1% of the PI-Managed Mission Cost. Contributions to the SC are permitted. The proposed NASA cost of the SC, up to the student collaboration incentive, may be outside of the PI-Managed Mission Cost. If the SC costs NASA more than the student collaboration incentive, then the rest of the NASA cost of the SC must be within the PI-Managed Mission Cost.

If a proposed investigation is selected, NASA retains the option to fund or not to fund any proposed SC.

In the Step-1 evaluation, a proposed SC will be evaluated only for its impact on mission feasibility. The merit of the proposed SC will not be evaluated in the Step-1 evaluation; the merit of the proposed SC will be evaluated as part of the evaluation of the Step-2 Concept Study Report.

Requirement 62. If a proposal contains a SC, the proposal shall demonstrate that the proposed SC is clearly separable from the proposed Baseline and Threshold Science Mission investigations, to the extent that the SC will not impact the science investigation in the event that the SC is not funded; that the SC fails during flight operations; or that the SC encounters technical, schedule, or cost problems during development (see Appendix B, Section I.3, for additional detail).

Requirement 63. If a proposal contains a SC, the proposal shall identify the funding set aside for the SC; this funding may be outside the PI-Managed Mission Cost up to the student collaboration incentive, and any SC costs beyond the student collaboration incentive shall be within the PI-Managed Mission Cost.

5.6 Cost Requirements

5.6.1 PI-Managed Mission Cost and Total Mission Cost

The Phase A through D portions of the PI-Managed Mission Cost, excluding the cost of launch vehicles (Section 5.9.2), is capped at $450M FY 2015 dollars. Development of ground or flight system software and the development, fabrication, or refurbishment of test-beds, which may occur during Phase E, will be considered deferred Phase D work and will be included under the AO Cost Cap.

Requirement 64. Proposals shall include the proposed PI-Managed Mission Cost and the proposed Total Mission Cost in all required AO cost tables (see Appendix B, Section H, for required AO cost tables).

Requirement 65. The proposed costs shall comply with the AO Cost Cap.

Requirement 66. No more than 25% of the PI-Managed Mission Cost may be spent between initial selection for a Phase A Concept study and KDP-C (Confirmation).

5.6.2 Cost of the Phase A Concept Study

Proposers selected through this AO will be awarded a contract to conduct a Phase A concept study with a duration of approximately nine months following the establishment of initial contracts. The cost of the Phase A concept study is capped at $3M Real Year (RY) dollars. See Sections 7.4.3 and 7.4.4 for additional information on the Phase A concept study.

Requirement 67. Proposals shall include the cost of the Phase A concept study, which shall be included within the PI-Managed Mission Cost, and the proposed cost shall comply with the Phase A concept study cost cap.

Requirement 68. Proposals shall specify the proposed teaming arrangements for the Phase A concept study, including any special contracting mechanisms that are advantageous for specific partners in the team. If more than one contractual arrangement between NASA and the proposing team is required, proposals shall identify how funds are to be allocated among the partnering organizations.

Unique mission management approaches and organizational arrangements in the selected proposals may require the Program Office to implement diverse contract administration and funding arrangements.

5.6.3 Cost Estimating Methodologies and Cost Reserve Management

As the provision of in-depth cost details is not anticipated until the conclusion of concept studies, proposals may use estimates derived from models or cost estimating relationships from analogous missions (see Appendix B, Section H, for additional detail). However, the credibility of proposed costs are likely to be enhanced by the application of methodologies that are typically employed for mature projects. To improve the ability of NASA to validate proposed costs in the absence of detailed discussions with proposers, NASA has designated two parametric cost models as common benchmarks: SEER for Software and SEER for Hardware, Electronics and Systems Core (SEER-H) with Electro-Optical Sensors and Integrated Circuits extended capabilities or PRICE® TruePlanning™ Cost Estimating Framework. Proposers must apply one of these models to their proposed investigation. This should not be construed to limit proposers own discretion in the method(s) chosen to estimate and validate costs.

Requirement 69. Proposals shall identify the methodologies (cost models, cost estimating relationships of analogous missions, etc.) and provide the rationale used to develop the proposed cost.

Requirement 70. Proposals shall include a discussion of sources of estimate error and uncertainty in the proposed cost and management approaches for controlling cost growth.

Requirement 71. Proposals shall provide input file(s) for a single parametric cost model, specified in Requirement B-55 that was used to benchmark the proposed cost. The configuration of the cost estimation tool used (*e.g.,* version of model, version of underlying database, versions of plugins used) shall be explicitly described.

Proposals that are unable to show adequate unencumbered cost reserves are likely to be judged a high cost risk and not selected. For the purpose of this AO, the unencumbered cost reserves on the PI-Managed Mission Cost are measured as a percentage against the cost to complete through Phases A/B/C/D. The numerator is the amount of unencumbered cost reserves for Phases A/B/C/D, not including funded schedule reserve. The denominator is the PI-Managed Mission Cost to complete Phases A/B/C/D, including the cost of technical design margin, including funded schedule reserve, and encumbered cost reserve, but not including unencumbered cost reserve (See the definitions following Requirement B-36).

Adequate unencumbered cost reserves for Phases A/B/C/D are defined to be a minimum of 25%. Adequate unencumbered cost reserves must be demonstrated at each of the following milestones: KDP-A (demonstrated in the proposal), KDP-B (demonstrated in the Phase A Concept Study Report), KDP-C (the independent cost estimate for Confirmation), and KDP-D (at the end of Phase C).

Requirement 72. Proposals shall justify the adequacy of the proposed cost reserves. Proposals shall comply with the requirement for unencumbered cost reserves against the cost to complete and shall demonstrate an approach to maintaining required unencumbered cost reserves through subsequent development.

Requirement 73. Although minimum unencumbered cost reserves are not specified in this AO for Phases E and F, proposals shall establish, identify and justify adequate reserves for these phases of the mission.

5.6.4 Work Breakdown Structure

Requirement 74. Proposals shall provide a Work Breakdown Structure (WBS) that conforms to NPR 7120.5E. Costs for most elements shall be specified to WBS Level 2. Exceptions are the costs of elements that explicitly appear only at a level below WBS Level 2; these exceptions include individual instruments, unique flight system elements, the use of NASA or NASA-procured tracking and communications, and data analysis/archiving (see Appendix B, Section H, for additional detail).

5.6.5 Master Equipment List

Due to the potentially sensitive nature of information in the Master Equipment List, it will be redacted from any proposal sent to a non-U.S. person serving as a reviewer.

Requirement 75. Proposals shall include a Master Equipment List (MEL) summarizing all spacecraft system element components and individual instrument element components to support validation of proposed mass estimates, power estimates, contingencies, design heritage, and cost (see Appendix B, Section J.9, for additional detail).

5.6.6 Full Cost Accounting for NASA Facilities and Personnel

For the purpose of calculating the full cost of NASA-provided services, proposal budgets from NASA Centers, whether as the proposing organization or as a supporting organization, are to include within the PI-Managed Mission Cost all costs normally funded by an SMD Project under NASA's full cost accounting practices, including civil servant labor (salaries and

benefits), civil service travel, and procurements. All of these costs must be clearly identified by year within the budget justification section of the proposal.

Estimated NASA Center Management and Operations (CM&O) overhead costs must also be included within the AO Cost Cap, to enable a level playing field for all proposers. Per HQ policy guidance signed in June 2010 by the Associate Administrator, Mission Support Directorate and by the Agency Chief Financial Officer, all NASA Centers shall use an identical CM&O burden rate of $43K (Fiscal Year 2015) per "equivalent head." As per Agency policy, this rate must be applied as a "cost per equivalent head" to all Civil Servant Full-Time Equivalents (FTEs) plus on- or near-site contractor Work-Year Equivalents (WYEs) associated with the proposal. The estimated FTEs and WYEs per fiscal year, and the resulting CM&O burden, must be identified in a separate table within the budget justification section of the proposal. The CM&O rate will not change from year to year in Fiscal Year 2015 dollars, though in Real Year terms, it will inflate.

The CM&O burden costs must be clearly denoted in all budget tables. These costs may not be included or rolled into any other budget lines in such a way that they become unidentifiable.

Do not include within the cost proposal, or within the PI-Managed Mission Cost, any estimate for Agency Management and Operations (AM&O, a.k.a. NASA Headquarters overhead).

	Identify in proposal?	Include in PI-managed mission cost?	Funding source	Comments
Civil Service Labor	Yes	Yes	SMD Program	Includes salaries and benefits
Civil Service Travel	Yes	Yes	SMD Program	
Other Direct/Procurements	Yes	Yes	SMD Program	Includes procurements as typically identified by flight projects in the NASA N2 budget database
CM&O	Yes	Yes	CASP	Applied to NASA provided labor, including Center civil servants and on-site contractors
AM&O	No	No	CASP	
NASA Contributed Costs	Yes	No	Identify	Must be non-SMD
Non-NASA Federal Government (funding requested from NASA)	Yes	Yes	SMD Program	If NASA funding is requested for the non-NASA Federal Government agency
Contributions	Yes	No	Identify	Includes all non-NASA contributions

Table 2: Cost Elements for NASA Center Budget Proposals in response to SMD AOs

Requirement 76. Proposals including costs for NASA Centers shall conform to the full cost policy stated in this Section. Each of the elements of the NASA Center costs (direct labor, travel, procurements) shall be separately identified by year.

If any NASA funded item(s) or services are to be considered as contributed costs, then the contributed item(s) must be separately funded by a non-SMD effort complementary to the proposed investigation, the value of the contribution(s) must be estimated, and the funding source(s) must be identified.

Requirement 77. If any NASA funded item(s) or services are considered as contributed costs, then the proposal shall estimate the value of the contribution(s) and shall identify the funding source(s).

Any non-NASA Federal Government costs must follow the appropriate agency accounting standards for full cost. If no standards are in effect, the proposers must follow the *Managerial Cost Accounting Concepts and Standards for the Federal Government*, as recommended by the Federal Accounting Standards Advisory Board and available in the Program Library.

Requirement 78. Proposals including costs for non-NASA Federal Government agencies shall follow the applicable accounting standards.

5.6.7 Contributions

Contributions from both U.S. and non-U.S. sources, other than NASA programs (including the Discovery Program), are welcome. These may include, but are not limited to, labor, services, and/or contributions to the instrument complement or the spacecraft, subject to the following exceptions and limitations: (i) contributions of non-U.S. nuclear power sources are prohibited; and (ii) in order to ensure a preponderance of NASA interest in the mission, as well as to ensure that missions of roughly comparable scope are proposed for purposes of equitable competition, the sum of contributions of any kind to the entirety of the investigation is not to exceed one-third (1/3) of the proposed PI-Managed Mission Cost. Such contributions will not be counted against the PI-Managed Mission Cost, but they must be included in the calculation and discussion of the Total Mission Cost (Section 4.3.2).

Additionally, non-NASA contributions to the science instruments are not to exceed one-third (1/3) of the PI-Managed Instrument Cost. The “PI-Managed Instrument Cost” is defined as the sum of the costs assigned to elements 4.0 (Science) and 5.0 (Payload(s)) in the standard Work Breakdown Structure. See NPR 7120.5E and references therein.

Values for all contributions of property and services must be established in accordance with applicable cost principles. The cost of contributed hardware must be estimated as either: (i) the cost associated with the development and production of the item, if this is the first time the item has been developed and if the mission represents the primary application for which the item was developed; or (ii) the cost associated with the reproduction and modification of the item (*i.e.*, any recurring and mission-unique costs), if this is not a first-time development. If an item is being developed primarily for an application other than the one in which it will be used

in the proposed investigation, then it may be considered as falling into the second category (with the estimated cost calculated as that associated with the reproduction and modification alone).

The cost of contributed labor and services must be consistent with rates paid for similar work in the proposer's organization. The cost of contributions does not include funding spent before the start of the investigation (*i.e.,* before initiation of Phase B). The value of materials and supplies must be reasonable and must not exceed the fair market value of the property at the time of the contribution.

Requirement 79. If a proposal includes one or more contributions, the proposal shall separately identify all contributions, the organizations providing the contributions, and the organizations providing the funding for the contributions; the costs for the contributions shall be clearly identified within the Total Mission Cost.

Requirement 80. If a proposal includes one or more contributions, the total value of the contributions shall be established in accordance with the applicable and stated cost principles and shall comply with the stated cap on the sum of all contributions and the cap on contributed instruments.

Letters of Commitment are required from each organization responsible for a contribution (for U.S. organizations, see Section 5.8.1.1 and Requirement 89; for non-U.S. contributing organizations, also see Section 5.7.2 and Requirement 83).

The requirement for institutional Letters of Commitment for contributions does not apply to contributed support for collaborators; no institutional Letters of Commitment are required with the Step-1 proposal for collaborator support. The requirement for personal statements of commitment from collaborators is given in Section 5.8.1.3 and Requirement 91.

A contributed item that is essential for the success of the proposed investigation and/or is in the critical path of mission development is a risk factor. Risks include 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. When no mitigation is possible, this should be explicitly acknowledged and the rationale for accepting the unmitigated or residual risk should be explicitly stated.

Requirement 81. If a proposal includes contributions that are essential to the success of the proposed investigation or in the critical path, the proposal shall include: (i) demonstrations of clear and simple technical and management interfaces in the proposed cooperative arrangements, (ii) explicit evidence that the proposed contributions are within the contributors' scientific and technical capabilities, and (iii) contingency plans for coping with potential failures of proposed cooperative arrangements or, where no mitigation is possible, an explicit acknowledgement to that effect and an explicit rationale for accepting the risk.

5.7 Non-U.S. Participation Requirements

5.7.1 Overview of Non-U.S. Participation

NASA solicits research proposals from both U.S. and non-U.S. sources (see NFS 1835.016-70).

NASA's policies for international cooperation in space research projects may be found in NPD 1360.2B, *Initiation and Development of International Cooperation in Space and Aeronautics Programs*. The characteristics of successful international cooperation include mutual benefits, clearly defined division of responsibilities, responsibilities for each participant within known capabilities, recognition of export control laws prohibiting the unwarranted transfer of technology abroad, and no-exchange-of-funds. Because space research projects generally involve major investments of resources, and because NASA is a Government agency, NASA's counterparts will generally be non-U.S. Government agencies rather than non-U.S. universities or private organizations.

Owing to NASA's policy to conduct research with non-U.S. entities on a cooperative, no-exchange-of-funds basis, NASA does not normally fund non-U.S. research proposals or non-U.S. research efforts that are part of U.S. research proposals. Rather, cooperative research efforts are normally implemented via agreements between NASA and the appropriate non-U.S. entity. Non-U.S. proposers must arrange for non-U.S. financing for their portion of the research.

The direct purchase of supplies and/or services, which do not constitute research, from non-U.S. sources by U.S. award recipients is permitted.

Proposals must not include bilateral participation, collaboration, or coordination with China or any Chinese-owned company or entity, whether funded or performed under a no-exchange-of-funds arrangement.

5.7.2 General Guidelines Applicable to Non-U.S. Proposals and Proposals including Non-U.S. Participation

All non-U.S. proposals will undergo the same evaluation and selection process as those originating in the U.S. All proposals must be typewritten in English and must comply with all submission requirements stated in this AO and in Appendix B of this AO.

<u>Requirement 82.</u> Unless otherwise noted, proposals from non-U.S. entities shall not include a cost plan unless the proposal involves collaboration with a U.S. institution, in which case a cost plan that covers only the participation of the U.S. entity shall be included. Proposals from U.S. institutions with non-U.S. participation shall include a cost plan that only covers U.S. entities.

<u>Requirement 83.</u> Proposals from non-U.S. entities and proposals from U.S. entities that include non-U.S. participation shall be formally endorsed, through Letters of Commitment, by the responsible funding agency in the country of origin. The required elements of a Letter of Commitment for a contribution are given in Section 5.8.1. Officials who are

authorized to commit the resources of the non-U.S. funding agencies must sign these Letters of Commitment.

Contributions from non-U.S. sources offer benefits but also represent complexity and risk to a project. The benefits of proposed contributions will be assessed as they contribute to scientific and technical merit and feasibility. The stability and reliability of proposed partners, and the appropriateness of any proposed contribution, will be assessed outside of the evaluation process, as a programmatic risk element in the proposal.

Requirement 84. Proposals from U.S. proposers shall include a discussion of mitigation plans, where possible, for the failure of funding or contributions to materialize when they are outside the control of the PI. When no mitigation is possible, this should be explicitly acknowledged and the rationale for accepting the unmitigated or residual risk should be explicitly stated.

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. When no mitigation is possible, this must be explicitly acknowledged and the rationale for accepting the unmitigated or residual risk must be explicitly stated. In addition to budget and technical risk, non-U.S. contributions introduce schedule risk for implementing agreements, as well as for obtaining any necessary licenses for exchanges of goods and technical data. An adequate and realistic schedule must be allocated for having international agreements executed. NASA will not normally initiate development of any international agreements until after the downselect decision is made at the conclusion of Phase A.

Any proposed non-U.S. participation must be described at the same level of technical, schedule, and management detail as that of U.S. partners. A cost plan for the non-U.S. participation should not be included, though (see Requirement 82). Failure to document technical and schedule data, management approaches, or failure to document the commitment of team members or funding agencies may cause a proposal to be found unacceptable.

Requirement 85. To the maximum extent practical, and allowing for any AO-specified exemptions (*e.g.*, Requirement 82), any proposed non-U.S. contribution shall be described at the same level of detail as those of U.S. partners.

Requirement 86. Proposals with non-U.S. participation shall include a table listing: (i) non-U.S. participants (individuals, institutions), (ii) roles and responsibilities, (iii) funding organization, (iv) approximate value of contribution and method for estimating value (detailed budget not required), and (v) cross-reference to any Letters of Commitment in the proposal appendix. Proposals with non-U.S. participation must clearly describe the flow of design requirements (potentially export controlled information) and hardware between U.S. and non-U.S. participants. This description may take the form of a flowchart. See Section J.4 of Appendix B.

5.7.3 Agreements with Selected Non-U.S. Participants

Should a non-U.S. proposal or a U.S. proposal with non-U.S. participation be selected, NASA's Office of International and Interagency Relations will arrange with the non-U.S. sponsor for the proposed participation on a no-exchange-of-funds basis, in which NASA and the non-U.S. sponsor will each bear the cost of discharging its respective responsibilities.

It is the policy of NASA to establish formal agreements with non-U.S. partners in cooperation on flight missions. Owing to the short duration of the concept study phase, it is not possible for NASA to conclude an international agreement prior to the due date for concept study reports. Additionally, in some cases, interim agreements may be put in place, after the conclusion of Phase A, until a more permanent arrangement is reached.

Requirement 87. If applicable, proposals shall show how the Phase A concept study can be completed in the absence of an international agreement.

5.7.4 Export Control Guidelines Applicable to Non-U.S. Proposals and Proposals including Non-U.S. Participation

Requirement 88. Non-U.S. proposals and U.S. proposals that include non-U.S. participation shall describe plans for compliance with U.S. export laws and regulations, *e.g.*, 22 CFR Parts120-130 and 15 CFR Parts 730-774, as applicable to the circumstances surrounding the particular non-U.S. participation (see Appendix B, Section J.5, for additional detail).

5.8 Additional Proposal Requirements

5.8.1 Letters of Commitment

Institutional Letters of Commitment signed by an institutional official must be provided from (i) all organizations offering contributions of goods and/or services (both U.S. and non-U.S.) on a no-exchange-of-funds basis and (ii) all major organizational partners in the proposal regardless of source of funding. See Appendix B, Section J.2, for additional detail.

The required elements in an Institutional Letter of Commitment for a contribution are: (i) evidence that the institution and/or appropriate Government officials are aware and supportive of the proposed investigation; (ii) a precise description of what is being contributed by the partner and what assumptions are being made about NASA's role; (iii) a statement that the organization intends to provide the contribution or required funding for the investigation, if it is selected by NASA; (iv) the strongest possible statement of financial commitment from the responsible organization to assure NASA that all contributions will be provided as proposed, including whether the contribution and/or funding has been approved and/or what further decisions must be made before the funding is committed by the partner; and (v) a signature by an official authorized to commit the resource of the organization for participation in the investigation (if it is not clear from the signer’s title that the signer has the necessary authority, then the signer’s authority should be explicitly stated in the Letter).

The required elements in an Institutional Letter of Commitment for a major partner are: (i) a statement of commitment for the effort that is assigned to that participant in the proposal, (ii) a

description of what is being provided, and (iii) a signature by an official authorized to commit the organization.

5.8.1.1 Institutional Letters of Commitment for Contributions

An Institutional Letter of Commitment for a contribution must contain the required elements described in Section 5.8.1.

Requirement 89. For all U.S. organizations offering contributions, proposals shall include appropriate Letters of Commitment from both the organization(s) providing any contributed property or service and from the organization(s) providing any required funding.

Additional requirements for Institutional Letters of Commitment from non-U.S. organizations offering contributions are given in Section 5.7.2 and Requirement 83.

5.8.1.2 Institutional Letters of Commitment for Major Partners

Major partners are the organizations, other than the proposing organization, responsible for providing science leadership, project management, system engineering, major hardware elements, science instruments, integration and test, mission operations, and other major products or services as defined by the proposer. All other participants are regarded as not major. Major partners are listed in Section (i) of the Table of Proposal Partners (see Appendix B, Section J.1, for additional detail).

An Institutional Letter of Commitment for a major partner must contain the required elements described in Section 5.8.1.

Requirement 90. Unless otherwise explicitly exempted elsewhere in this AO (*e.g.*, Section 5.2.5), proposals shall include an Institutional Letter of Commitment from each major partner in the proposal, regardless of source of funding. For major partners providing one or more contributions, only a single Letter of Commitment is required.

5.8.1.3 Personal Statements of Commitment

No Personal Statements of Commitment are required in the Step-1 proposal. No Institutional Letters of Commitment are required for individuals in the Step-1 proposal, unless the individual is contributed and part of the Proposal Team. The Proposal Team is defined to include, but not be limited to, all members of the Key Management Team and any Co-I who is not part of the Key Management Team. Proposal Team members are identified on the NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES) proposal cover page. Proposal Team members indicate their commitment to the proposed investigation through NSPIRES (see Appendix B, Section A.3, for instructions). Requirements to provide personal and institutional Letters of Commitment in Step-2 Concept Study Reports are given in the *Guidelines and Criteria for the Phase A Concept Study* document (available in the Program Library).

Requirement 91. Every Proposal Team member shall indicate his/her commitment to the proposed investigation and specifically to the role, responsibilities, and participating organization proposed for him/her, through NSPIRES.

5.8.2 Export Controlled Material in Proposals

Under U.S. law and regulations, spacecraft and their specifically designed, modified, or configured systems, components, and parts are generally considered "Defense Articles" on the United States Munitions List and are, therefore, subject to the provisions of the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120-130.

While inclusion of export controlled material in proposals is not prohibited, proposers are advised that the inclusion of such material in proposals may complicate NASA's ability to evaluate proposals, as NASA may employ the services of non-U.S. persons (roughly, individuals who are neither U.S. citizens nor lawful permanent residents) to review proposals submitted in response to this AO. In order to enable proper evaluation of proposals, any export-controlled information subject to ITAR must be marked with a notice to that effect.

Requirement 92. If the proposal contains export controlled material, the following statement shall be prominently displayed in Section A of the proposal (following the Proposal Summary Information):

> "The information (data) contained in [insert specific identification such as page, section and paragraph numbers] of this proposal is (are) subject to U.S. export laws and regulations. It is furnished to the Government with the understanding that it will not be exported without the prior approval of the proposer under the terms of an applicable export license or technical assistance agreement. **The identified information (data) is (are) printed in a red font and figure(s) and table(s) containing the identified information (data) is (are) placed in a red-bordered box." [Amended January 16, 2015]**

Note that it is the proposer's responsibility to determine whether any proposal information is subject to the provisions of ITAR. Information about U.S. export regulations is available at http://www.pmddtc.state.gov/ and at http://www.bis.doc.gov/.

For the purposes of this AO, information on the proposed approach to attitude determination and control should be included in the statement identifying ITAR-controlled information.

If a non-U.S. person is used as a reviewer, the material identified in the above statement, along with the Master Equipment List and the description of the approach to attitude determination and control will be redacted from his or her copy of the proposal.

5.8.3 Classified Proposal Appendix Regarding Heritage

In order to increase the capabilities of investigations proposed in response to this AO while minimizing the development and operations risks within the PI-Managed Mission Cost, proposers may choose to leverage technology that was developed by other institutions and

agencies as well as technology developed by NASA and NASA-funded partners. It is recognized that some technology relevant to proposed missions may have classified heritage.

Proposals that propose the use of hardware with classified heritage may provide a classified proposal appendix to NASA to allow validation of classified heritage claims. The classified appendix regarding heritage may include Letters of Validation for classified heritage claims from technology development sponsors. The proposer is responsible for determining what information is classified and what information is unclassified; any classified information provided to NASA must be handled appropriately.

Requirement 93. Proposals submitted in response to this AO, as well as the proposed investigations and all proposed technologies, shall be unclassified. The proposal shall be complete including an unclassified appendix regarding heritage (see Appendix B, Section J.10, for further details).

When a proposer submits a classified appendix regarding heritage in addition to a complete proposal, the evaluation processes (Section 7.1.1) will be supplemented. At least one reviewer with appropriate clearance and relevant expertise will review the classified appendix regarding heritage; this reviewer may be a member of the review panel or this reviewer may be a specialist reviewer. All findings generated during the review of the classified appendix regarding heritage will be unclassified, and these findings will be provided to the technical/management/cost review panel as input for assessing the technical, management, and cost (TMC) feasibility of the proposed approach for mission implementation. No clarifications will be requested concerning findings from evaluation of the classified appendix regarding heritage.

The entire proposal including the unclassified appendix regarding heritage will be read and evaluated by the entire evaluation review panel. The evaluation review panel will not have access to the classified appendix regarding heritage. Proposers are strongly encouraged to provide as much information and detail as possible on their technology heritage in the unclassified appendix regarding heritage.

NASA will endeavor to use the information in the classified appendix regarding heritage to better understand the proposed investigation. However, NASA cannot guarantee that this process will be fully successful in informing the review panel of the impact of a classified appendix regarding heritage that they have not read.

If the proposer wishes to send a classified appendix regarding heritage to NASA, it must be provided to NASA Headquarters separately from the proposal and no later than the due date for the proposal. A single copy of the classified appendix regarding heritage must be submitted along with a cover letter referencing the submitted proposal by name, PI, and proposing organization. The proposer is responsible for obtaining any “need to know” permission for at least one reviewer with appropriate clearance and relevant expertise to evaluate the classified appendix regarding heritage; that permission should be discussed in the cover letter. The proposer assumes all responsibility for determining the appropriate security clearance and method of deliver to NASA Headquarters of the classified appendix regarding heritage. The

classified appendix regarding heritage must be handled and delivered to NASA Headquarters in compliance with NPR 1600.1, *NASA Security Program Procedural Requirements*.

Requirement 94. Proposers that choose to submit a classified appendix regarding heritage shall submit the appendix and a cover letter to NASA Headquarters no later than the proposal due date. The proposer shall determine the appropriate security classification for the classified appendix, the proposer shall obtain any permission required for a reviewer to read the classified appendix, and the proposer shall ensure that all appropriate security requirements are followed in delivering the classified appendix to NASA Headquarters.

The requirements on content and format of the classified appendix regarding heritage are the same as those for the unclassified appendix regarding heritage included in the proposal (see Appendix B, Section J.10, for further details) with the exception that Letters of Validation may be included in the classified appendix regarding heritage.

The address for delivery of the package containing the classified appendix is: Mail Custodian, Suite 1M40, 300 E Street SW, Washington, DC 20546. The package containing the classified appendix should be sent to NASA Headquarters by whatever means is appropriate (courier, U.S. Registered Mail, etc.). The point-of-contact for the AO (Section 6.1.5) should be notified that a classified appendix has been submitted. The Heritage Appendix should additionally indicate that a classified appendix has been submitted.

5.9 Program Specific Requirements and Constraints

5.9.1 Schedule Requirements

Requirement 95. Proposals shall propose a launch readiness date no later than December 31, 2021.

5.9.2 Launch Services

A Discovery investigation will be launched as the primary payload on a single expendable launch vehicle (ELV) that NASA will provide as Government Furnished Equipment (GFE). Standard launch services utilizing a domestic launch vehicle certified as category 3 per NPD 8610.7D, *NASA Launch Services Risk Mitigation Policy for NASA-Owned or NASA-Sponsored Payloads/Missions*, regardless of the payload classification, will be provided at no charge to the PI-Managed Mission Cost. There will be a charge against the PI-Managed Mission Cost for any launch services beyond the standard launch services offered. Detailed information on launch vehicle performance options, including a description of standard launch services and the nominal costs for nonstandard services, is provided in the *ELV Launch Services Information Summary* document in the Program Library.

The *ELV Launch Services Information Summary* describes six categories of launch vehicles in the intermediate performance class. NASA will provide, at no cost to the proposer, a “baseline” launch service in the medium range of the intermediate class with a 4m fairing. A charge will be counted against the PI-Managed Mission Cost for investigations that require the use of more capable launch vehicles or larger fairings (see Table 3). A credit to the PI-Managed Mission

Cost will be made for investigations that utilize a launch vehicle with less performance than the baseline. Further details are provided in the *ELV Launch Services Information Summary*.

PERF.	FAIRING SIZE 4m	5m
Low	(16)	13
Med	—	28
High	14	43

Table 3: *Costs* for launch services ($M). Credits are shown in parentheses.

Funds allocated to the PI-Managed Mission Cost cannot be used to purchase a launch vehicle or launch services other than those vehicles and services described in this AO.

Co-manifested or secondary payloads on a U.S. or non-U.S. launch vehicle may not be proposed nor will be considered under this AO.

Requirement 96. Proposals shall define the required launch vehicle capability and demonstrate that it is compatible with the standard launch services offered.

Requirement 97. If services beyond the standard launch services offered are required, the proposal shall include the cost of such services in the PI-Managed Mission Cost.

Launch delay costs as a result of spacecraft or payload delays are not a standard launch service. Any such launch delay costs must be funded out of the PI-Managed Mission Cost and, therefore, represent a cost risk to the PI-Managed Mission Cost.

For investigations using radioactive materials, an as-built databook for the launch system (*i.e.*, payload and launcher) must be completed under the NASA Launch Services contract no later than three years before launch. Launch processing of a mission that utilizes radioactive materials (*e.g.*, radioisotope heating units) will involve nonstandard launch services. The costs for these services will be included in the PI-Managed Mission Cost. Costs associated with the launch of radioactive materials are shown in Table 1 in Section 5.2.4.4.

Contributed launch services cannot be proposed or considered under this AO.

Due to the volatility of the launch services market, NASA cannot ensure which launch vehicles will be available at the time of the launch deadline specified in Section 5.9.1. Accordingly, proposers are advised to plan for compatibility with vehicle families that provide the required performance and are expected to be available through spacecraft Preliminary Design Review (PDR), see the *ELV Launch Services Information Summary* in the Program Library. It is recommended that payload designs accommodate launch environments for these vehicle families.

Requirement 98. Proposals shall discuss flexibility to be accommodated on multiple launch vehicle families.

Participation of Discovery investigators as a contributor to a larger mission, what SMD has traditionally called a "Partner Mission of Opportunity" in prior AOs, is not permitted in response to this AO.

5.9.3 Technology Infusion

A wide-range of NASA-developed technologies has been presented to the scientific and engineering community, most recently at the Discovery AO Technology Workshop (charts, a record of the online chat, and a video are available at http://discovery.larc.nasa.gov/technology_workshop.html).

The use of any NASA-developed technology is strictly optional. Some technologies will be offered as Government-furnished Equipment (in whole or part) and some will carry incentives for use (to be considered an increase in the AO Cost Cap). In many cases, risks associated with the readiness of these technologies will not impact the evaluation of the risk of the mission proposing to use that technology.

The following table describes the technology infusion approaches taken in this AO.

Table 4: Infusion strategies of NASA-developed technologies.

Technology	What is GFE?	Incentive for use?	What is included in PI-Managed Mission Cost?	Evaluation of Risk?
NASA Evolutionary Xenon Thruster (NEXT)	2 thrusters + 2 PPUs	No	All other costs	Risk of thruster and PPU readiness for mission integration will not impact proposal evaluation.
Heatshield for Extreme Entry Environment Technology (HEEET)	NASA pays for HEEET team consulting & technology transfer	Cost of 3D woven TPS material up to $10M	Costs for procurement of woven TPS material above $10M and heat shield fabrication.	Risk of developing 3D woven TPS on time will not impact proposal evaluation.
Deep Space Optical Communications (DSOC)	DSOC hardware and funding for integration and operations support team	$30M	Costs of integration & spacecraft operations team during demonstration	Risk of DSOC readiness for mission integration will not impact proposal evaluation.

Technology	What is GFE?	Incentive for use?	What is included in PI-Managed Mission Cost?	Evaluation of Risk?
Light Weight Radio-isotope Heater Units (LWRHUS)	All needed RHUs up to 30 (the number available).	No	NEPA/NLSA costs	Risk of LWRHU readiness for mission integration will not impact proposal evaluation.
Advanced Solar Arrays (ASA)†	Nothing	No	All costs	Will be treated as a commercial procurement of a mature product from a proven vendor(s) in the same manner as any spacecraft component (where the mission specific accommodation will be evaluated, but the basic design and performance, *i.e.*, technology readiness level, of the component itself is not evaluated nor considered a risk)
Deep Space Atomic Clock (DSAC)*	Nothing	$5M	All costs	Risk of DSAC readiness for mission integration will not impact proposal evaluation.
Green Propellant*†	Nothing	No	All costs	Will be treated as a commercial procurement of a mature product from a proven vendor(s) in the same manner as any spacecraft component (where the mission specific accommodation will be evaluated, but the basic design and performance, *i.e.*, technology readiness level, of the component itself is not evaluated nor considered a risk)

Technology	What is GFE?	Incentive for use?	What is included in PI-Managed Mission Cost?	Evaluation of Risk?
Autonomous Landing and Hazard Avoidance Technology (ALHAT)	Nothing	No	All costs	Will be treated as any proposed technology or advanced engineering development, as appropriate.

*Available as demonstrated. Any additional mission-specific adaptations must be paid for by the mission as part of the PI-Managed Mission Cost.
† NASA plans to develop and demonstrate ASA and green propellant in a relevant environment prior to the end of FY 2017.

5.9.4 Program Infrastructure Requirements and Opportunities

Investigations proposing the development of a Mars mission are subject to the telecommunication and navigation policies of the Mars Exploration Program (MEP). The MEP has developed an integrated telecom and navigation strategy based on an evolving orbital infrastructure, standardized, interoperable communications/navigation services, and time-phased capabilities matched to the scientific and engineering needs of the Program. The strategy evolves a Mars Network by implementing a standardized proximity link communications/navigation payload — the *Electra* UHF radio — (see the *Mars Relay Description for Discovery 2014 Proposals* and *Electra Mars Proximity Link Communications and Navigation Payload Description* documents in the Program Library) deployed on every long-lived (greater than one Earth year) Mars science orbiter mission. This combined strategy will establish an initial Mars Network infrastructure with gradually increasing capability and with redundant on-orbit assets.

Requirement 99. Although MEP expects to support the Odyssey, Mars Reconnaissance Orbiter (MRO), Mars Atmosphere and Volatile Evolution (MAVEN), and ExoMars/Trace Gas Orbiter missions as Mars relay communication assets as described in the *Mars Relay Description for Discovery 2014 Proposals*, proposers to this AO shall provide sufficient information so that the planned use of such infrastructure resources can be evaluated (see Appendix B, especially Requirement B-37).

As a matter of policy, the MEP requires that missions with one Earth-year or more of expected life in Mars orbit must carry a UHF communications package (see the *Electra Mars Proximity Link Communications and Navigation Payload Description* document in the Program Library) to provide telecommunications support for data relay for future missions and to provide support during critical events (see further details in Section 5.2.5). Orbiter missions required to carry such a UHF relay will have it provided as GFE at no cost to the proposer, although the cost of its integration into the payload shall be included in the PI-Managed Mission Cost. Relay operations should not significantly impact the nominal orbiter mission. Furthermore, the operations of the orbiter UHF relay payload for other Mars missions will be paid for by the MEP**.**

Requirement 100. Proposals for a Mars orbiter with one Earth-year or more of expected life in Mars orbit shall include a UHF communications package provided as GFE. Proposals for such qualifying missions shall discuss the technical approach, including schedule and cost, for implementing the UHF relay in the event of selection.

NASA has developed a smaller version of the Electra payload specially tailored to the mass, volume, and power constraints of Mars landers, for flight on the 2011 Mars Science Laboratory mission. Known as Electra-Lite, this standardized UHF relay subsystem provides inherent interoperability with existing Mars relay infrastructure. Proposed landed missions planning to utilize MEP-provided relay services are encouraged to use this payload to fit into the existing Mars telecommunications network. The Electra-Lite payload is described in the *Electra-Lite Mars Proximity Link Communications and Navigation Payload Description* document in the Program Library. If instead a non-Electra-Lite relay payload is selected, it is incumbent on the proposed mission to ensure interoperability with the MEP relay payloads, as described in the *Mars Relay Description for Discovery Proposals* document in the Program Library.

Requirement 101. Proposals for a Mars lander utilizing a UHF-relay system other than the *Electra-Lite* shall be interoperable with MEP relay payloads as described in the *Mars Relay Description for Discovery Proposals* document in the Program Library.

6. Proposal Submission Information

6.1 Preproposal Activities

6.1.1 Preproposal Conference

A Preproposal Conference will be held either in the Washington, DC, area or via web/teleconference in accordance with the schedule in Section 3. Further information, including logistics, will be available at the Discovery Acquisition Homepage (see Section 6.1.4) prior to the Preproposal Conference.

All interested parties may participate. All expenses and arrangements for participating in this meeting are the responsibility of the attendees. Note that travel and associated costs of participation are not allowable as direct costs under another Federal Government award, *e.g.,* a contract, grant, or cooperative agreement. Government employees may attend and be authorized travel and associated costs as a matter of official business.

The purpose of this conference will be to address questions about the proposal process for this AO. Questions should be sent to the Discovery Program Scientist at the address given in Section 6.1.5. NASA personnel will address all questions that have been received no later than five working days prior to the Conference. Questions submitted after this date may be addressed at the Conference as time permits and as appropriate answers can be generated. Anonymity of the authors of all questions will be preserved. Presentations made at the Preproposal Conference, including answers to all questions addressed at the conference, will be posted on the Discovery Acquisition Homepage at the address given in Section 6.1.4 two weeks after this event. Additional questions and answers subsequent to the conference will also appear in this location, if necessary. Questions may be submitted until 14 days before the

proposal due date given in Section 3. Answers will be provided no later than 10 days before the proposal due date.

6.1.2 Notice of Intent to Propose

To facilitate planning of the proposal evaluation and peer review process, and to inform prospective proposers of any changes to this AO, NASA **strongly encourages** all prospective proposers to submit a Notice of Intent (NOI) to propose. NOIs are due by 11:59 pm Eastern Time on the date given in Section 3 of this AO. Material in a NOI is deemed confidential and will be used for NASA planning purposes only.

An NOI is submitted electronically by entering the requested information at http://nspires.nasaprs.com/. Registration on the NSPIRES website is required to submit NOIs and proposals. Proposers who experience difficulty in using the NSPIRES site should contact the Help Desk by E-mail at nspires-help@nasaprs.com for assistance.

The following information (to the extent that it is known by the NOI due date) is requested for the NOI:

(a) Name, address, telephone number, fax number, E-mail address, and institutional affiliation of the PI.
(b) Full names and institutional affiliations of each known Proposal Team member. If any Proposal Team members are from non-U.S. institutions, the vehicle by which these people expect to be funded should be identified in the comments box on the NOI form.
(c) Anticipated launch vehicle performance class.
(d) A brief statement (150 words or less) for each of the following:
  (i) science objectives of the proposed mission;
  (ii) identification of new technologies that may be employed as part of the mission.
(e) The name of the organizational lead from each organization (industrial, academic, nonprofit, and/or Federal) included in the proposing team, and the organization's role in the proposed investigation, as may be known at the time of the NOI.

SMD requests that proposers communicate any changes to the investigation team, between NOI and proposal submission, to the Discovery Program Scientist identified in Section 6.1.5 of this AO. Submitting an NOI does not commit the team to submitting a proposal.

6.1.3 Teaming Interest

As a result of recent AOs similar to this one, commercial aerospace and technology organizations have requested a forum to inform potential proposers of their services and/or products. NASA is willing to offer this service with the understanding that the Agency does not endorse any information thus transmitted and does not accept responsibility for the capabilities or actions of these organizations. The organizations listed on the Discovery Teaming Interest page of the Discovery Acquisition Homepage (see address given in Section 6.1.4) have expressed interest in teaming with other organizations on Discovery proposals. This is not a comprehensive list of organizations that are capable of teaming; it is simply a list of those organizations that have asked to be included. Proposers are not required to team with any organization on this list.

6.1.4 Program Library and Acquisition Home Page

A Discovery Acquisition Homepage, available at discovery.larc.nasa.gov, will provide updates and any AO addenda during the Discovery AO solicitation process. It will provide links to the Program Library, information about the Preproposal Conference, a list of potential teaming partners, and questions and answers regarding the AO.

The Discovery Program Library provides additional regulations, policies, and background information on the Discovery Program. Information on the Program Library is contained in Appendix D. The Program Library is described in Appendix D and is accessible at discovery.larc.nasa.gov/dpl.html.

Updates to the AO and any amendments will be posted on the NSPIRES website. A link will be provided on the Discovery Acquisition Homepage to the NSPIRES index page for the AO.

6.1.5 Point of Contact for Further Information

Inquiries about this AO may be directed to the Lead Discovery Program Scientist:

Dr. Michael H. New
Planetary Science Division
Science Mission Directorate
National Aeronautics and Space Administration
Washington, DC 20546-0001
Telephone: 202-358-1766
E-mail: michael.h.new@nasa.gov

6.2 Proposal Preparation and Submission

6.2.1 Structure of the Proposal

General NASA guidance for proposals is given in Appendix A of this AO, which is considered binding unless specifically amended in this AO. A uniform proposal format is required from all proposers to aid in proposal evaluation. The required proposal format and contents are summarized in Appendix B. Failure to follow Appendix B may result in reduced ratings during the evaluation process or, in some cases, could lead to rejection of the proposal without review.

Requirement 102. Proposals shall conform to the uniform proposal format outlined in Appendix B.

6.2.2 Certifications

The authorizing institutional signature on the proposal certifies that the proposing institution has read and is in compliance with the required certifications printed in full in Appendix H. Therefore, it is not necessary to separately submit these certifications with the proposal.

If the certifications need to be amended, they may be submitted as an additional proposal appendix.

6.2.3 Submission of Proposals

Requirement 103. Electronic proposal files (see Appendix B) shall be submitted electronically via NASA's master proposal database system, the NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES) at nspires.nasaprs.com. This data site is secure and all information entered is strictly for NASA's use only. The proposal submittal deadline is specified in Section 3. [Partially repeats Requirement 1]

Requirement 104. In addition to electronic submission, two identical, clearly labeled CD-ROMs that contain electronic proposal file(s) and Microsoft Excel files of tables (see Appendix B) shall be delivered to the following address by the proposal submittal deadline specified in Section 3. [Partially repeats Requirement 2]

NASA Research and Education Support Services (NRESS)
Suite 500
2345 Crystal Drive
Arlington, VA 22202

Telephone for commercial delivery: 202-479-9030

NASA will notify proposers that their proposals have been received. Proposers who have not received this confirmation within two weeks after submittal of their proposals should contact the Discovery Program Scientist at the address given in Section 6.1.5.

Proposals received after the submittal deadline will be treated in accordance with Appendix A, Section VII.

6.2.4 Electronic Submission of Proposal Summary Information

This AO requires that proposal summary information, referred to as the Electronic Cover Page, must be submitted electronically through NSPIRES, NASA's master proposal database system located at http://nspires.nasaprs.com/. This data site is secure and all information entered is strictly for NASA's use.

Potential proposers should access this site well in advance of the proposal due date to familiarize themselves with its structure and to enter the requested identifier information. Every individual named as a Proposal Team member on the proposal's Electronic Cover Page must be registered in NSPIRES. Such individuals must register themselves; that is, no one may register a second party, even the PI of a proposal in which that person is committed to participate. The proposal's Electronic Cover Page must be submitted electronically by one of the officials at the proposing organization who is authorized to make such a submission. Every organization that intends to submit a proposal to NASA in response to this AO must be registered in NSPIRES. Such registration must be performed by the organization's Electronic Business Point-Of-Contact (EBPOC) in the Central Contractor Registry (CCR).

Requirement 105. The proposing organization and all individuals named as Proposal Team members on the Electronic Cover Page shall be registered in NSPIRES.

All Proposal Team members shall indicate their commitment to the proposed investigation through NSPIRES (see Requirement 91).

Frequently Asked Questions (FAQs) on the use of NSPIRES can be accessed through the NSPIRES Proposal Online Help site at http://nspires.nasaprs.com/external/help.do.

Additional instructions for creating the Electronic Cover Page are given in Appendix B, Section A.2.

7. Proposal Evaluation, Selection, and Implementation

7.1 Overview of the Proposal Evaluation and Selection Process

7.1.1 Evaluation Process

All proposals will be initially screened to determine their compliance with requirements and constraints of this AO. Additional compliance checks occur during the evaluation process. Proposals that do not comply may be declared noncompliant and returned to the proposer without further review. A submission compliance checklist is provided in Appendix F. This checklist provides proposers a list of the items that NASA will check for compliance before releasing a proposal for evaluation. This checklist is for the convenience of proposers; it is not required to be submitted as part of a proposal.

Compliant proposals will be evaluated against the criteria specified in Section 7.2 by panels of individuals who are peers of the proposers. Proposals will be evaluated by more than one panel (*e.g.*, a science panel and a technical/management/cost panel); each panel will evaluate proposals against different criteria. Panel members will be instructed to evaluate every proposal independently without comparison to other proposals. These panels may be augmented through the solicitation of nonpanel (mail in) reviews, which the panels have the right to accept in whole or in part, or to reject.

Proposers should be aware that, during the evaluation and selection process, NASA may request clarification of specific points in a proposal; if so, such a request from NASA and the proposer's response must be in writing. In particular, before finalizing the evaluation of the scientific implementation merit and feasibility (see Section 7.2.3) and the feasibility of the mission implementation (see Section 7.2.4), NASA will request clarification on specific, potential major weaknesses in the scientific implementation merit and the feasibility of mission implementation that have been identified in the proposal. NASA will request clarification in a uniform manner from all proposers. The ability of proposers to provide clarification to NASA is extremely limited, as NASA does not intend to enter into discussions with proposers. A typical limited response is to direct NASA's attention to pertinent parts of the proposal without providing further elaboration.

7.1.2 Categorization and Steering Process

NASA will convene an *ad hoc* categorization subcommittee of the SMD AO Steering Committee, composed wholly of Civil Servants and Intergovernmental Personnel Act appointees (some of whom may be from Government agencies other than NASA) and

appointed by the Associate Administrator for the Science Mission Directorate, The categorization subcommittee will consider the science merit and feasibility peer reviews and TMC peer review results and, based on the evaluations, categorize the proposals in accordance with procedures required by NFS 1872.403-1(e). The categories are defined as follows:

Category I. Well conceived and scientifically and technically sound investigations pertinent to the goals of the program and the AO's objectives and offered by a competent investigator from an institution capable of supplying the necessary support to ensure that any essential flight hardware or other support can be delivered on time and data that can be properly reduced, analyzed, interpreted, and published in a reasonable time. Investigations in Category I are recommended for acceptance and normally will be displaced only by other Category I investigations.

Category II. Well-conceived and scientifically or technically sound investigations which are recommended for acceptance, but at a lower priority than Category I.

Category III. Scientifically or technically sound investigations which require further development. Category III investigations may be funded for development and may be reconsidered at a later time for the same or other opportunities.

Category IV. Proposed investigations which are recommended for rejection for the particular opportunity under consideration, whatever the reason.

The SMD AO Steering Committee will then review the results of the evaluations and categorizations. The AO Steering Committee will conduct an independent assessment of the evaluation and categorization processes regarding their compliance to established policies and practices, as well as the completeness, self-consistency, and adequacy of all supporting materials.

7.1.3 Selection Process

After the review by the AO Steering Committee, the final evaluation results will be presented to the Associate Administrator for the Science Mission Directorate, who will make the final selection(s). As the Selection Official, the SMD Associate Administrator may consult with senior members of SMD and the Agency concerning the selections.

As part of the selection process, a decision will be made as to whether or not any Category III proposals will receive funding for technology development.

7.2 Evaluation Criteria

7.2.1 Overview of Evaluation Criteria

The evaluation criteria, which are defined more fully in the following sections and will be used to evaluate proposals as described in Section 7.1.1, are as follows:

- Scientific merit of the proposed investigation;
- Scientific implementation merit and feasibility of the proposed investigation; and

- Technical, management, and cost (TMC) feasibility of the proposed mission implementation, including cost risk.

The proposal categorizations, discussed in Section 7.1.2, will be based on these criteria. For categorization, scientific merit is weighted approximately 40%, scientific implementation merit and feasibility is weighted approximately 30%, and TMC feasibility, including cost risk, is weighted approximately 30%.

These criteria are defined more fully in the following sections. Evaluation findings for each evaluation criterion will be documented with narrative text in the form of specific major and minor strengths and weaknesses, as well as an adjectival summary score. The adjectival summary scores for the first two criteria (scientific merit and scientific implementation merit) will be reported as Excellent, Very Good, Good, Fair, or Poor, as defined in the table below.

Summary Evaluation	**Basis for Summary Evaluation**
Excellent	A comprehensive, thorough, and compelling proposal of exceptional merit that fully responds to the objectives of the AO as documented by numerous and/or significant strengths and having no major weaknesses.
Very Good	A fully competent proposal of very high merit that fully responds to the objectives of the AO, whose strengths fully outbalance any weaknesses.
Good	A competent proposal that represents a credible response to the AO, having neither significant strengths nor weaknesses and/or whose strengths and weaknesses essentially balance.
Fair	A proposal that provides a nominal response to the AO, but whose weaknesses outweigh any perceived strengths.
Poor	A seriously flawed proposal having one or more major weaknesses (*e.g.*, an inadequate or flawed plan of research or lack of focus on the objectives of the AO).

The third criterion, technical merit and feasibility, including cost risk, will be reported as LOW Risk, MEDIUM Risk, or HIGH Risk, as defined in the table below.

Summary Evaluation	Basis for Summary Evaluation
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. Investigation 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.

7.2.2 Scientific Merit of the Proposed Investigation

The information provided in a proposal will be used to assess the intrinsic scientific merit of the proposed investigation. Scientific merit will be evaluated for the Baseline Science Mission and the Threshold Science Mission; science enhancement options beyond the Baseline Science Mission will not contribute to the assessment of the scientific merit of the proposed investigation. The factors for scientific merit include the following:

- Factor A-1. Compelling nature and scientific priority of the proposed investigation's science goals and objectives. This factor includes the clarity of the goals and objectives; how well the goals and objectives reflect program, Agency, and National priorities; the potential scientific impact of the investigation on program, Agency, and National science objectives; and the potential for fundamental progress, as well as filling gaps in our knowledge relative to the current state of the art.
- Factor A-2. Programmatic value of the proposed investigation. This factor includes the unique value of the investigation to make scientific progress in the context of other ongoing and planned missions; the relationship to the other elements of NASA's science programs; how well the investigation may synergistically support ongoing or planned missions by NASA and other agencies; and the necessity for a space mission to realize the goals and objectives.
- Factor A-3. Likelihood of scientific success. This factor includes how well the anticipated measurements support the goals and objectives; the adequacy of the anticipated data to complete the investigation and meet the goals and objectives; and the appropriateness of the mission requirements for guiding development and ensuring scientific success.
- Factor A-4. Scientific value of the Threshold Science Mission. This factor includes the scientific value of the Threshold Science Mission using the standards in the first factor of this section and whether that value is sufficient to justify the proposed cost of the mission.

Factors A-1 through A-3 are evaluated for the Baseline Science Mission assuming it is implemented as proposed and achieves technical success. Factor A-4 is similarly evaluated for the Threshold Science Mission.

This evaluation will result in narrative text, including specific major and minor strengths and weaknesses, as well as an appropriate adjectival rating for the scientific merit of the investigation.

7.2.3 Scientific Implementation Merit and Feasibility of the Proposed Investigation

The information provided in a proposal will be used to assess merit of the plan for completing the proposed investigation, including the scientific implementation merit, feasibility, resiliency, and probability of scientific success of the proposed investigation. The factors for scientific implementation merit and feasibility include the following:

- Factor B-1. Merit of the instruments and mission design for addressing the science goals and objectives. This factor includes the degree to which the proposed mission will address the goals and objectives; the appropriateness of the selected instruments and mission design for addressing the goals and objectives; the degree to which the proposed instruments and mission can provide the necessary data; and the sufficiency of the data gathered to complete the scientific investigation.
- Factor B-2. Probability of technical success. This factor includes the maturity and technical readiness of the instruments or demonstration of a clear path to achieve necessary maturity; the adequacy of the plan to develop the instruments within the proposed cost and schedule; the robustness of those plans, including recognition of risks and mitigation plans for retiring those risks; the likelihood of success in developing any new technology that represents an untested advance in the state of the art; the ability of the development team - both institutions and individuals - to successfully implement those plans; and the likelihood of success for both the development and the operation of the instruments within the mission design.
- Factor B-3. Merit of the data analysis, cartography, data archiving plan, and/or sample analysis plan. This factor includes the merit of plans for data analysis and/or sample analysis, data archiving, cartography, and/or sample curation to meet the goals and objectives of the investigation; to result in the publication of science discoveries in the professional literature; and to preserve data and analysis samples of value to the science community. Considerations in this factor include assessment of planning and budget adequacy and evidence of plans for well-documented, high-level data products, maps, and software usable to the entire science community; assessment of adequate resources for physical interpretation of data; an assessment of the planning and budget adequacy and evidence of plans for the preliminary evaluation and curation of any returned samples; reporting scientific results in the professional literature (*e.g.*, refereed journals); and assessment of the proposed plan for the timely release of the data to the public domain for enlarging its science impact.
- Factor B-4. Science resiliency. This factor includes both developmental and operational resiliency. Developmental resiliency includes the approach to descoping the Baseline Science Mission to the Threshold Science Mission in the event that development problems force reductions in scope. Operational resiliency includes the ability to

withstand adverse circumstances, the capability to degrade gracefully, and the potential to recover from anomalies in flight.

- Factor B-5. Probability of science team success. This factor will be evaluated by assessing the experience, expertise, and organizational structure of the science team and the mission design in light of any proposed instruments. The role of each Co-Investigator will be evaluated for necessary contributions to the proposed investigation; the inclusion of Co-Is who do not have a well-defined and appropriate role may be cause for downgrading during evaluation.
- Factor B-6. Merit of any Science Enhancement Options (SEOs), if proposed. This factor includes assessing the appropriateness of activities selected to enlarge the science impact of the mission; the potential of the selected activities to enlarge the science impact of the mission; and the appropriate costing of the selected activities. The peer review panel will inform NASA whether the evaluation of the proposed SEO(s) impacted the overall rating for scientific implementation merit and feasibility. Lack of an SEO will have no impact on the overall rating for scientific implementation merit and feasibility.
- Factor B-7. Merit of any Technology Demonstration Opportunities (TDOs), if proposed. This factor includes assessing the potential of the TDO(s) to enlarge the science impact of the mission, the value to future missions of demonstrating the selected technology, and the risk to the mission science objectives posed by the TDO. There will be no penalty for any inherent higher technical risk of the TDO itself.

Student Collaboration proposals, if any, will be evaluated only for the impact they have on science implementation feasibility to the extent that they are not separable; student collaboration proposals will not be penalized in Step-1 for any inherent higher cost, schedule, or technical risk, as long as the student collaboration is shown to be clearly separable from the implementation of the Baseline Science Mission. The intrinsic merit of student collaborations will not be evaluated at this time.

This evaluation will result in narrative text, including specific major and minor strengths and weaknesses, as well as an appropriate adjectival rating for the scientific implementation merit and feasibility of the scientific investigation.

7.2.4 TMC Feasibility of the Proposed Mission Implementation, Including Cost Risk

The technical and management approaches of all submitted investigations, including any TDOs proposed, will be evaluated to assess the likelihood that they can be successfully implemented as proposed, including an assessment of the likelihood of their completion within the proposed cost and schedule. The factors for feasibility of mission implementation include the following:

- Factor C-1. Adequacy and robustness of the instrument implementation plan. The maturity and technical readiness of the instrument complement will be assessed, as will the ability of the instruments to meet mission requirements. This factor includes an assessment of the instrument design, accommodation, interface, heritage, and technology readiness. This factor includes an assessment of the instrument hardware and software designs, heritage, and margins. This factor includes an assessment of the proposer's understanding of the processes, products, and activities required to

accomplish development and integration of the instrument complement. This factor also includes adequacy of the plans for instrument systems engineering and for dealing with environmental concerns. This factor includes an assessment of plans for the development and use of new instrument technology and advanced engineering developments as well as the adequacy of backup plans to mature systems within the proposed cost and schedule when systems having a TRL less than 6 are proposed.

- Factor C-2. Adequacy and robustness of the mission design and plan for mission operations. This factor includes an assessment of the overall mission design and mission architecture, the spacecraft design and design margins (including margins for launch mass, delta-V, and propellant), the concept for mission operations (including communication, navigation/tracking/trajectory analysis, and ground systems – hardware and software – and facilities), and the plans for launch services. This factor includes mission resiliency – the flexibility to recover from problems during both development and operations – including the technical resource reserves and margins, system and subsystem redundancy, and reductions and other changes that can be implemented without impact to the Baseline Science Mission.
- Factor C-3. Adequacy and robustness of the flight systems. This factor includes an assessment of the flight hardware and software designs, heritage, and margins. This factor includes an assessment of the proposer's understanding of the processes, products, and activities required to accomplish development and integration of all elements (flight systems, ground and data systems, etc.). This factor includes an assessment of the adequacy of the plans for spacecraft systems engineering, qualification, verification, mission assurance, launch operations, and entry/descent/landing. This factor includes the plans for the development and use of new technology, plans for advanced engineering developments, plans for the infusion of NASA-developed technologies, and the adequacy of backup plans to ensure success of the mission when systems having a TRL less than 6 are proposed. The maturity and technical readiness of the spacecraft, subsystems, and operations systems will be assessed. 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. NASA-developed technologies offered in the AO will be included in this factor to the extent described in Table 4.
- Factor C-4. Adequacy and robustness of the management approach and schedule, including the capability of the management team. This factor includes: the adequacy of the proposed organizational structure and WBS; the management approach including project level systems engineering; the roles, qualifications, and experience of the PI, PM, other named Key Management Team members, and implementing organization, mission management team, and known partners; the commitment, spaceflight experience, and relevant performance of the PI, PM, other named Key Management Team members, and implementing organization, mission management team, and known partners against the needs of the investigation; the commitments of partners and contributors; and the team’s understanding of the scope of work covering all elements of the mission, including contributions. Also evaluated under this factor is the adequacy of the proposed risk management approach, including 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 approach to any proposed descoping of mission capabilities will be assessed against the proposed Baseline Science Mission. The plans for managing the risk of contributed critical goods and services will be assessed, including the plans for any international participation, the commitment of partners and contributors, as documented in Letters of Commitment, and the technical adequacy of contingency plans, where they exist, for coping with the failure of a proposed cooperative arrangement or contribution. This factor also includes assessment of elements such as the relationship of the work to the project schedule, the project element interdependencies, the associated schedule margins, and an assessment of the likelihood of launching by the proposed launch date. Also evaluated under this factor are the proposed project and schedule management tools to be used on the project

- Factor C-5. Adequacy and robustness of the cost plan, including cost feasibility and cost risk. This factor includes elements such as cost, cost risk, cost realism, and cost completeness including assessment of the basis of estimate, the adequacy of the approach, the methods and rationale used to develop the estimated cost, the discussion of cost risks, the allocation of cost reserves by phase, and the team's understanding of the scope of work (covering all elements of the mission, including contributions). The adequacy of the cost reserves will be evaluated; understanding of the cost risks will be assessed. This factor also includes an assessment of the proposed cost relative to estimates generated by the evaluation team using parametric models and analogies. Also evaluated under this factor are the proposed cost management tools to be used on the project.

The application and scope of any proposed use of NASA-developed technology will be evaluated for appropriateness. Any development or flight readiness risk for NEXT, HEEET, DSOC, and DSAC will not impact the evaluation of the development risk of proposed investigations. The Advanced Solar Array technologies and the use of "green" propellant will be considered to be standard procurements of COTS technology. The implementation feasibility and risk of the proposed use of NASA-developed technology, though, will be evaluated against the factors in this section. All proposers will receive feedback, if applicable, on their proposed use of NASA-developed technology.

When appropriate, Factor C-2 will include an assessment of proposed planetary protection provisions to avoid potential biological contamination (forward and backward) that may be associated with the mission. An evaluation of the implementation of planetary protection provisions in the preparation or processing of proposed instruments, the development of the flight system, and management of the project will be included in the evaluations of Factors C-1, C-3, C-4, and C-5, as appropriate. The impact to the proposed costs of the proposed implementation of planetary protection provisions will also be evaluated, as appropriate.

Student Collaboration proposals, if any, will be evaluated only for the impact they have on overall mission feasibility to the extent that they are not separable; student collaboration proposals will not be penalized in Step-1 for any inherent higher cost, schedule, or technical risk, as long as the student collaboration is shown to be clearly separable from the implementation of the baseline mission. The intrinsic merit of student collaborations will not be evaluated at this time.

Programmatic risks may be assessed but are not included in the TMC risk rating.

This evaluation will result in narrative text, including specific major and minor strengths and weaknesses, as well as an appropriate risk rating for the feasibility of mission implementation.

7.3 Selection Factors

As described in Section 7.1.3, the results of the proposal evaluations based on the criteria above and the categorizations will be considered in the selection process.

Considering the critical role of the PI, PM, PSE, and their institutions, prior experience (especially in meeting cost and schedule constraints) will be an important risk factor in the selection of an investigation under this AO.

The Selection Official may take into account a wide range of programmatic factors in deciding whether or not to select any proposals for Phase A study and in selecting among top-rated proposals, including, but not limited to, planning and policy considerations, available funding, programmatic merit and risk of any proposed partnerships, and maintaining a programmatic and scientific balance across SMD. While SMD develops and evaluates its program strategy in close consultation with the scientific community through a wide variety of advisory groups, the SMD program is an evolving activity that ultimately depends upon the most current Administration policies and budgets, as well as program objectives and priorities that can change quickly based on, among other things, new discoveries from ongoing missions.

The overriding consideration for the final selection of proposals submitted in response to this AO will be to maximize scientific return and minimize implementation risk while advancing NASA's science goals and objectives within the available budget for this program. Therefore, the proposed PI-Managed Mission Cost will be considered in the final selection of investigations through this AO. Depending on the availability of proposals of appropriate merit, this objective may be achieved by the selection of investigation(s) at the AO Cost Cap, one or more investigations significantly below the AO Cost Cap that would allow a more rapid release of the next AO, or a combination of investigations of various costs. Proposers are encouraged to propose well below the AO Cost Cap, as that permits greater flexibility and robustness in the Program and in SMD.

7.4 Implementation of Selected Proposals

7.4.1 Notification of Selection

Following selection, the PIs of the all investigations will be notified by telephone of the dispositions of their proposals, followed by formal written notification. The written notification sent to PIs of selected investigation may include any special conditions or terms of the offer of selection (*e.g.*, partial selections, see Section II of Appendix A) and any special instructions for the concept study. The formal notification will also include instructions for scheduling a debriefing at which written debriefing materials will be provided, and any issues noted during the evaluation that may require attention during the Phase A concept study will be discussed, as well as instructions for attending the Project Initiation Conference.

The Selection Statement for this solicitation, which will be signed by the Selection Official, may include information from the Proposal Summary for any proposal, whether or not it is selected. Since the Selection Statement is a releasable document, the Proposal Summary shall not contain proprietary or confidential information that the submitters wish to protect from public disclosure.

7.4.2 Principal Investigator-led Team Masters Forum

One step toward successful execution of PI-led missions is to ensure that PI-led mission management teams receive the instruction necessary to enable them to better execute their missions for NASA. SMD, in conjunction with the NASA Academy of Program, Project, and Systems Engineering Leadership (APPEL), has established a two and one half day PI-led Team Masters Forum for newly selected PI-led mission management teams. The purpose of the PI-led Team Masters Forum is to facilitate knowledge sharing in areas that are deemed necessary to successfully execute PI-led SMD science missions. Course attendance by the leaders of newly selected PI-led mission management teams (PI, Project Manager, Project Scientist, and Project Systems Engineer) and the NASA Headquarters Program Scientist and Program Executive (where assigned) is required as soon as practical after proposal selection.

7.4.3 Award Administration and Funding

Oversight management responsibilities have been assigned to the Discovery Program Office at the NASA Marshall Space Flight Center. The responsibilities of the Program Office will include oversight of mission implementation; coordination of Government-furnished services, equipment and facilities; and contract management for selected investigations.

It is anticipated that the Program Office will provide funding to each selected investigation. The award of the Phase A concept study is to be initiated as soon as possible after notification of selection. NASA Centers will receive funding via intra-agency funding mechanisms. For each Phase A selection, NASA will request Statements of Work (SOWs), cost and pricing data, and small business subcontracting plans. If more than one contractual arrangement between NASA and the proposing team is required, a separate SOW and budget breakdown is required for each organization. For Phase A contracts that exceed $700K, the contractor will be required to provide cost and pricing data to support the Phase A cost estimate and to certify the cost proposed for the Phase A contract in accordance with FAR 15.406-2. The contactor will also be required to provide cost and pricing data, and a SOW, for a five-month Phase B bridge option.

For those investigations that are selected, it will be in the best interest of their PI-led mission management teams to provide SOWs, cost and pricing data, and small business subcontracting plans in as timely a manner as possible. The process of awarding contracts cannot begin until SOWs, cost and pricing data, and small business subcontracting plans have been received, and funds cannot be provided to the implementing organizations until this process has been completed.

SOWs will be required for selected investigations regardless of whether a proposing organization is Governmental or non-Governmental. SOWs will include the requirement for a

Phase A Concept Study Report as described in the *Guidelines and Criteria for the Phase A Concept Study* document available in the Program Library, as well as general task statements for Phases B through F. SOWs will include the following as a minimum: Scope of Work, Deliverables (including science data), and Government Responsibilities (as applicable). SOWs need not be more than a few pages in length.

Each Phase A contract will contain a priced option for a Bridge Phase, to be exercised upon investigations down-selected to proceed into Phase B. The Bridge Phase option will allow work to be continued uninterrupted under the contract after a Step-2 downselection decision is made. The Bridge Phase is intended to cover a five-month period of Phase B effort to provide program continuity while negotiations are completed to modify the contract to include Phases B, C/D, and E/F. The Bridge Phase option will be exercised only on the contract for the mission(s) chosen during the Step-2 downselection process to continue beyond the Phase A concept study. Additional phases will be added to the contract after each Phase has been approved through the program review process. The five-month Bridge Phase period will be used to begin the negotiation of the remaining phases of the contract with the successful PI(s) downselected during following Phase A.

7.4.4 Conduct of the Phase A Concept Study

The concept studies are intended to provide NASA with more definitive information regarding the cost, risk, and feasibility of the investigations, as well as a detailed plan for the conduct of any optional student collaboration, before final selection for implementation. The product of the concept studies is a Phase A Concept Study Report to be delivered by each selected investigation team nine months following the establishment of initial contracts. The content and format of the study reports are specified in the *Guidelines and Criteria for the Phase A Concept Study* document in the Program Library.

The PI will provide in the Phase A Concept Study Report a proposed set of Level 1 requirements, including the criteria for full mission success satisfying the Baseline Science Mission and the criteria for minimum mission success satisfying the Threshold Science Mission. The PI will also provide in the Phase A Concept Study Report the allocation of the proposed cost reserves among the appropriate WBS elements. The Phase A-D portion of the PI-Managed Mission Cost, including any Phase D work deferred until Phase E such as the development, fabrication or refurbishment of test beds or the development of flight and ground software, will not increase by more than 20% from that in the Step-1 proposal to that in the Phase A Concept Study Report, and, in any case, will not exceed the AO Cost Cap. The NASA review of the completed Concept Study Report will include all mission facets. Risk reduction that has been accomplished during Phase A will be closely reviewed. NASA may request presentations and/or site visits to review the final concept study results with the investigators.

Each mission’s Concept Study Report must conclude with a commitment by the PI for the cost, schedule, and scientific performance of the investigation. For each Phase B selection, and unless otherwise stated in the selection letter, the selected mission’s cost will be set at the Concept Study Report’s proposed cost.

NASA cannot guarantee that the proposed funding profile can be accommodated within the Discovery Program's budget. A funding profile for the selected mission will be negotiated during Phase B.

7.4.5 Downselection of Investigations

The SMD Associate Administrator will make downselection decisions based on the evaluation of the Phase A Concept Study Reports and on programmatic considerations. The criteria for evaluating the concept study are as follows:

- Scientific merit of the proposed investigation;
- Scientific implementation merit of the proposed investigation;
- Technical, management, and cost feasibility, including cost risk, of the proposed investigation; and
- Quality of plans for small business subcontracting plans and optional student collaboration, if proposed.

The evaluation criteria and downselection factors are described in the *Guidelines and Criteria for the Phase A Concept Study* document in the Program Library. Any changes to science and science implementation contained in the Phase A Concept Study Report will be carefully evaluated. Assuming no changes to the first two criteria, the emphasis during downselection will be on the latter two.

At the conclusion of Phase A, it is anticipated that the Selecting Official will select one or more investigations to proceed into the subsequent phases of mission development for flight and operation. The target date for this continuation decision (*i.e.* "downselection") is given in Section 3.

Investigations may be downselected to enter Phase B or may be downselected for a funded Extended Phase A so one or more risks can be retired before it is allowed to proceed to Phase B. For investigations selected to enter Phase B immediately, the downselect serves as the Initial Confirmation Review gate (KDP-B); an investigation downselected for an Extended Phase A must subsequently pass an Initial Confirmation Review gate (KDP-B) with the SMD Program Management Council (PMC) before entering Phase B. There is no guarantee that an investigation downselected for an Extended Phase A will be approved to enter Phase B, even if all risks have been retired during the Extended Phase A. In no case is NASA required to exercise any option. NASA will not exercise any contract option nor continue funding those investigations not selected to proceed.

Upon a continuation decision, NASA will execute the Bridge Phase option and begin to provide Phase B funding for the project that is continued beyond the Phase A concept study. During the Bridge Phase, NASA and the continued project will negotiate and sign a contract modification necessary for the remaining portion of Phase B. Deliverables for Phase B will be negotiated during the Bridge Phase, on the basis of information provided in the Concept Study Report.

For those investigations that are not continued, the contracts will be allowed to terminate without further expense to NASA. Every investigation team will be offered a debriefing of the evaluations of its Concept Study Report.

Should a non-U.S. proposal or a U.S. proposal with non-U.S. participation be selected, NASA's Office of International and Interagency Relations, Science Division, will arrange with the non-U.S. sponsoring agency for the proposed participation on a no-exchange-of-funds basis, in which NASA and the non-U.S. sponsoring agency will each bear the cost of discharging their respective responsibilities. Depending on the nature and extent of the proposed cooperation, these arrangements may entail a letter of notification by NASA with a subsequent exchange of letters between NASA and the sponsoring governmental agency or a formal Agency-to-Agency memorandum of understanding.

The contract or other funding mechanism for further formulation and implementation will conform to all applicable Federal and NASA procurement requirements. A *Draft Model Contract* for Phase B/C/D/E formulation and implementation is available in the Program Library.

7.4.6 Confirmation of Investigations

Per NPR 7120.5E, at the end of Phase B, NASA will conduct an independent review of the investigation's readiness to proceed. This review must be completed before the project will be authorized to spend more than 25% of the PI-Managed Mission Cost. The results of the independent review and the project status will be presented to the SMD Program Management Council (PMC) at the Confirmation Review (KDP-C) for Confirmation to enter Phase C. If the project is classified Category 1 according to NPR 7120.5E, the Confirmation results will need subsequent approval from the Agency PMC. Following Confirmation, no rephasing between fiscal years of Phase E costs to Phase C/D will be permitted.

7.5 Opportunity for Debriefing of Nonselected Proposers

Proposers of investigations that are not selected will be notified by telephone and in writing and offered oral debriefings for themselves and a representative from each of their main partners (if any). Written debriefing materials will be provided at the time of the oral debriefing. Such debriefings may be in person at NASA Headquarters or by telephone if the proposal PI prefers. In the former case, please note that all expenses and arrangements for attending a debriefing are the responsibility of the attendee. Travel and associated costs of attendance are not allowable as a direct cost under another Federal Government award, *i.e.*, contract, grant, or cooperative agreement. Government employees may attend and be authorized travel and associated costs as a matter of official business.

7.6 Process for Appeals

7.6.1 Agency Procurement Ombudsman

The Agency Procurement Ombudsman, designated in NPD 5101.32E, *Procurement, Grants, and Cooperative Agreements*, will: take action to resolve concerns, disagreements, and recommendations submitted by interested parties that cannot be resolved at the Center level, or those having Agency-wide implications; refer Center-specific issues to the appropriate Center

Procurement Ombudsman for action; and periodically communicate with Center Procurement Ombudsmen on common Agency-wide issues and refer those issues to the appropriate office for action. Under NPD 5101.32E, the designated Agency Procurement Ombudsman is:

Director of the Contract Management Division
Office of Procurement
NASA Headquarters
Washington, DC 20546
USA

7.6.2 Protests

Only prospective offerors seeking contract awards under this AO have the right to file a protest, either at the Government Accountability Office (GAO) or with the Agency, as defined in FAR 33.101. The provisions at FAR 52.233-2 ("Service of Protest") and NFS 1852.233-70 ("Protests to NASA") are incorporated into this AO. Under both of these provisions, the designated official for receipt of protests to the Agency and copies of protests filed with the GAO is:

Assistant Administrator for Procurement
Office of Procurement
NASA Headquarters
Washington, DC 20546
USA

8. Conclusion

The Discovery Program provides an opportunity for NASA and its partners to accomplish important scientific exploration, as well as to generate opportunities to enhance education and engage the public in the excitement of science discoveries. NASA invites both the U.S. and international science communities to submit proposals for Discovery investigations in response to this Announcement.

James Green
Director
Planetary Science Division

John M. Grunsfeld
Associate Administrator
for Science Mission Directorate

APPENDIX A

GENERAL INSTRUCTIONS AND PROVISIONS
See NASA FAR Supplement, Part 1872.705-1

I. INSTRUMENTATION AND/OR GROUND EQUIPMENT

By submitting a proposal, the investigator and institution agree that NASA has the option to accept all or part of the offeror's plan to provide the instrumentation or ground support equipment required for the investigation, or NASA may furnish or obtain such instrumentation or equipment from any other source as determined by the selecting official. In addition, NASA reserves the right to require use of Government instrumentation or property that subsequently becomes available, with or without modification, that meets the investigative objectives.

II. TENTATIVE SELECTIONS, PHASED DEVELOPMENT, PARTIAL SELECTIONS, AND PARTICIPATION WITH OTHERS

By submitting a proposal, the investigator and the organization agree that NASA has the option to make a tentative selection pending a successful feasibility or definition effort. NASA has the option to contract in phases for a proposed experiment and to discontinue the investigative effort at the completion of any phase. NASA may desire to select only a portion of the proposed investigation and/or that the individual participates with other investigators in a joint investigation. In this case, the investigator will be given the opportunity to accept or decline such partial acceptance or participation with other investigators prior to a NASA selection. Where participation with other investigators as a team is agreed to, one of the team members will normally be designated as its leader or contact point. NASA reserves the right not to make an award or cancel this AO at any time.

III. SELECTION WITHOUT DISCUSSION

The Government intends to evaluate proposals and award contracts without discussions with offerors. Therefore, each initial offer should contain the offeror's best terms from a cost or price and technical standpoint. However, the Government reserves the right to conduct discussions, if later determined by the Contracting Officer to be necessary.

IV. NONDOMESTIC PROPOSALS

The guidelines for proposals originating outside of the United States are the same as those for proposals originating within the United States, except that the additional conditions described in AO Section 5.7 shall also apply.

V. TREATMENT OF PROPOSAL DATA

It is NASA policy to use information contained in proposals and quotations for evaluation purposes only. While this policy does not require that the proposal or quotation bear a restrictive notice, offerors or quoters should, in order to maximize protection of trade secrets or other

information that is commercial or financial and confidential or privileged, place the following notice on the title page of the proposal or quotation and specify the information, subject to the notice by inserting appropriate identification, such as page numbers, in the notice. In any event, information (data) contained in proposals and quotations will be protected to the extent permitted by law, but NASA assumes no liability for use and disclosure of information not made subject to the notice.

RESTRICTION ON USE AND DISCLOSURE OF
PROPOSAL AND QUOTATION INFORMATION (DATA)

> The information (data) contained in (insert page numbers or other identification) of this proposal or quotation constitutes a trade secret and/or information that is commercial or financial and confidential or privileged. It is furnished to the Government in confidence with the understanding that it will not, without permission of the offeror, be used or disclosed for other than evaluation purposes; provided, however, that in the event a contract is awarded on the basis of this proposal or quotation, the Government shall have the right to use and disclose this information (data) to the extent provided in the contract. This restriction does not limit the Government's right to use or disclose this information (data), if obtained from another source without restriction.

VI. STATUS OF COST PROPOSALS

Submission of cost or pricing data, as defined in FAR 15.403-4, is required if the combined Phase A and Bridge Phase costs exceed $700,000. Cost or pricing data will also be required for proposals for subsequent mission phases. The investigator's institution agrees that the cost proposal submitted in response to the AO is for proposal evaluation and selection purposes, and that, following selection and during negotiations leading to a definitive contract, the institution may be required to resubmit or execute all certifications and representations required by law and regulation.

VII. LATE PROPOSALS

The Government reserves the right to consider proposals or modifications thereof received after the date indicated for such purpose, if the selecting official deems it to offer NASA a significant technical advantage or cost reduction. (See NFS 1815.208.)

VIII. SOURCE OF SPACE INVESTIGATIONS

Investigators are advised that candidate investigations for space missions can come from many sources. These sources include those selected through this AO, those generated by NASA in-house research and development, and those derived from contracts and other agreements between NASA and external entities.

IX. DISCLOSURE OF PROPOSALS OUTSIDE THE GOVERNMENT

NASA may find it necessary to obtain proposal evaluation assistance outside the Government. Where NASA determines it is necessary to disclose a proposal outside the Government for evaluation purposes, arrangements will be made with the evaluator for appropriate handling of the proposal information. Therefore, by submitting a proposal, the investigator and institution agree that NASA may have the proposal evaluated outside the Government. If the investigator or institution desires to preclude NASA from using an outside evaluation, the investigator or institution should so indicate on the cover. However, notice is given that if NASA is precluded from using outside evaluation, it may be unable to consider the proposal.

X. EQUAL OPPORTUNITY

For any NASA contract resulting from this solicitation, the clause at FAR 52.222-26, "Equal Opportunity," shall apply.

XI. PATENT RIGHTS

a. For any NASA contract resulting from this solicitation awarded to other than a small business firm or nonprofit organization, the clause at NFS 1852.227-70, New Technology, shall apply. Such contractors may, in advance of a contract, request waiver of rights as set forth in the provision at NFS 1852.227-71, Requests for Waiver of Rights to Inventions.

b. For any NASA contract resulting from this solicitation awarded to a small business firm or nonprofit organization, the clause at FAR 52.227-11, Patent Rights -- Retention by the Contractor (Short Form), (as modified by NFS 1852.227-11) shall apply.

XII. RIGHTS IN DATA

Any contract resulting from this solicitation will contain the Rights in Data – General clause: FAR 52.227-14.

XIII. SMALL AND SMALL DISADVANTAGED BUSINESS SUBCONTRACTING

a. Offerors are advised that NASA is subject to statutory goals to allocate a fair portion of its contract dollars to SDB concerns, HBCUs, and OMIs, as these entities are defined in 52.219-8 and 52.226-2 of the FAR. Offerors are encouraged to assist NASA in achieving these goals by using best efforts to involve these entities as subcontractors to the fullest extent consistent with efficient performance of their investigations.

b. Offerors are advised that, by law, NASA prime contracts resulting from this solicitation which offer subcontracting possibilities, exceed $650,000, and are with organizations other than small business concerns, the clause at FAR 52.219-9 shall apply. Accordingly, offerors awarded contracts for Phase A concept studies that exceed $650,000 are required to submit small business subcontracting plans consistent with the FAR, covering the

study phase only, unless they adequately demonstrate that subcontracting opportunities are not reasonably available in the performance of these concept studies. Failure to do so will make the offeror ineligible for award. These plans should be submitted for negotiation after selection in conjunction with contract execution.

c. As part of the down selection of investigations, offerors, other than small business concerns, are required to submit small business subcontracting plans, covering implementation and operation Phases B/C/D/E/F, at the time the Phase A concept study reports are delivered. Failure to submit a subcontracting plan will make the offeror ineligible for award. As part of the down select decision, these subcontracting plans will be evaluated on the participation goals and quality and level of work performed by small business concerns overall, as well as that performed by the various categories of small business concerns listed in FAR 52.219-9, except for SDBs. Offerors shall separately identify and will be evaluated on participation targets of SDBs in North American Industry Classification System (NAICS) codes determined by the Department of Commerce to be underrepresented industry sectors.

XIV. WITHDRAWAL OF PROPOSALS

Proposals may be withdrawn by the proposer at any time before award. Proposers are requested to notify NASA if the proposal is funded by another organization or of other changed circumstances that dictate termination of evaluation.

APPENDIX B

REQUIREMENTS FOR PROPOSAL PREPARATION

INTRODUCTION

The following requirements apply to preparation of proposals in response to this Announcement of Opportunity (AO). While the body of the AO specifies the general policies and requirements for preparing Step-1 proposals, as well as for implementing missions proposed in response to this opportunity, Appendix B contains the specific requirements for the format and content of Step-1 proposals. In the event of apparent conflicts between this Appendix and the policies and requirements specified within the body of the AO, the latter takes precedence.

GENERAL REQUIREMENTS

The following expands requirements in the AO, in particular Requirement 102.

Requirement B-1. A proposal shall consist of one file divided into readily identifiable sections that correspond and conform to Sections A through J of this appendix. It shall be typewritten in English and shall employ metric (SI) and/or standard astronomical units, as applicable. It shall contain all data and other information that will be necessary for scientific and technical evaluations; provision by reference to external sources, such as Internet websites, of additional material that is required for evaluation of the proposal is prohibited.

Requirement B-2. Proposal page size shall be either American standard 8.5 x 11 inches or European standard A4. Foldout pages (11 x 17 inches or A3) may also be employed at the proposers' discretion (see below for assessment of foldout pages against the page limit).

Requirement B-3. Text shall not exceed 55 lines per page and page numbers shall be specified. Margins at the top, both sides, and bottom of each page shall be no less than 1 inch if formatted for 8.5 x 11 inch paper; no less than 2.5 cm at the top and both sides, and 4 cm at the bottom if formatted for A4 paper. Single-column or double-column formats are acceptable for text pages. Type fonts for text and figure captions shall be no smaller than 12-point (*i.e.*, no more than 15 characters per inch; six characters per centimeter). There is no minimum requirement for fonts used within figures and tables, but all text in figures and tables shall be legible; fonts smaller than 8-point are often illegible.

Proposal Structure and Page Limits		
Section	**Contents**	**Page Limits**
A	Proposal Summary Information Graphic Cover Page Export controlled material statement (Section 5.8.2) Optional Restriction on Use statement (see Appendix A, Section V)	As per NSPIRES 1 0.5 0.5
B	Fact Sheet	2
C	Table of Contents	None
D E	Science Investigation Science Implementation, including optional SEO and/or TDO	30 + 2 pages / instrument + 2 pages for SEO + 2 pages for TDO **
F G	Mission Implementation Schedule Foldout(s) Management	35 + 2 pages/flight element ** (Schedule Foldout(s) do(es) not count against limit)
H	Cost and Cost Estimating Methodology Cost Tables B3a and B3b	15 (Tables B3a and B3b foldouts do not count against limit)
I	Optional Student Collaboration Plan	2
J	Proposal Appendices (no others permitted):	
J.1	Table of Proposal Participants	None
J.2	Letters of Commitment	None
J.3	Resumes	None
J.4	Summary of Proposed Program Cooperative Contributions	None
J.5	Draft International Participation Plan Discussion on Compliance with U.S. Export Laws and Regulations	None
J.6A	Planetary Protection Plan	None
J.6B	Sample and Space-Exposed Hardware Curation Plan	None
J.7	Discussion of End-of-Mission Spacecraft Disposal Requirements	None
J.8	Compliance with Procurement Regulations by NASA PI Proposals	None
J.9	Master Equipment List (MEL)	None
J.10	Heritage	None
J.11	List of Abbreviations and Acronyms	None
J.12	List of References (optional)	None
J.13	Plan for Infusion of NASA-Developed Technology (if applicable)	5

J.14	Description of Engineering Science Investigation	5
J.15	Justification for the use of non-AMMOS MOS/GDS Tools (if applicable)	3

** Total extra pages limited to 15 as described in Requirement B-4.

Requirement B-4. Proposals shall conform to the page limits specified in the *Proposal Structure and Page Limits* table. 2 extra page(s) each is (are) allotted for each additional separate science instrument in the Science Section (Sections D and E), 2 extra page(s) each is (are) allotted for each additional separate, non-identical flight element (*e.g.*, cruise element, landed element, sample return element, additional spacecraft) in the Mission Implementation and Management Sections (Sections F and G), and 2 extra page are allotted for all science enhancement options (SEOs) combined, and 2 extra pages are allotted for all technology demonstration options (TDOs) combined, in the Science Implementation Section (Section E). The total number of such extra pages in the Science and Mission Implementation sections combined shall not exceed a maximum of 15 extra pages regardless of the number of science instruments and unique flight elements. Every page upon which printing appears will count against the page limits and, unless specifically exempted (*e.g.*, Requirement B-42 and Requirement B-52), each foldout page will count as two pages against the page limits as appropriate for its area (*e.g.*, a fold-out with the total area of two standard pages counts as two pages, *etc.*).

Requirement B-5. Electronic proposals shall be a single searchable Adobe Portable Document Format (PDF) file, comprised of the main proposal, all tables (see Requirement B-53 and Requirement B-73), and all applicable proposal appendices (see Section J of this appendix). Electronic proposals shall be limited to 20 MB in size. Once uploaded to NSPIRES, this document will be considered the official submission.

Requirement B-6. Two CD-ROMs of proposals shall include electronic proposals specified in Requirement B-5, and shall additionally include Microsoft Excel files of tables (see Requirement B-53 and Requirement B-73), Microsoft Project file of project schedule (see Requirement B-43), parametric cost input file(s) and model results (see Requirement B-55), and trajectory files (see Requirement B-32). CD-ROMs of proposals may additionally include up to 100 MB, but otherwise identical, versions of electronic proposals. In the event of a conflict between versions of electronic proposals or the additional files, the version of the electronic proposal specified in Requirement B-5 shall take precedence.

A. PROPOSAL SUMMARY INFORMATION AND GRAPHIC COVER PAGE

1. Electronic Proposal.

The following expands requirements in the AO, in particular Requirement 102.

Requirement B-7. Proposal Summary Information and the Graphic Cover Page, prepared as directed below, shall preface every proposal. The Proposal Summary Information will not be counted against the page limits. The Proposal Summary shall not contain proprietary or confidential information that the submitters wish to protect from public disclosure. Note that the

Graphic Cover Page should be the first page of the electronic proposal specified in Requirement B-5; when combined by NSPIRES with the Proposal Summary Information, the Graphic Cover page will follow that information.

Requirement B-8. The Graphic Cover Page shall contain, at a minimum, the following information and elements displayed on the cover page of the proposal:

- The proposal title;
- The name of the proposing organization;
- The name of the PI;
- The name and title of an official who is authorized to commit the proposing organization through the submission of the proposal;
- The signature of the PI and the authorizing official (unless these signatures appear on the Proposal Summary Information), and

Optionally, the Graphic Cover Page may also contain:

- Any illustrations or graphic elements of the proposer's choice (or none); and
- Any additional information of the proposer's choice that is nonproprietary and that does not provide additional content beyond what is in the proposal (or none).

2. Electronic Cover Page (NSPIRES Submission).

The following expands requirements in the AO, in particular Requirement 105
Electronic submission must be through the NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES) at http://nspires.nasaprs.com/.

Requirement B-9. This AO requires that proposal summary information, referred to as the Electronic Cover Page, shall be submitted electronically. The forms for the Electronic Cover Page are found in NSPIRES at http://nspires.nasaprs.com/.

The NSPIRES electronic cover page includes the response to the following instruction: "List all participants in this investigation, both requesting funding and not requesting funding, who do not appear on the proposal's cover page as a Co-investigator, collaborator, or any other category of participant. Include name, institution, city, state or country, and a description of the role in five words or less (e.g. data analyst, facility provider, support technician)." It is recognized that individuals may be affiliated with the proposed investigation without being listed as team members on the proposal cover page. The information provided is used to ensure that the evaluation panels do not include individuals as reviewers who have participated in one or more proposals they have the appearance of being biased.

Requirement B-10. Proposers shall ensure that the response to this instruction includes all team members as may be known at this time not listed in the Team Member section of the cover page who participated in a substantial way in the development of the investigation concept or the proposal itself, or who will participate substantially in the development and conduct of the investigation.

The proposal evaluation process requires evaluators be free of Conflict of Interest. In order to assist in planning of the proposal evaluation process, NASA requires a comprehensive list of proposed investigation participants.

Requirement B-11. With the proposal submission via NSPIRES, the proposers shall identify any institution that is specified in the proposal but that does not appear in either the "Team Member" section of the cover page or in answer to the question about "participants […] who do not appear on the proposal's cover page." The proposer shall list the institution and division name, role (e.g., instrument component provider), and estimated real year dollars to be received. This information will be used to avoid financial and organizational conflicts of interest during the evaluation process by checking evaluators against institutions that are proposed to supply materials, parts, or services.

3. Proposal Team Member Commitment Through NSPIRES.

The following expands requirements in the AO, in particular Requirement 105.

Every Proposal Team member must be identified on the NSPIRES proposal cover page, and must indicate his/her commitment to the proposed investigation through NSPIRES prior to proposal cover page submission. Team members must additionally confirm the organization through which they are participating on this proposal; identification of the organization serves as the commitment to the team specified in Requirement 105.

A Proposal Team member will receive an E-mail from NSPIRES indicating that he/she has been added to the proposal by the PI. The Proposal Team member should log in to NSPIRES. Once logged in, the Proposal Team member should follow the link in the "Reminders and Notifications" section of his/her NSPIRES home page, titled "Need <role> confirmation for proposal <title> for Solicitation <solicitation number>." On the "Team Member Participation Confirmation" page, the Proposal Team member should read language about the Organizational Relationship, then click the "Continue" button.

If the contact information then displayed on the "Team Member Profile" screen is out of date, the Proposal Team member should update this information **later** using the "Account Mgmt" link in the NSPIRES navigation bar across the top. Prior to making that update, however, the team member should follow the on-screen prompts to identify the organization through which he/she is participating on this proposal. Click the "Link Relationship" button to the right side of the "Organizational Relationship" banner. Select the organization from the "Link Proposal to an Association" part of the page. If the correct organization is not displayed here, try using the "Add Association" button to add the organization to this list. Then click the "Save" button at the bottom of the page. If the team member cannot find the organization when searching in the "Add Association" area (*i.e.*, the organization is not registered), type in the formal name in the space provided (or select "Self" if appropriate). Once the organization is selected and the "Save" button is clicked, there is a confirmation page that allows the team member to edit that relationship if it was chosen incorrectly. Click "Continue".

Note that the organization through which the Proposal Team member is participating in the proposal might not be the Proposal Team member's primary employer or primary mailing address. If the address information is accurate (or once it has been edited to be accurate), the Proposal Team member may log out of NSPIRES.

NSPIRES will send an E-mail to both the team member and the PI confirming that the commitment was made and the organization was identified. The PI may additionally monitor the status of Proposal Team member commitments by examining the "Relationship Confirmed" column on the Team Member page of the NSPIRES proposal cover page record. Note that the proposal cover page cannot be submitted until all identified team members have confirmed their participating organization.

Requirement B-12. Every Proposal Team member named on the proposal cover page shall personally commit to the proposed investigation through NSPIRES and identify the organization through which he/she is participating. The PI and every Proposal Team member shall ensure that the organization listed on the proposal cover page is the organization through which the Proposal Team member is participating in the proposal.

B. FACT SHEET

The following expands requirements in the AO, in particular Requirement 102.

Requirement B-13. Every proposal shall include a fact sheet that provides a brief summary of the proposed investigation. Information conveyed on this fact sheet shall include:

- Science objectives (including the importance of the science to the program science goals);
- Mission overview;
- Instrument complement;
- Key spacecraft characteristics;
- Mission management and participating organizations (including teaming arrangements, as known);
- Anticipated need for curatorial services for returned samples, as applicable;
- Schedule summary;
- The proposed PI-Managed Mission Cost in real year dollars (RY$) and in FY 2015 dollars (FY 2015$) from Tables B3a and B3b respectively; and
- The proposed Total Mission Cost, including a breakdown of any contributed costs by contributing organization, in real year dollars (RY$) and in FY 2015 dollars (FY 2015$) from Table B3a and B3b respectively.

C. TABLE OF CONTENTS

The following expands requirements in the AO, in particular Requirement 102.

Requirement B-14. Every proposal shall contain a table of contents that conforms to the outlines provided in Sections D through J of this appendix, below.

D. SCIENCE INVESTIGATION

The following expands requirements in the AO, in particular Requirement 4 through Requirement 25.

1. Scientific Background, Goals, and Objectives.

Requirement B-15. This section shall describe the goals and objectives of the investigation; the compelling nature of the investigation; the investigation's value to advancing NASA's science objectives; and the relationship of the proposed investigation to past, current, and future investigations and missions.

2. Science Requirements.

Requirement B-16. This section shall describe the investigation to be performed, the types of measurements to be taken; the characteristics, precision, and accuracy required to attain the scientific objectives; and the projected instrument performance. This section shall describe the data to be returned in the course of the investigation. The quality (*e.g.*, resolution, coverage, pointing accuracy, measurement precision, etc.) and quantity (bits, images, etc.) of data that must be returned shall be described. The relationship between the proposed data products (*e.g.*, flight data, ancillary or radiometric and geometric calibration data, theoretical calculations, higher order analytical or data products, sample returns, witness samples, laboratory data, etc.) and the scientific objectives, as well as the expected results, shall be described. How the science products and data obtained will be used to fulfill the scientific requirements shall be demonstrated and supported by quantitative analysis. These descriptions shall constitute the Baseline Science Mission.

Requirement B-17. Traceability from science goals to measurement requirements to instrument requirements (functional and performance), and to top-level mission requirements shall be provided in tabular form and supported by narrative discussion. Projected instrument performance shall be compared to instrument performance requirements.

Table B1 of this appendix provides an example of a tabular Science Traceability Matrix, with examples of matrix elements. This matrix provides the reference points and tools needed to track overall mission requirements, provide systems engineers with fundamental requirements needed to design the mission, show clearly the effects of any descoping or losses of elements, and facilitate identification of any resulting degradation to the science.

3. Threshold Science Mission.

Requirement B-18. This section shall identify the minimum acceptable data and scientific return for the mission (the Threshold Science Mission), below which the mission would not be worth pursuing. The Threshold Science Mission is identified with the "Threshold Science Requirements" in NPR 7120.5E. The scientific value of the Threshold Science Mission shall be discussed. NASA recognizes that, in some circumstances, the Threshold Science Mission may be

identical to the Baseline Science Mission. In such cases, the proposer shall explain why there is no viable mission below the Baseline Science Mission.

E. SCIENCE IMPLEMENTATION

The following expands requirements in the AO, in particular Requirement 6 through Requirement 25 and Requirement 59 through Requirement 61.

1. Instrumentation.

Requirement B-19. This section shall describe the instrumentation and the rationale for its selection. It shall identify the instrument systems (i.e., the individual instruments), instrument subsystems, and instrument components, including their characteristics and requirements, and indicate items that are proposed for development, as well as any existing instrumentation or design/flight heritage. It shall provide a clear understanding of how the concept will provide the required data, show how it can be accommodated by the spacecraft, demonstrate that instruments have the necessary unobstructed fields-of-view over the measurement period required, describe the technology readiness levels and the approach to bring each instrument to technology readiness level (TRL) 6 by the preliminary design review (PDR). If no development plan is needed, the reasons for this shall be explicitly stated and the rationale shall be described. A preliminary description of each instrument design, with a block diagram showing the instrument subsystems and components and their interfaces, along with a description of the estimated performance of the instrument, shall be included. These performance characteristics (which shall be considered as requirements on the flight system) shall include mass, power, volume, data rate(s), thermal, pointing (such as control, stability, jitter, drift, accuracy, etc.), spatial and spectral resolution, observable precision, retrieved parameter sensitivity and accuracy, and radiometric and geometric calibration requirements. This section shall demonstrate that the instrumentation can meet the measurement requirements, including factors such as retrieval results for each remote sensor, error analysis of the information in all sensors, vertical and horizontal resolution, signal-to-noise (S/N) calculations, etc. It shall also discuss effects, such as radiation and contamination, on each instrument's measurement capabilities as a function of mission time.

Requirement B-20. The following information shall be provided for each science instrument proposed:

- Mass (include breakouts of electronics and optics);
- Viewing direction in body coordinates;
- Pointing accuracy and stability requirements;
- Operational modes;
- Operational mode timeline;
- Data demand for each instrument operational mode;
- Onboard data processing and storage required from spacecraft;
- Power demand for each instrument operational mode including peak, average, and stand-by power; and
- Instrument thermal control capability.
- Applicable instrument diagrams (e.g., optical path).

- Characteristics of relevant instrument components (e.g., listing of size of optics) in the MEL.

2. Data Sufficiency.

Requirement B-21. This section shall discuss the quality and quantity of data to be generated by each instrument, as they relate to the proposed science investigation goals and objectives. The flow-down from science investigation goals to measurement objectives and instrument performance shall be stated clearly and supported by quantitative analysis.

3. Science Mission Profile.

Requirement B-22. This section shall discuss the science observing profile, including all mission-relevant parameters, such as orbit, navigation accuracy, operational time lines (including observing periods, data transmission periods and techniques, and time-critical events), etc. The manner in which the proposed investigation objectives, selected instruments, and measurement requirements drive the proposed mission design and operations plan should be apparent from this discussion.

4. Data Plan.

Requirement B-23. A schedule-based end-to-end data management plan, including approaches for data retrieval, validation, preliminary analysis, and archiving shall be described. The science products (*e.g.*, flight data, ancillary or radiometric and geometric calibration data, theoretical calculations, higher order analytical or data products, sample returns, witness samples, laboratory data, etc.) shall be identified, including a list of the specific data products and the individual team members responsible for the data products. The plan shall identify the appropriate NASA data archive and the formats and standards to be used. It shall include an estimate of the raw data volume and a schedule for the submission to the data archive of raw and reduced data in physical units accessible to the science community.

5. Science Team.

Requirement B-24. This section shall identify each key member (*i.e.*, one whose participation is essential to the success of the investigation) of the science team and his/her role and responsibilities. Resumes or curriculum vitae of science team members shall be included as appendices to the proposal (see Section J.3 of this appendix). The role of each Co-investigator (Co-I) shall be explicitly defined, the necessity of that role shall be justified, and the funding source (NASA or contributed) for the PI and each Co-I shall be noted. Nonfunded members of the science team shall be identified in the proposal as collaborators (see Section 5.4 of this AO). The role of collaborators may be defined and justified.

6. Plan for Science Enhancement Option (SEO).

Requirement B-25. If an SEO is proposed, this section shall define and describe the proposed activities (see Section 5.1.6 of this AO).

7. Plan for Technology Demonstration Option (TDO).

Requirement B-26. If a TDO is proposed, this section shall define and describe the proposed activities (see Section 5.1.7 of this AO).

F. MISSION IMPLEMENTATION

The following expands requirements in the AO, in particular AO Requirement 25 through Requirement 33.

1. General Requirements and Mission Traceability.

Requirement B-27. This section shall provide a description of the spaceflight mission that is proposed to enable the science investigation.

In some areas *(e.g.,* instruments), the data requested may have already been presented in another section of the proposal (*e.g.,* the Science Implementation section). In such a case, a proposal may provide a reference to that section and need not repeat the data in this section.

Requirement B-28. The mission requirements that the science goals and objectives impose on the mission design elements, including mission design, instrument accommodation, spacecraft design, required launch vehicle capability, ground systems, communications approach, and mission operations plan, shall be provided in tabular form and supported by narrative discussion. Table B2 provides an example of a tabular Mission Traceability Matrix, with examples of matrix elements. Specific information that describes how the science investigation imposes unique requirements on these mission design elements shall be included.

This matrix, along with Table B1, provides the reference points and tools needed to track overall mission requirements, provides systems engineers with fundamental requirements needed to design the mission, shows clearly the effects of any descoping or losses of mission elements, and facilitates identification of any resulting degradation to the science.

Requirement B-29. NASA recognizes that the full depth of information requested in Requirement B-30 through Requirement B-42 may not be available for some aspects of mission implementation at this stage of mission design. In such cases, this section shall (i) describe the current design concept, (ii) explain why the design information is not complete, (iii) provide a time-based plan for completing the design, (iv) justify that the development of that aspect of the design is not required at this stage and that it is acceptable to develop details later, and (v) explain why the lack of information at this stage does not translate into a risk to the proposer's ability to implement the mission as proposed. The approach for developing the required depth of information, along with a corresponding development schedule, shall be included among the plans for future activity. In cases where a mission is proposed at or near the AO Cost Cap, but depth of technical implementation detail is deferred, the proposal shall justify the adequacy of the proposed cost reserves to prevent increases beyond the AO Cost Cap during Phase A and subsequent phases.

This requirement is levied to establish NASA's standard for completeness of information necessary to support a comprehensive assessment of implementation feasibility and risk. The quality of the proposal's response to this requirement contributes significantly to the quality of the TMC assessment. However, NASA recognizes the preliminary nature of Step-1 proposals, and thus Requirement B-29 will apply to all cases where the required information cannot, for whatever reason, be provided.

2. Mission Concept Descriptions.

Requirement B-30. Designs for all elements of the mission shall be described in sufficient detail to demonstrate that the proposed concept meets all of the basic requirements for a space flight mission, including mission design, spacecraft design, and supporting ground systems. Discussion of how the various mission elements meet the Mission Functional Requirements shall be included. At a minimum, the following mission elements shall be addressed: mission design, flight system capabilities, mission operations, and any additional elements.

Requirement B-31. Mission Design: This section shall address the following elements of mission design to the extent that they are applicable to the proposed mission and that they are known at the time of proposal submission. Any additional elements that are applicable to explaining the mission and demonstrating its feasibility shall also be addressed.

- Launch readiness date (including launch date flexibility);
- Mission duration;
- Orbit type (Earth orbit, heliocentric, etc.) and orbit information (semimajor axis, eccentricity, inclination, node time of day, argument of perigee, altitude), and/or trajectory design, as applicable to the proposed investigation;
- Critical events; and
- Ground station(s) usage (*e.g.*, location(s), transmitting and receiving communication parameters).

Requirement B-32. Trajectory: The following information shall be provided in a file or files on the CD-ROM containing the electronic version of the proposal. There is no requirement that this data also be included in the electronic proposal (uploaded PDF file). Any graphical references, tables, figures, etc. must be presented in a minimum of 150 dots per inch (dpi).

- Checkout Duration: The minimum duration allocated after launch before the primary propulsion system will be commanded to provide required ΔV.
- Initial Mass Assumptions: Provide the initial mass used for generation of the trajectories including propellant loading assumptions.
- Event Basics: Provide the date/time of each trajectory event with a brief event description (e.g., Launch, Gravity Assist, Fly-by, Rendezvous, Mid-Course Burn) and the appropriate data for the event (e.g., flyby altitude, flyby angle, flyby/intercept velocity, delta-v magnitude). These data should be included for three different scenarios corresponding to the Open, Middle, and Closing time of the proposed launch window.
- Event Body Ephemeris: Provide ephemeris data for all event bodies (fly-by planet, asteroid fly-by, comet rendezvous, etc.). Include the source of the ephemeris data and the epoch for the actual ephemeris point used for a particular event.

For investigations using solar-electric propulsion, the following information should also be included:

- Power model for performance based on solar distance: Provide the functional relationship showing the performance of the solar arrays as a function of the spacecraft's distance from the Sun.
- EP Throttling Model: Provide the throttling model used to generate EP engine performance at any point during the trajectory and a brief explanation of the approach.
- Assumed Engine Duty Cycle: Provide the overall Duty Cycle for the EP engines and if applicable provide the duty cycle over each trajectory segment.
- Number of Engines: Provide the maximum number of engines on the spacecraft that could be operating simultaneously. In addition, provide the number of engines operating throughout each phase of the trajectory.

Any other trajectory specific information not called out above that would be relevant to reviewers attempting to validate the trajectory should also be included.

Requirement B-33. Launch Services and Launch Vehicle Compatibility: For NASA- provided launch services, compatibility with the proposed launch vehicle shall be demonstrated by providing in the appropriate proposal section the launch site, fairing size, spacecraft mass, and mission orbit characteristics such as altitude (km – circular or apogee/perigee), inclination, C3, heliocentric and/or declination (DLA). Describe any known nonstandard requirements such as additional fairing doors, cleanliness and purge requirements, planetary protection, etc.

Requirement B-34. Flight System Capabilities: This section shall address the following flight system capabilities to the extent that they are applicable to the proposed mission and that they are known at the time of proposal submission. Any additional elements that are applicable to explaining the mission and demonstrating its feasibility shall also be addressed.

- Spacecraft Parameters:
  (a) Figure of the complete spacecraft/instrument system, on the launch vehicle and inflight, with major components labeled and approximate overall dimensions.
  (b) Block diagram of the spacecraft subsystems and their components.
- Subsystem descriptions including structure, telecommunications, thermal, power, propulsion (if required), attitude determination and control, command and data handling, in-flight fault management, flight software, and ground software. (Note that the discussion of the telecommunications subsystem should be limited to specifications, design, and proposed component hardware – discussion of the link performance is addressed as part of the mission operations approach). Subsystem detail shall include to the extent possible the following information:
  (a) Propulsion, including (i) Delta-V budget; (ii) for each propulsion mode, propulsion type(s) (monoprop, bi-prop, dual-mode, solar electric, etc.), engines and thrust levels, and specific impulse; (iii) propellant allocation (impulse vs. attitude control system); and (iv) propellant margin, including nominal (to meet Delta-V requirement) and additional (to meet mass growth).
  (b) Command and Data Handling, including (i) spacecraft housekeeping data rates for nominal and safing strategy; (ii) data storage unit size (Mbits); and (iii) maximum storage record and playback rate.
  (c) Power

Deep Space, including Heliocentric Orbit, Missions (non-RPS):

(i) identify type of array structure (rigid, flexible, body mounted); (ii) solar array axes of rotation (vector projected in spacecraft coordinates); (iii) array size; (iv) solar cell type and efficiency; (v) expected power generation at Beginning of Life and End of Life; (vi) worst case Sun incidence angle to solar panels during science mission; (vii) battery type and storage capacity; (viii) worst case battery Depth of Discharge (DOD); and (ix) spacecraft bus voltage.

Earth and Lunar Orbiter Missions, and Earth-Sun L1/L2:

(i) expected power requirement for each mission phase; (ii) minimum power capability needed to meet all requirements; and (iii) associated battery Depth of Discharge (DOD).

(d) Attitude Determination and Control, including system pointing requirements and capabilities. Describe or define the following: (i) each spacecraft operational mode, including the sensors and actuators used, control method, and safing and/or contingency modes; (ii) attitude determination methodology and estimate of accuracy, including identifying whether ground postprocessing is required to meet science needs; (iii) agility requirements for slews or scanning; (iv) appendage pointing requirements, including articulation control methods and deployment accommodations; (v) sensor selection and performance, including identifying mounting location and field-of-view (FOV); (vi) actuator selection and sizing, including identifying mounting location(s); (vii) translational maneuver (Delta-V) control and accuracy; (viii) momentum management approach and mitigation of impacts on navigation accuracy, if applicable; (ix) on-orbit radiometric and geometric calibrations, if required, including expected accuracy; and (x) attitude control requirements for the spacecraft pointing control, pointing knowledge (at the instrument interface), pointing stability, or jitter. Due to the potentially sensitive nature of information on attitude determination and control, this section will be redacted from any proposal sent to a non-U.S. person serving as a reviewer.

(e) Thermal control, including (i) temperature requirements including deltas, (ii) temperature control approach (*i.e.* passive *vs.* active), (iii) cooling loads, and (iv) special thermal design considerations (*e.g.*, cryogenic instrument requirements).

(f) Flight software, including (i) logical lines of code by Computer Software Configuration Item (CSCI), (ii) description of the functionality for each CSCI, (iii) code counts categorized as either New, Modified, Full Reuse, or Autogenerated, (iv) development method (spiral, waterfall, agile, etc.), and (v) development language.

Requirement B-35. Additional Mission Elements: This section shall address any other major mission elements (*i.e.*, lander, upper-stage, etc.) to the extent that they are applicable to the proposed mission and to the extent that they are known at the time of proposal submission. Any additional elements that are applicable to explaining the mission and demonstrating its feasibility shall also be discussed.

- Provide a block diagram and description of relevant subsystems; and
- Demonstrate that the proposed design can accomplish the mission within the allocated resources.

Requirement B-36. Flight System Contingencies and Margins: This section shall summarize contingencies and margins of all key flight systems resources. For the driving mission element

requirements derived from the Mission Functional Requirements, it should provide estimates of implementation performance and design margins with respect to the required performance. At a minimum, it shall include the following:

- Mass;
- Propellants;
- Power;
- Data Storage; and
- Attitude Control System.

For any other driving mission element requirements derived from the Mission Functional Requirements, provide estimates of implementation performance and design margins with respect to the required performance.

Definitions:

Contingency, when added to the current estimate for a resource, results in the maximum expected value for that resource. Percent contingency is the value of the contingency divided by the value of the resource less the contingency.

Margin is the difference between the maximum possible capability 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 available margin divided by its maximum expected value.

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

Example: The end-of-life (EOL) capability of a spacecraft power system is 200 Watts, of which 75 Watts has been allocated to the instrument and 100 Watts has been allocated to the spacecraft bus. The power margin is the unallocated 25 Watts or 25/175 = 14.3%. The current best estimate for the instrument power is 60 Watts, leaving 15 Watts or 15/60 = 25% contingency to the 75 Watt maximum expected value.

Acknowledging that the maximum expected resource value is equal to the maximum proposed resource value (including contingency), the above technical terms can be expressed in equation form as:

Contingency = (Max Expected Resource Value) – (Current Estimate of Resource Value)

$$\%\ \text{Contingency} = \frac{\text{Contingency}}{(\text{Max Expected Resource Value}) - \text{Contingency}} \times 100$$

Margin = Max Possible Resource Value – Max Expected Resource Value

$$\%\ \text{Margin} = \frac{\text{Margin}}{\text{Max Expected Resource Value}} \times 100$$

Requirement B-37. Mission Operations: This section shall address, at a minimum, the following elements of mission operations to the extent that they are applicable to the proposed mission and that they are known at the time of proposal submission. Any additional elements that are applicable to explaining the mission operations and demonstrating their feasibility shall also be addressed. This section shall provide, at a minimum, the following items:

- Description of ground systems and facilities, including supporting ground software required for development and testing;
- Telecommunications, Tracking, and Navigation (Deep-Space/Lunar and Earth Orbital missions, as well as missions that utilize telecom relay orbiters), including (i) downlink information data volume; (ii) uplink information; (iii) for all transmit and receive modes, provide mode timeline, data rate(s), and durations; and (iv) ground network utilization plan, including ground stations, downlink parameters (frequencies, periods, capacities, margins, etc.), and retransmission capability;
- Description of approach for acquiring and returning critical event data, including clear identification of procurement and costing for supplemental resources (*e.g.*, mobile ground stations) if such are needed; and
- A high-level discussion of operations plan, including nominal sequence planning and commanding, team training, availability of spacecraft experts for operations, and operations center development.

3. Development Approach.

Requirement B-38. This section shall describe the development approach. This description shall include, at a minimum, the following items:

- Systems engineering approach (*e.g.*, plans, tools, processes for requirements, interfaces, and configuration management);
- Mission assurance approach, including (i) fault tolerance and fault management, (ii) product assurance, and (iii) reliability (*e.g.*, use or nonuse of redundancy, requirements for burn-in of parts, requirements for total operating time without failure prior to flight, *etc.*);
- Identification of instrument to spacecraft interfaces;
- Design maturity and heritage of mission elements (instruments, spacecraft, ground systems, and mission design, etc.) by reference to Appendix J.10, Heritage, of the proposal (see Section J of this appendix);
- Essential trade studies that are to be conducted;
- Approach to management and closure of action items, hardware discrepancies, test anomalies, etc.; and
- Approach for handling special processes (*e.g.*, if radioactive sources are proposed, the approach to supporting the development, submittal, and approval of the necessary NEPA process and the Nuclear Safety Launch Approval process).

4. New Technologies/Advanced Engineering Developments.

Requirement B-39. This section shall describe any proposed new technologies and/or advanced engineering developments and the approaches that will be taken to reduce their associated risks. Descriptions shall address, at a minimum, the following topics:

- Identification and justification of the TRL for each proposed system (level 3 WBS payload developments and level 3 WBS spacecraft elements) incorporating new technology and/or advanced engineering development at the time the proposal is submitted (for *TRL definitions*, see NPR 7123.1B, *NASA Systems Engineering Processes and Requirements*, Appendix E, in the Program Library);
- Rationale for combining the TRL values of subsystems and components to derive each full system TRL as proposed, appropriately considering TRL states of integration (see NASA/SP-4776 2007-6105 Rev 1, *NASA Systems Engineering Handbook*);
- Rationale for the stated TRL value of an element that is an adaptation of an existing element of known TRL;
- The approach for maturing each of the proposed systems to a minimum of TRL 6, by PDR:
  - Demonstration (testing) in a relevant environment can be accomplished at the system level or at lower level(s);
  - If applicable, justify what demonstration(s) in a relevant environment at lower level(s) (subsystem and/or subsystem-to-subsystem) would be sufficient to meet system level TRL 6, considering (i) where any new technology is to be inserted, (ii) the magnitude of engineering development to integrate elements, (iii) any inherent interdependencies between elements (e.g., critical alignments), and/or (iv) the complexity of interfaces – see the Program Library for examples;
  - Include discussion of simulations, prototyping, demonstration in a relevant environment, life testing, etc., as appropriate;
- An estimate of the resources (manpower, cost, and schedule) required to complete the technology and/or advanced engineering development; and
- Approaches to fallbacks/alternatives that exist and are planned, a description of the cost, decision date(s) for fallbacks/alternatives, relevant development schedules, and performance liens they impose on the baseline design, and the decision milestones for their implementation.

If no new technologies or advanced engineering development is required, system TRL 6 or above at the time of proposal submission shall be clearly demonstrated.

5. Assembly, Integration, Test, and Verification.

Requirement B-40. An illustration and brief discussion of the time-phased flow of the Integration and Test (I&T) Plan shall be presented. It shall summarize the key facilities, testbeds, and team members involved in the I&T Plan.

Requirement B-41. The project's verification approach shall be described briefly in this section. Flow diagrams, narrative text, and/or other relevant data may be used to convey this information. Elements of the approach that pose special challenges for the project (*e.g.*, mission critical performance or functional requirements that can't be tested on the ground, special facilities that may be required for testing, large scale simulation tools that must be developed and how they

will be validated, critical path items, etc.) shall be highlighted. The I&T description shall demonstrate the credibility of the overall I&T approach, as reflected by consistency between the described test plans and the schedule, cost, and other resources needed to carry them out.

6. Schedule.

Requirement B-42. A project schedule foldout(s) covering all phases of the investigation shall be provided. This foldout will not be counted against the page limits. The schedule format shall indicate the month and year of each milestone, have a corresponding table of dates, and follow standard NASA WBS elements for task descriptions as prescribed in NPR 7120.5E. The schedule foldout and accompanying narrative, which is included in the page count for this section, shall address proposed major milestones including, at a minimum, the following items:

- Spacecraft development and major review dates;
- Instrument development and major review dates, including instrument-to-spacecraft/host integration and test;
- Ground systems development and major review dates (*e.g.*, mission operations and data analysis development schedule);
- Major deliverables (*e.g.*, Interface Control Documents (ICDs), simulators, engineering modules, flight modules, *etc.*);
- Launch vehicle integration and launch readiness;
- Compliance with NEPA and Nuclear Safety Launch Approval processes, if appropriate;
- Long-lead item specifications, development paths, and their impacts to schedule;
- Development schedule for SEOs, if any;
- Schedule critical path identification; and
- Funded schedule reserve, with indications of appropriate reserves associated with major milestones and deliverables.

Requirement B-43. The project schedule shall be additionally provided in Microsoft Project format on each CD-ROM submitted. Although the project schedule foldout(s) in Requirement B-42 does not need to have been generated in Microsoft Project, the project schedule provided on each CD-ROM shall address the items specified in Requirement B-42 at a level of detail commensurate with that of the graphical foldout. The Microsoft Project schedule is not intended to be a fully Integrated Master Schedule for the project, but rather, it is to be a representation of the summarized schedule foldout that provides a quantified data set that will facilitate understanding of the proposed flow of development activities, timelines, milestones, schedule reserves, and risk. Although tasks in this high-level summary schedule are not expected to be fully linked to their predecessor and successor tasks, the level of linkage detail should support the assignment of the critical path in the graphical foldout. Task links are also needed to identify points of assembly, integration, and testing in the schedule and links to major milestones.

G. MANAGEMENT

The following expands requirements in the AO, in particular Requirement 30, Requirement 48 through Requirement 55, Requirement 68, and Requirement 84.

Requirement B-44. This section shall describe the investigator's proposed management approach. The management organization (including an organization chart) and decision-making process shall be described, and the teaming arrangement and team communications shall be discussed. The organization chart should clearly indicate how the mission team is structured. The names of the primary team members, their organization, and their reporting relationship within the project shall be provided.

Requirement B-45. This section shall describe the specific roles and responsibilities of the PI, PM, PSE, and other named Key Management Team members. It shall describe the qualifications and experience, especially any unique capabilities or previous experience with similar systems and/or equipment (including their performance in meeting cost and schedule), of these Key Management Team members, and demonstrate that they are commensurate with the technical and managerial needs of the proposed investigation. It shall also describe the qualifications and experience of the primary implementing institutions and demonstrate that they are commensurate with the technical and managerial needs of the proposed investigation.

Requirement B-46. This section shall describe the top risks considered significant by the PI and the PM, especially technical risks and risks associated with contributed hardware (if any), and potential mitigation strategies and associated schedule impacts. If cost risks are in this list, they should be described here and then discussed in Section H (see Requirement B-51). The management strategies for control, allocation, and release of technical margins, cost reserves, and schedule reserves shall be described. The approach to any potential descopes, including savings of resources (mass, power, dollars, schedule, etc.) by implementing descopes, the decision milestone(s) for implementing descopes, and the scientific impact of individual as well as combined descopes shall be discussed. Specifically, this description shall identify how these margins and reserves are to be allocated, tracked, and monitored, with what tools and by whom, and who will have the authority to release them. When contracts are required, the acquisition strategy, including any incentive strategy, shall be described.

Requirement B-47. If the proposal contains proposed contributions or cooperative arrangements, this section shall describe the technical and management interfaces in any proposed cooperative arrangements, explicitly demonstrating that the contributions are within the contributors' scientific and technical capabilities, and contingency plans for coping with potential failures of the proposed cooperative arrangements.

Requirement B-48. In the case where a proposal does not provide the required management and schedule details, for whatever reason, this section shall (i) describe the current management approach and schedule, (ii) justify that the development of that aspect of the project management and schedule is not required at this stage and that it is acceptable to develop details later, and (iii) explain why the lack of information at this stage should not translate into a risk to the proposer's ability to implement the mission as proposed, and (iv) justify the adequacy of the

proposed cost reserves, given that the PI-Managed Mission Cost is not allowed to increase beyond the AO Cost Cap during Phase A or at any later time. The process for developing the required depth of information, along with a corresponding schedule, shall be explicitly included among the plans for future activity.

H. COST AND COST ESTIMATING METHODOLOGY

The following expands requirements in the AO, in particular Requirement 63 through Requirement 67 and Requirement 69 through Requirement 80.

This section of the proposal must include an estimated cost of the investigation, a description of the methodologies used to develop the estimate, and a discussion of cost risks.

Requirement B-49. This section shall include the estimated cost of the proposed investigation. The estimated cost shall encompass all proposed activities, including all applicable mission phases, mission unique or special launch services, flight systems, ground systems, ground network fees, contributions, any other AO-specific activities (*e.g.*, SC), and all cost reserves. These costs shall be consistent with the policies and requirements described in Sections 4 and 5 of this AO.

Requirement B-50. This section shall describe the Basis of Estimate, including a description of the methodologies used to develop the estimate and an overview of the cost estimate development process. The full scope of effort, including labor, hardware, software, and materials shall be described for significant elements of the Work Breakdown Structure. The BOE shall be replicable and clearly traceable to Tables B3a and B3b. Ground rules, assumptions, and other supporting data shall be quantified and presented. Data supporting the BOE should include:

- For Build Up, Grassroots, Bottoms Up, Subject Matter Expertise, Engineering Judgment, and Expert Opinion estimates: Estimates based on these techniques and methodologies should detail, quantify and justify how these estimates were generated. Driving cost assumptions should be clearly identified and explained.
- For Analogy estimates: Comparisons (e.g. relevant technical, performance, programmatic, and cost) should be presented and any adjustments or scaling factors should be quantified and justified. Clear linkages should be made between the BOE and relevant discussions in proposal Appendix J.10 Heritage.
- For Parametric estimates: Key model inputs, settings, and results should be presented. Rationale for driving inputs and significant model settings should be provided. Model mechanics should also be described for parametric models and tools that are not commonly accessible.
- For Vendor Quotes: The date of the quote, expiration date, and similar purchase history should be described.
- For Proprietary cost/pricing/bidding systems: The cost basis and underlying mechanics should be substantiated to the extent possible.

Any additional cost estimates or other validation efforts shall be described, including results and discussion of any significant discrepancies. Key inputs and settings should also be provided. The rationale for the proposed unencumbered cost reserve level(s) shall be presented. The rationale

should provide insight into the adequacy and robustness of the proposed unencumbered cost reserve level(s).

Requirement B-51. This section shall include a discussion of cost risks.

Requirement B-52. This section shall provide foldout cost tables, Tables B3a and B3b, which will not be counted against the page limit. Tables B3a and B3b shall identify the proposed cost required in each mission phase and in each fiscal year; the costs shall be in real year dollars (RY$) in Table B3a and FY15 dollars (FY15$) in Table B3b. The top portion of Tables B3a and B3b shall contain cost data relevant to the PI-Managed Mission Cost. The lower portion shall contain cost data for contributions and enhanced mission costs. The rows in Tables B3a and B3b shall be the NASA standard WBS elements as defined in NPR 7120.5E. The costs for most elements shall be provided to WBS level 2, as shown in Tables B3a and B3b. Exceptions are the costs of individual instruments and any unique flight system elements such as landers or sample return capsules, archiving, and non-standard elements such as sample facilities, which shall be explicitly shown. The columns in Tables B3a and B3b shall be grouped and subtotaled by mission phase and shall be labeled with the appropriate real or fiscal years. Years that span more than one mission phase shall be split into two columns by mission phase. The final columns in each of Tables B3a and B3b are totals in real year dollars (RY$) and totals in fiscal year 2015 dollars (FY15$). Proposers shall use their own forward pricing rates to translate between real year dollars (RY$) and fiscal year 2015 dollars (FY15$). For organizations that are without approved forward pricing rates, proposers may use the NASA inflation/deflation indices in Table B4 to translate between real year dollars (RY$) and fiscal year 2015 dollars (FY15$).

Requirement B-53. Tables B3a and B3b shall be provided additionally in Microsoft Excel format on each CD-ROM submitted. Microsoft Excel format templates are available for download in the Program Library.

Requirement B-54. This section shall include a statement as to whether the proposer's approved forward pricing rates were used or NASA's inflation/deflation indices were used. If the proposer's approved forward pricing rates were used, this section shall include the forward pricing rates, with an explanation of how they were derived to translate between real year dollars (RY$) and fiscal year 2015 dollars (FY 2015$) in Table B3.

Requirement B-55. Input file(s) and results for a single parametric cost model shall be provided on each CD-ROM submitted. The parametric cost model shall be one of: SEER for Software and SEER for Hardware, Electronics and Systems Core (SEER-H) with Electro-Optical Sensors and Integrated Circuits extended capabilities or PRICE® TruePlanning™ Cost Estimating Framework. Rationales for individual inputs and settings should be provided within the input file(s). The parametric cost model results may be the basis for the proposed cost or a validation of the proposed cost – if applicable, indicate which within the input file(s). There is no requirement that the input data also be included in the electronic proposal.

Compliance with Requirement B-55 should not be construed to limit proposers' discretion in fulfilling Requirement B-50. In particular, offerors are not prohibited from using and submitting

the results of parametric cost estimates from models other than those required above, in order to meet Requirement B-50.

I. OPTIONAL STUDENT COLLABORATION PLAN

The following expands requirements in the AO, in particular Requirement 62 and Requirement 63.

Requirement B-56. If a Student Collaboration (SC), as described in Section 5.5.3 of this AO, is proposed, then this section shall provide details of the development schedule of the SC, including decision points for determining SC readiness for flight. This section shall describe how the SC can be incorporated into the mission on a nonimpact basis. This section shall show that the SC is clearly separable from the rest of the proposed effort.

J. PROPOSAL APPENDICES

Requirement B-57. The following additional information is required to be supplied with the proposal as Appendices and, as such, will not be counted within the specified page limit. No other appendices are permitted.

J.1. Table of Proposal Participants

The following expands requirements in the AO, in particular Requirement 58.

Requirement B-58. A table of Proposal Participants shall be provided. The table shall include all organizations named in the proposal including contributing organizations. The primary purpose of the table is to aid NASA in avoiding conflicts of interest during the evaluation of the proposal. A secondary purpose is to provide material helpful for the evaluation and selection process. The table shall have three columns: (i) name of organization, including city and state/country where it is located, (ii) role of organization, and (iii) total cost or budget for that organization (real year dollars over the life of proposal for baseline mission). The table shall have a row for every organization named in the proposal, and the rows shall be organized into three sections: (i) major partners, (ii) science only, nonhardware partners, and (iii) minor partners, vendors, and suppliers, as known at the time of the proposal. Major partners are defined to be organizations responsible for providing project management, system engineering, major hardware elements, science instruments, spacecraft accommodations, launch services, integration and test, mission operations, and other major elements of the proposed investigation, as defined by the proposer.

J.2. Letters of Commitment.

The following expands requirements in the AO, in particular Requirement 40, Requirement 83, Requirement 89, and Requirement 90.

Requirement B-59. Letters of commitment signed by an institutional official shall be provided from (i) all organizations offering contributions of goods and/or services (both U.S. and non-U.S.) on a no-exchange-of-funds basis and (ii) unless otherwise explicitly excepted

elsewhere in this AO, all major partners in the proposal regardless of source of funding. Major partners are the organizations listed in Section (i) of the Table of Proposal Participants. Requirements for letters of commitment may be found in Section 5.8.1 of this AO.

J.3. Resumes.

The following expands requirements in the AO, in particular Requirement 48 through Requirement 50, Requirement 58, and Requirement 59.

Requirement B-60. This section shall include resumes or curriculum vitae for the PI, PM, PM Alternate (if named), PS (if named), PSE, and all Co-Is identified in the science section, and for any key project personnel who are named in the proposal. Specifically, each resume shall cite the individual's experience that is pertinent to the role and responsibilities that she/he will assume in the proposed investigation. Project management experience shall be included in the resumes of the PI, PM, PM Alternate, and PSE. Resumes or curriculum vitae shall be no longer than three pages for the PI and one page for each additional participant. Resumes shall be organized alphabetically, by surname after that of the PI.

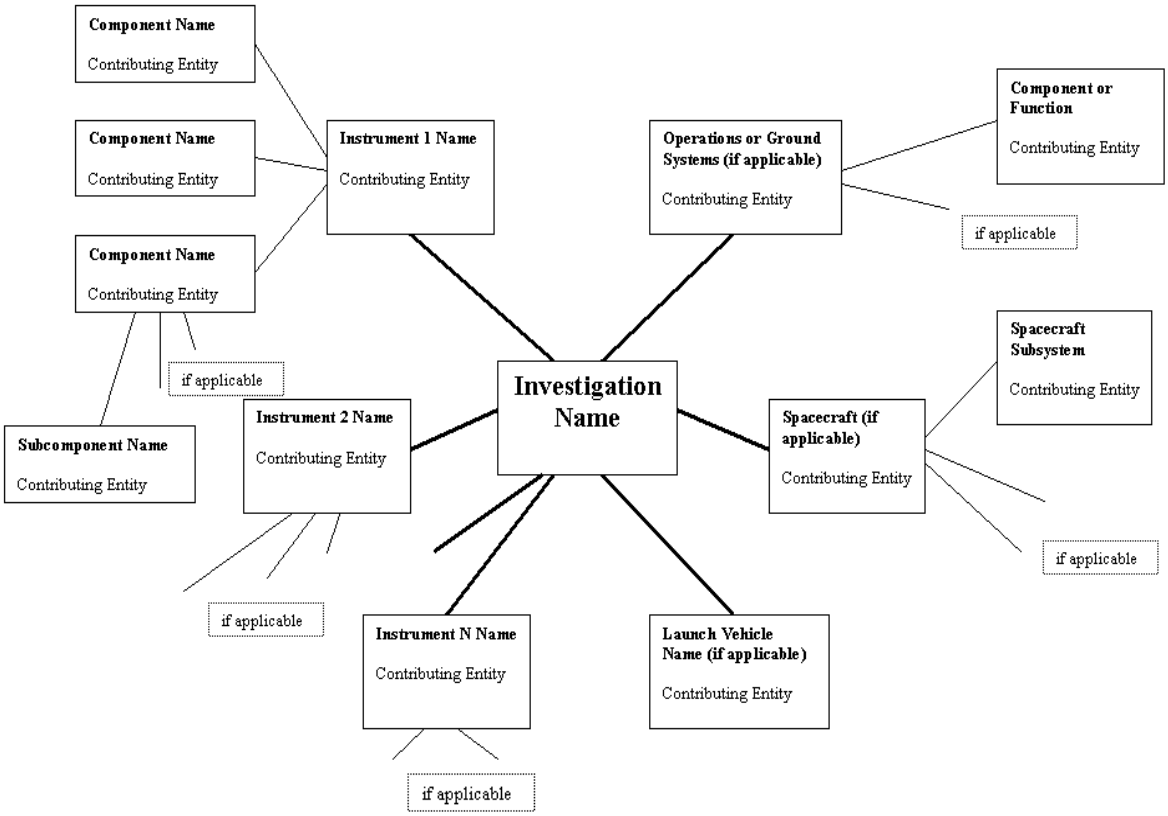
J.4. Summary of Proposed Program Cooperative Contributions.

The following expands requirements in the AO, in particular Requirement 79 through Requirement 81 and Requirement 86.

Cooperative contributions are defined to be those that are to be provided to the proposed investigation from a U.S. or non-U.S. partner on a no-exchange-of-funds basis. In order to aid NASA in conducting an equitable assessment of risks, this section shall include (a) an "exploded diagram" of the investigation and (b) a supporting table.

a. An "exploded diagram" of the investigation.

SAMPLE EXPLODED DIAGRAM



Requirement B-61. If a proposal includes cooperative contributions, this section shall include an "exploded diagram" of the investigation (see example figure) that provides a clear visual representation of cooperative contributions incorporated in the proposed implementation approach. All cooperative contributions, including those that will require an international agreement or interagency memorandum of agreement, shall be shown in this diagram. Each contribution shown shall display a unique name for the contribution, as well as the identity of the contributing entity. However, the following should not be shown:

(i.) If there are no cooperative contributions of spacecraft, launch vehicle or services, or ground operations or facilities, these boxes should not be shown on the diagram at all.

(ii.) Scientific collaborations, such as joint data analysis that do not involve contribution of flight hardware or other critical items, should not be shown.

(iii.) U.S. or non-U.S. goods and services obtained by contract using NASA funds are not cooperative contributions and are also not to be shown.

b. A supporting table of collaborative contributions

Requirement B-62. If a proposal includes cooperative contributions, this section shall include a supporting table with more information that elaborates upon each cooperative contribution shown in the exploded diagram. The table shall include, for each contribution, the following information:

(i.) Unique name identifying the contribution (matching the name on the exploded diagram);
(ii.) The identity of the providing organization, whether U.S. or non-U.S.;
(iii.) The roles and responsibilities of the providing organization, including cross reference to information in the proposal providing further detail as required in Section 5.6.7 of this AO;
(iv.) The identification of the funding sponsor, if different from the organization identified in item (ii) above;
(v.) The approximate value of the contribution, in U.S. dollars, as defined in Section 5.6.7 of this AO; and
(vi.) Cross reference to letters of commitment, as required in Section 5.8.1 of this AO.

J.5. Draft International Participation Plan - Discussion on Compliance with U.S. Export Laws and Regulations.

The following expands requirements in the AO, in particular Requirement 88.

Requirement B-63. If a proposal includes international participation, either through involvement of non-U.S. nationals and/or involvement of non-U.S. entities, this section shall discuss compliance with U.S. export laws and regulations; *e.g.*, 22 CFR 120-130, *et seq*. and 15 CFR 730-774, *et seq*., as applicable to the scenario surrounding the particular international participation. The discussion shall describe in detail the proposed international participation and is to include, but not be limited to, whether or not the international participation may require the proposer to obtain the prior approval of the Department of State or the Department of Commerce via a technical assistance agreement or an export license, or whether a license exemption/exception may apply. If prior approvals via licenses are necessary, discuss whether the license has been applied for or, if not, the projected timing of the application and any implications for the schedule. Information regarding U.S. export regulations is available at http://www.pmddtc.state.gov/ and http://www.bis.doc.gov/. Proposers are advised that under U.S. law and regulation, spacecraft and their specifically designed, modified, or configured systems, components, parts, etc., such as instrumentation responsive to this AO, are generally considered "Defense Articles" on the United States Munitions List and subject to the provisions of the International Traffic in Arms Regulations (ITAR), 22 CFR 120-130, *et seq*.

Requirement B-64. Foreign nationals requiring access to NASA facilities and information systems will be required to comply with Homeland Security Presidential Directive HSPD-12 (see http://www.dhs.gov/homeland-security-presidential-directive-12), where applicable. This appendix shall also discuss the impact, if any, on the investigation and the proposed international participation of compliance with HSPD-12. If no impact is anticipated, this shall be explicitly stated.

6. Planetary Protection and/or Sample Curation Plan.

J.6a. Planetary Protection Plan

The following expands requirements in the AO, in particular Requirement 12 and Requirement 13.

Requirement B-65. If applicable, this section shall describe the plan for compliance with the planetary protection requirements described in Section 5.1.5.1 of this AO. At a minimum, it shall address (i) the anticipated planetary protection Category of the mission under NASA directives; (ii) the proposed mission operational accommodations to comply with the anticipated requirements, including organizational responsibilities; and (iii) the proposed steps to be taken for the preparation of flyby, orbital, and/or landed portions of the spacecraft to comply with any requirements for overall microbiological cleanliness and recontamination prevention prior to launch. If describing a sample return mission, this appendix shall additionally address (iv) the nature of the proposed implementation of back-contamination control and subsequent containment and testing of returned samples or the proposed rationale for the mission to be relieved from a containment requirement. This appendix shall address steps intended to be taken for planetary protection compliance and the implementing organization(s) responsible for implementing those steps.

J.6b. Sample and Space Exposed Hardware Curation Plan

The following expands requirements in the AO, in particular Requirement 14 through Requirement 18.

Requirement B-66. If applicable, this section shall describe the plan for sample and space-exposed hardware curation at the NASA JSC Astromaterials Curatorial Facility in accordance with the requirements in Section 5.1.5.2. At a minimum, this plan shall describe (i) the nature of samples expected to be returned, (ii) the methods used to prevent sample contamination or degradation during collection and return to Earth, (iii) the environmental conditions of the sample curatorial facility, (iv) the general procedures for storage, subsampling, documentation, distribution, and security, (v) the preliminary examination of the samples, and (vi) the preparation (within 6 months of return) of a sample catalog sufficient for other scientists to request samples. The plan shall demonstrate that at least 75% of the returned sample shall be preserved for future studies.

J.7. Discussion of End of Mission Spacecraft Disposal Requirements.

The following expands requirements in the AO, in particular Requirement 44.

This appendix is required only for proposed missions to Low Earth Orbit (LEO) (<2000 km perigee), near Geosynchronous orbit (GEO) (GEO ± 300 km), or the Moon (orbiters and landers).

Requirement B-67. This section shall discuss briefly how the mission meets the orbit disposal requirement applicable to its proposed orbit. For LEO missions, this section shall briefly discuss the lifetime of the mission and whether it meets the 25-year postmission (or 30-year from launch – whichever comes first) requirement for LEO missions.

This section shall include a mission lifetime analysis demonstrating satisfaction of the above requirement, addressing all assumptions and inputs contributing to the analysis. These assumptions and inputs shall include, at a minimum:

- Vehicle Mass
- Drag Area or Cross-sectional Area
- Initial orbit used for the analysis
- Solar and atmospheric conditions assumptions (*i.e.*, models or parameters)
- Methodology: analytical tool, table lookup, reference plot.

If the plan is to dispose of the satellite at the end of mission, this section shall provide the parameters of the disposal orbit, the delta-v allocation for disposal, and any other relevant assumptions.

Requirement B-68. For Lunar missions, this section shall include a discussion of how end-of-mission requirements will be met.

The following references are available in the Program Library:

- NPR 8715.6A, *NASA Procedural Requirements for Limiting Orbital Debri*s; and
- NASA-STD-8719.14, *NASA Process for Limiting Orbital Debris.*

J.8. Compliance with Procurement Regulations by NASA PI Proposals.

The following expands requirements in the AO, in particular Requirement 57.

This appendix is required only for proposals submitted by NASA PIs or NASA Centers (excluding JPL). Proposals submitted by NASA Centers must comply with regulations governing proposals submitted by NASA PIs (NFS 1872.308). Additional instructions may be found in Procurement Information Circular (PIC) 05-15 which is available in the Program Library.

Requirement B-69. For NASA Center proposals, this section shall include any descriptions, justifications, representations, indications, statements, and/or explanations that are required by the regulations.

J.9. Master Equipment List.

The following expands requirements in the AO, in particular Requirement 75.

Requirement B-70. This section shall include a Master Equipment List (MEL) summarizing all major components of each flight element subsystem and each instrument element component to support validation of proposed mass estimates, power estimates, contingencies, design heritage, and cost. A template for this MEL is included as Table B5.

Requirement B-71. Contributed flight element subsystem components and individual instrument element components that are a part of the PI's proposed hardware development, as well as any fully contributed instruments – specified to the component level – regardless of PI-led development, shall be included in the MEL. However, do not include the spacecraft when it is entirely contributed.

Requirement B-72. The MEL shall be additionally provided in Microsoft Excel format on each CD-ROM submitted. A Microsoft Excel template of the MEL is available for download in the Program Library.

The breakouts should be traceable to block diagrams and heritage claims provided in other parts of the proposal. For each major component, current best estimates (CBE) and contingency for mass and power, number of flight units required, and some description of the heritage basis must be provided. Power values should represent nominal steady-state operational power requirements. Information to be provided includes identification of planned spares, identification of engineering models and prototypes with their fidelities, required deliveries for simulators and testing, contingency allocations for individual components, and other component description/characteristics. Certain items should include additional details sufficient to assess functionality and/or cost, to identify and separate individual elements.

List each electronic board separately, identify the functionality of each board (either in the MEL or in the Mission Implementation section), and provide the speed the board will be running at. If proposing Field-Programmable Gate Arrays (FPGAs) or Application-Specific Integrated Circuits (ASICs), or Radio Frequency Integrated Circuits (RFICs), list the design size (in the appropriate sizing parameter such as logic cells, logic elements), the board the chip(s) will be integrated onto, and how much heritage will be used in the design.

J.10. Heritage.

The following expands requirements in the AO, in particular Requirement 69.

Requirement B-73. This section shall discuss each element of any heritage from which the proposed investigation derives substantial benefit, including heritage from spacecraft subsystems, instruments, ground systems, flight and ground software, test set ups, simulations, analyses, etc. This discussion shall be at an appropriate level of granularity (*e.g.*, component, assembly, subsystem) to clearly separate the heritage element from other elements of the design. The discussion of each element shall include:

- a concise description of the design heritage claimed;
- the anticipated benefits to the proposed investigation;
- a brief rationale supporting the claim that the benefits of heritage will be achieved; and
- for any proposed elements with substantial design heritage, a comparison of the cost of the heritage items to the proposed cost.

Proposals must substantiate all heritage claims, including descriptions of changes required to accommodate project-unique applications and needs. Where enhancements to heritage elements

are proposed or heritage is from a different application, sufficient descriptions must be provided to independently assess the current level of maturity.

Requirement B-74. If a proposal claims any heritage from which the proposed investigation derives substantial benefit, this appendix shall discuss each element to an appropriate level of granularity (*e.g.*, component, assembly, subsystem) to clearly separate the heritage element from other elements of the design.

The evaluation team will use a scale with three levels (full, partial, or none) as illustrated in the table below.

	Full heritage	**Partial heritage**	**No heritage**
Design	Identical	Minimal modifications	Major modifications
Manufacture	Identical	Limited update of parts and processes necessary	Many updates of parts or processes necessary
Software	Identical	Identical functionality with limited update of software modules (<50%)	Major modifications (≥50%)
Provider	Identical provider and development team	Different however with substantial involvement of original team	Different and minimal or no involvement of original team
Use	Identical	Same interfaces and similar use within a novel overall context	Significantly different from original
Operating Environment	Identical	Within margins of original	Significantly different from original
Referenced Prior Use	In operation	Built and successfully ground tested	Not yet successfully ground tested

J.11. List of Abbreviations and Acronyms.

The following expands requirements in the AO, in particular Requirement 102.

Requirement B-75. This appendix shall provide a list of abbreviations and acronyms.

J.12. List of References (optional).

In addition to the above items, this appendix may provide a reference list of documents and other materials that were fundamentally important in generating the proposal. This may include a Uniform Resource Locator (URL) for documents that are available through the Internet. As noted at the outset of Appendix B of this AO, however, proposals must be self-contained: any

data or other information intended as part of a proposal must be included within the proposal itself. If any documents or other materials are submitted as a part of a proposal, they must fit within the prescribed page limits. If internal documents such as Flight Project Practices are referenced, an externally accessible URL shall be provided to download them.

J.13. Infusion Plan for NASA-Developed Technology.

The following expands requirements in the AO, in particular Requirement 33

Requirement B-76. This section, which shall not exceed five pages in length, shall describe any proposed utilization of NASA-developed technology. At a minimum, this description shall address the following topics to the extent that they are not addressed in the body of the proposal:

1) Demonstration of the offerors' understanding of the chosen NASA-developed technology, as well as their understanding of inherent risks associated with its use.
2) Description of technology infusion implementation plan with respect to utilization of the chosen NASA-developed technology. At a minimum, this shall include:
   a. Description of any required flight hardware development and integration plans for producing flight-qualified hardware/software.
   b. If any fallbacks/alternatives exist and are planned, description of the cost, schedule, and performance liens they will impose on the baseline design, as well as the decision milestones for their implementation.
3) Description of the application, appropriate use, and benefits of the NASA-developed technology in the proposed investigation, including description of how this technology could enhance the proposed investigation's science return.
4) Description of how the offeror would engage with the relevant NASA program office's intention to have insight into the flight hardware development, IV&V testing and results, flight development lessons learned, and performance data obtained during flight for the chosen NASA-developed technology.

This section need not repeat information that may be found in the body of the proposal. However, for completeness, discussions of NASA-developed technology in the body of the proposal should be referenced from this section.

J.14 Description of Engineering Science Investigation (ESI).

The following expands requirements in the AO, in particular Requirement 24

Requirement B-77. This section, which shall not exceed five pages in length, shall describe proposed approach to achieving the goals and objectives of the Entry, Descent, and Landing ESI. At a minimum, this description shall address the following topics:

1) Demonstration of the offerors' understanding of the goals and objectives of the ESI.
2) Description of the method(s) to be applied to obtain diagnostic and technical data about vehicle performance and entry environments. At a minimum, this shall include:

a. Description of any required flight hardware development and integration plans for producing flight-qualified hardware/software.
b. Description of the data to be collected, planned calibrations, and downlink process.
c. Demonstration that the proposed data are sufficient to achieve the goals and objectives of the ESI.
d. If any fallbacks/alternatives exist and are planned, description of the cost, schedule, and performance liens they will impose on the baseline design, as well as the decision milestones for their implementation.

3) A discussion of potential impacts of the ESI on the prime science mission.
4) Estimated mass, power, telecommunications, ~~cost,~~ and schedule impacts associated with the implementation of the proposed ESI. **[Amended January 16, 2015]**

J.15 Justification for the use of non-AMMOS MOS/GDS Tools

The following expands requirements in the AO, in particular Requirement 47.

Requirement B-78. This section, which shall not exceed three pages in length, shall describe the justification for using MOS/GDS tools other than those available from the AMMOS. For each non-AMMOS tool, this section shall contain:

1. A list of requirements that the equivalent AMMOS tool does not meet for the proposed flight project; and,
2. the proposed non-AMMOS tool that satisfies the listed requirements.

If an AMMOS tool will meet the flight project requirements, this section must outline the reasons for not using that tool (*e.g.*, cost of mission-specific adaptations to the AMMOS tool, extensive heritage of use of the non-AMMOS tool by the mission operator).

TABLE B1
EXAMPLE SCIENCE TRACEABILITY MATRIX

Science Goals	Science Objectives	Scientific Measurement Requirements		Instrument Requirements		Projected Performance	Mission Requirements (Top Level)
		Physical Parameters	**Observables**				
GOAL 1	Obj. 1	Column density of absorber	Absorption Line	Alt. Range	XX km	ZZ km	Observing strategies: Requires yaw & elevation maneuvers Launch window: to meet nadir & limb overlap requirement. Window applies day-to-day.
		Density & temperature of emitter	Emission Line				
		Size of Features	Morphological Feature	Vert. Resolution	XX km	ZZ km	Need NN seasons to trace evolution of phenomenon
				Horiz. Resolution	XX deg *x* XX lat *x* XX long	ZZ deg *x* ZZ lat *x* ZZ long	
			Rise time of Eruptive Phenomena	Temperature Resolution	XX min	ZZ min	Need MM months to observe variability of phenomenon.
				Precision	XX K	ZZ K	
				Accuracy	XX K	ZZ K	

TABLE B2
EXAMPLE MISSION TRACEABILITY MATRIX

Mission Requirements	Mission Design Requirements	Spacecraft Requirements	Ground System Requirements	Operations Requirements
From Table B1	Rocket type Launch date: Mission length Orbit altitude requirement and rationale Geographic coverage and how it drives orbit requirement Orbit local time and rationale for the requirement Type of orbit, e.g. Sun synchronous, precessing, Lagrangian point, other Other	Spinning, stabilized Mass Power Volume: Data Rate Temperature Range for spacecraft systems Pointing Control: Knowledge, Stability, Jitter, Drift , Other Detector radiation shielding requirements and rationale Other	Passes per day and duration Assumed antenna size Data volume per day Real time data transmission requirements Transmit frequency Power available for comm (Watts) Downlink data rate Number of data dumps per day Spacecraft data destination (e.g., mission operations center) Science data destination (e.g., science operations center) Other	General spacecraft maneuver requirements and frequency Special maneuvers requirements Rationale for maneuvers Ephemeris requirements Changes in viewing modes and directions per orbit, per day or over longer time periods. Rationale for these changes Other
Mission Requirements or Instrument Accommodation (from Table B1)	Mission	Spacecraft	Ground System	Operations
Four different observing strategies: Solar, limb, nadir, zenith; requires yaw and elevation maneuvers		Agility requirements Slew rate = y deg/sec Settle = stability < .001 deg/sec after 30 secs		Target planning on 3 day centers Ephemeris accuracy of x with updates every 2 days
Instrument X precision of 5K		Thermal stability of 1 deg/hr S/C bus stability of .01 deg over 10 secs	Bit error rate < 1e-5 Time correlation to 2 msec over 1 week	Weekly time correlation

TABLE B3a

TOTAL MISSION COST RY$ PROFILE TEMPLATE

Total Mission Cost Profile Template
FY Costs and Totals in Real Year Dollars (RY$)

WBS#	WBS Element	Phase A			Phase B			Phase C/D				RY$	Phase E				Phase F			RY$
		FY2015	FY2016	Total	FY2016	FY2017	Total	FY2017	FY2018	FY2019	Total	A-D Total	FY2019	FY2020	FY2021	Total	FY2021	FY2022	Total	A-F Total
01	Project Management																			
02	Systems Engineering																			
03	Safety & Mission Assurance																			
04	Science / Technology																			
	Breakout pre-launch science from technology development activities																			
05	Payload(s)																			
	List each instrument separately																			
06	Spacecraft																			
	List each major flight system element separately																			
07	Mission Operations																			
	Breakout separable services, e.g., DSN, etc.																			
08	Launch Vehicle / Services																			
09	Ground System(s)																			
	Breakout non-standard cost, e.g., coordinating ground stations																			
10	Systems Integration & Testing																			
11	Student Collaboration in Excess of Incentive																			
	Reserves																			
	PI-Managed Mission Cost																			
	Student Collaboration Incentive (if applicable)																			
	Contributions																			
	List by organization and WBS element																			
	Total Mission Cost																			
	Student Collaboration Incentive (if applicable)																			
	Other AO-specific Activities																			
	List by activity and WBS element																			
	Enhanced PI-Managed Mission Cost																			
	Phase B Bridge Phase Funding (*included above*)																			

Label columns with actual fiscal years. Add or remove FY columns as necessary.

A Microsoft Excel version of this template is available in the Program Library.

TABLE B3b
TOTAL MISSION COST FY$ PROFILE TEMPLATE

Total Mission Cost Profile Template
FY Costs and Totals in Fiscal Year <<CAP YEAR>> Dollars (FY<<CAP YEAR>>$)

WBS#	WBS Element	Phase A			Phase B			Phase C/D				FY<<CAP YEAR>>$	Phase E				Phase F			FY<<CAP YEAR>>$
		FY2015	FY2016	Total	FY2016	FY2017	Total	FY2017	FY2018	FY2019	Total	A-D Total	FY2019	FY2020	FY2021	Total	FY2021	FY2022	Total	A-F Total
01	Project Management																			
02	Systems Engineering																			
03	Safety & Mission Assurance																			
04	Science / Technology																			
	Breakout pre-launch science from technology development activities																			
05	Payload(s)																			
	List each instrument separately																			
06	Spacecraft																			
	List each major flight system element separately																			
07	Mission Operations																			
	Breakout separable services, e.g., DSN, etc.																			
08	Launch Vehicle / Services																			
09	Ground System(s)																			
	Breakout non-standard cost, e.g., coordinating ground stations																			
10	Systems Integration & Testing																			
11	Student Collaboration in Excess of Incentive																			
	Reserves																			
	PI-Managed Mission Cost																			
	Student Collaboration Incentive (if applicable)																			
	Contributions																			
	List by organization and WBS element																			
	Total Mission Cost																			
	Student Collaboration Incentive (if applicable)																			
	Other AO-specific Activities																			
	List by activity and WBS element																			
	Enhanced PI-Managed Mission Cost																			
	Phase B Bridge Phase Funding (*included above*)																			

Label columns with actual fiscal years. Add or remove FY columns as necessary.

A Microsoft Excel version of this template is available in the Program Library.

TABLE B4
NASA FY 2014 NEW START INFLATION INDEX
for use in FY 2015

Fiscal Year	2015	2016	2017	2018	2019	2020	2021	2022
Inflation Rate		2.6%	2.8%	2.8%	2.6%	2.6%	2.6%	2.6%
Cumulative Inflation Index	1.000	1.026	1.054	1.083	1.112	1.140	1.170	1.200

Use an inflation rate of 2.6% for years beyond 2022.

Note: Proposers shall use their own forward pricing rates. For organizations that are without forward pricing rates, proposers may use the NASA new start inflation index in Table B4 (see Appendix B, Section H).

TABLE B5
MASTER EQUIPMENT LIST

MASTER EQUIPMENT LIST Template - MISSION X

S/C Element 1		# OF UNITS			FLIGHT HARDWARE MASSES			FLIGHT HARDWARE POWER			OTHER COMPONENT INFORMATION	
Subsystem/Component	Unit Mass, Current Best Estimate (CBE)	Flight Units	Flight Spares	EMs & Proto-types	Total Mass, kg CBE	Contin-gency %	Total Mass w/ Contin-gency	Total Power, W CBE	Contin-gency %	Total Power w/ Contin-gency	Description (Vendor, Part #, Heritage Basis)	Other characteristics/issues (volume, other component-specific information)
Total Mass/Power												

S/C Element *n*		# OF UNITS			FLIGHT HARDWARE MASSES			FLIGHT HARDWARE POWER			OTHER COMPONENT INFORMATION	
Subsystem/Component	Unit Mass, Current Best Estimate (CBE)	Flight Units	Flight Spares	EMs & Proto-types	Total Mass, kg CBE	Contin-gency %	Total Mass w/ Contin-gency	Total Power, W CBE	Contin-gency %	Total Power w/ Contin-gency	Description (Vendor, Part #, Heritage Basis)	Other characteristics/issues (volume, other component-specific information)
Total Mass/Power												

Payload Element 1		# OF UNITS			FLIGHT HARDWARE MASSES			FLIGHT HARDWARE POWER			OTHER COMPONENT INFORMATION	
Subsystem/Component	Unit Mass, Current Best Estimate (CBE)	Flight Units	Flight Spares	EMs & Proto-types	Total Mass, kg CBE	Contin-gency %	Total Mass w/ Contin-gency	Total Power, W CBE	Contin-gency %	Total Power w/ Contin-gency	Description (Vendor, Part #, Heritage Basis)	Other characteristics/issues (volume, other component-specific information)
Total Mass/Power												

Payload Element *n*		# OF UNITS			FLIGHT HARDWARE MASSES			FLIGHT HARDWARE POWER			OTHER COMPONENT INFORMATION	
Subsystem/Component	Unit Mass, Current Best Estimate (CBE)	Flight Units	Flight Spares	EMs & Proto-types	Total Mass, kg CBE	Contin-gency %	Total Mass w/ Contin-gency	Total Power, W CBE	Contin-gency %	Total Power w/ Contin-gency	Description (Vendor, Part #, Heritage Basis)	Other characteristics/issues (volume, other component-specific information)
Total Mass/Power												

A Microsoft Excel version of this template is available in the Program Library.

APPENDIX C

GLOSSARY OF TERMS AND ABBREVIATIONS

Part C.1: GLOSSARY OF TERMS

Announcement of Opportunity (AO) — A document used to announce opportunities to participate in NASA programs.

AO Process — A term used to describe the program planning and acquisition procedure used to acquire investigations through an AO.

AO Steering Committee — A NASA committee composed wholly of full-time Federal Government employees that provides advice to the Mission Directorate Associate Administrator and provides procedural review over the investigation evaluation, categorization, and selection process.

Backward contamination — The transmittal to Earth from another body of viable organisms by a spacecraft or spacecraft component.

Baseline science mission — The mission that, if fully implemented, would fulfill the Baseline Science Requirements which are defined in NPR 7120.5E as the performance requirements necessary to achieve the full science objectives of the mission.

Baseline science objectives — The entire set of scientific objectives proposed for the investigation.

Basis of Estimate (BOE) — A record of the procedures, ground rules and assumptions, data, environment, and events that underlie a cost estimate's development or update. Good documentation of the BOE supports the cost estimate's credibility.

Categorization — The process whereby proposed investigations are classified into four categories synopsized here as Category I (recommended for acceptance); Category II (recommended for acceptance but at a lower priority than Category I proposals); Category III (sound investigations requiring further development); Category IV (not recommended).

Categorization Subcommittee — An *ad hoc* subcommittee of the AO Steering Committee, composed wholly of Civil Servants and Intergovernmental Personnel Act appointees (some of whom may be from Government agencies other than NASA) and appointed by the Associate Administrator for the Science Mission Directorate, that categorizes proposals for investigations submitted in response to an AO based on the evaluations.

Co-Investigator (Co-I) — An investigator who plays a necessary role in the proposed investigation and whose services are either funded by NASA or are contributed by his/her employer. A NASA employee can participate as a Co-I on an investigation proposed by a private organization.

Collaborator — An individual who is less critical to the successful development of the mission than a Co-I. A collaborator may not be funded through the proposal. A collaborator may be committed to provide a focused contribution to the project for a specific task, such as data analysis. If funding support is requested in the proposal for an individual, that individual shall not be identified as a collaborator but shall be identified as a Co-Investigator or another category of team member.

Complete spaceflight mission — A science investigation requiring an Earth-orbiting, near-Earth, or deep-space mission, that encompasses all appropriate mission phases from project initiation (Phase A) through mission operations (Phase E) and spacecraft disposal (Phase F), including the analysis and publication of data in the peer reviewed scientific literature, delivery of the data to an appropriate NASA data archive, and, if applicable, extended mission operations or other science enhancements.

Communications — Comprises the comprehensive set of functions necessary to effectively convey — and provide an understanding of — a program, its objectives and benefits to target audiences, the public, and other stakeholders. This includes a diverse, broad, and integrated set of efforts and is intended to promote interest and foster participation in NASA's endeavors and the develop exposure to, and appreciation for, STEM.

Contingency — That quantity, when added to a resource, results in the maximum expected value for that resource.

Contribution — Labor, services, or hardware funded by any source other than Program sponsoring the AO.

Descope — Any alteration of a mission that results in savings of resources (mass, power, dollars, schedule, etc.) at the cost of reduced scientific performance.

Earned Value Management (EVM) — A tool for measuring and assessing project performance through the integration of technical scope with schedule and cost objectives during the execution of the project. EVM provides quantification of technical progress, enabling management to gain insight into project status and project completion costs and schedules.

Education — Comprises those activities designed to enhance learning in science, technology, engineering, and mathematics (STEM) content areas using NASA's unique capabilities.

Engineering Science Investigation — An investigation that provides engineering data on the performance of a vehicle or subsystem that is needed by the wider NASA community but that does not necessarily further the science objectives of the mission.

Federal Acquisition Regulation (FAR) — The regulations governing the conduct of acquisition.

Forward contamination — The transmittal from Earth to a targeted solar system body of viable organisms by a spacecraft or spacecraft component.

Guest Investigators — Investigators selected to conduct observations and obtain data within the capability of a NASA mission, which are additional to the mission's primary objectives. Sometimes referred to as Guest Observers or General Observers.

Hosted Payload — The utilization of available capacity on a spacecraft to accommodate additional hardware (e.g., a science instrument) typically arranged through a partnership.

Implementing organization — The organization chosen by the Principal Investigator to manage the development of the mission.

Investigation — Activities or effort aimed at the generation of new knowledge. NASA-sponsored investigations generally concern the generation and analysis of data obtained through measurement of space phenomena or Earth phenomena using spaceflight hardware developed and operated for that purpose.

Investigation Team — The group of scientists, engineers, and other professionals implementing an investigation.

Key Management Team Members **—** The project leaders whose qualifications and experience are relevant and necessary to the success of the project. Key Management Team members are the PI, PM, PSE, and, where appropriate, PS and partner leads, and other roles as identified in the proposal.

Margin — The allowance carried on a resource (*e.g.*, budget, schedule, mass) to account for uncertainties and risks. It is the difference between the maximum possible capability of a resource (the physical limit or the agreed-to limit) and the maximum expected value for a resource.

Mission — Used interchangeably with investigation.

Mission Architecture — The summary level description of the overall approach to the mission in the context of achieving the science objectives including mission elements such as flight systems, instruments, high-level mission plan, high-level operations concept, etc.

NASA FAR Supplement — Acquisition regulations promulgated by NASA in addition to the FAR.

Notice of Intent — A notice or letter submitted by a potential investigator indicating the intent to submit a proposal in response to an AO.

Passivation — The complete removal of any stored energy on board a spacecraft including residual propellants (by venting or burning), residual pressurants (by venting), electrical energy (by discharge or disconnection of batteries), kinetic energy (by unloading or de-spinning momentum wheels or gyros), and the disabling of range safety explosives.

Payload — A specific complement of instruments, space equipment, and support hardware carried to space to accomplish a mission or discrete activity in space.

Peer Review (n) — A gathering of experts in related disciplinary areas convened as a subcommittee of the AO Steering Committee to review proposals for flight investigations.

Peer Review (v) — The process of proposal review utilizing a group of peers in accordance with the review criteria as outlined in the Announcement of Opportunity.

Performance Metrics — A multiparty agreement between the Program Office, the PI institution, the project management institution, and other major partners that is used for project evaluation by NASA.

PI-Managed Mission Cost — The funding that the Program sponsoring the AO will be expected to provide to the PI's implementation team for the development and execution of the proposed project, Phases A through F. It includes any reserves applied to the development and operation of the mission as well. It also includes any costs that are required to be accounted for against the PI-Managed Mission Cost even if the PI is not responsible for those costs (*e.g.*, NASA-provided telecommunications in some AOs),

Planetary Protection — The practice of avoiding biological contamination of other planetary bodies and samples to be returned to Earth, to preserve the capability to perform future scientific and other investigations.

Principal Investigator (PI) — The person who conceives of an investigation and leads implementation of it. The PI is invested by NASA with primary responsibility for implementing and executing selected investigations. A NASA employee can participate as a PI only on a Government-proposed investigation.

Proposal Team — The Proposal Team includes, but is not be limited to, all members of the Key Management Team and any Co-I who is not part of the Key Management Team.

Program — An activity involving human resources, materials, funding, and scheduling necessary to achieve desired goals.

Project — Within a program, an undertaking with a scheduled beginning and ending, which normally involves the design, construction, and operation of one or more spacecraft and necessary ground support in order to accomplish a scientific or technical objective.

Project Manager (PM) — The individual responsible to the PI for overseeing the technical and programmatic implementation of the project. The PM works closely with the PI in order to ensure that the mission meets its objectives within the resources committed to the project.

Project Scientist (PS) — The member of the science team designated by the PI to be responsible for ensuring the scientific success of the project. The Project Scientist may have other responsibilities as defined by the PI or the implementing organization.

Project Office — An office established to manage a project.

Proposing Organization — The organization that submits the proposal; commonly this is also the Principal Investigator's home institution.

Reserve — Resource not allocated to any specific task but held by the project for unexpected needs.

Resiliency — The quality of a mission to gracefully degrade from the Baseline Science Mission to the Threshold Science Mission as technical, schedule, or budgetary problems occur.

Risk — The combination of the probability that a program or project will experience an undesired event and the consequences, impact, or severity of the undesired event, were it to occur. The undesired event may come from technical or programmatic sources (*e.g.*, a cost overrun, schedule slippage, safety mishap, health problem, malicious activities, environmental impact, failure to achieve a needed scientific or technological objective, or success criterion). Both the probability and consequences may have associated uncertainties.

Science Enhancement Option (SEO) — An activity, such as extended missions, guest investigator programs, general observer programs, participating scientist programs, interdisciplinary scientist programs, or archival data analysis programs that have the potential to broaden the scientific impact of investigations.

Selection Official — The NASA official designated to determine the source for award of a contract or grant.

Technology Demonstration Opportunity — An activity that demonstrates innovative technological approaches to achieve the scientific goals of a mission.

Termination review — A review established to determine whether remedial actions, including changes in management structure and/or key personnel, would better enable a project to operate within established cost, schedule, and/or technical constraints. If a termination review determines that no remedy is likely to improve matters, NASA may consider termination of the project.

Threshold science mission — A descoped Baseline Science Mission that would fulfill the Threshold Science Requirements, which are defined in NPR 7120.5E as the performance requirements necessary to achieve the minimum science acceptable for the investment.

Total Mission Cost — The PI-Managed Mission Cost plus any Student Collaboration costs up to the student collaboration incentive, plus any additional costs that are contributed or provided in any way other than through the Program sponsoring the AO.

Unencumbered reserve — Reserves that are free of liens identified by proposers and are held for risks that may be realized during project execution.

Work Breakdown Structure (WBS) — A product-oriented hierarchical division of the hardware, software, services, and data required to produce a project's end product(s), structured according to the way the work will be performed, and reflective of the way in which program/project costs, schedule, technical and risk data are to be accumulated, summarized, and reported.

Part C.2: COST ELEMENT DEFINITIONS

This is a short dictionary of definitions for the cost elements shown in the tables and discussed in the body of this AO.

Instruments — Instrument costs include costs incurred to design, develop, and fabricate the individual scientific instruments or instrument systems through delivery of the instruments to the spacecraft for integration. Costs for instrument integration, assembly, and test are to be shown separately from instrument development. Costs incurred for integration of the instruments to the spacecraft are included in the Spacecraft Integration, Assembly and Test cost element (see below).

Launch Approval Engineering or Launch Approval Process — The process by which National Environmental Protection Act and any applicable launch safety approval requirements are satisfied.

Launch Checkout and Orbital Operations — Launch checkout and orbital operations support costs are those involving prelaunch planning, launch site support, launch vehicle integration (spacecraft portion), and the first 30 days of flight operations.

Launch Services — Launch vehicles and services are either procured and provided by NASA to launch spacecraft under fixed price contracts or provided by the proposer. The launch service price includes procurement of the ELV, spacecraft-to-launch vehicle integration, placement of spacecraft into designated orbit, analysis, postflight mission data evaluation, oversight of the launch service and coordination of mission-specific integration activities.

Mission Operations and Data Analysis (MO&DA) — This cost element refers only to Phases E and F (postlaunch) and has two major components: Mission Operations and Data Analysis. Mission operations comprises all activities required to plan and execute the science objectives, including spacecraft and instrument navigation, control, pointing, health monitoring, and calibration. Data analysis activities include collecting, processing, distributing, and archiving the scientific data. MO&DA costs include postlaunch all costs for people, procedures, services, hardware, and software to carry out these activities. It includes postlaunch science team support costs. It does not include costs of any Science Enhancement Option (SEO) activities.

NASA Center Costs (all categories) — Additional costs borne by the science investigation for NASA Center participation. For example, there may be additional project management/systems engineering costs, above those incurred by the spacecraft prime contractor, which are due to NASA employee participation. These costs must be reported on a full-cost accounting basis.

Prelaunch Science Team Support — Includes all Phase B/C/D (prelaunch) support costs for the science team. (See MO&DA for postlaunch component.)

Prelaunch Ground Data System (GDS)/Mission Operations Services (MOS) Development — Includes costs associated with development and acquisition of the ground infrastructure used to transport and deliver the telemetry and other data to/from the Mission Operations Center and the Science Operations Center. (For more information, refer to *NASA's Mission Operations and Communications Services* document in the Program Library.) Includes development of science data processing and analysis capability. Also includes prelaunch training of the command team, development and execution of operations simulations, sequence development, and flight control software. This element includes any mission-unique tracking network development costs.

Project Management/Mission Analysis/Systems Engineering — Project management costs include all efforts associated with project level planning and directing of prime and subcontractor efforts and interactions, as well as project-level functions such as quality control and product assurance. Mission Analysis includes preflight trajectory analysis and ephemeris development. Systems engineering is the project-level engineering required to ensure that all satellite subsystems and payloads function properly to achieve system goals and requirements. This cost element also includes the data/report generation activities required to produce internal and deliverable documentation.

Project-Unique Facilities — If the proposed science investigation requires construction or lease of any ground facilities, include here only the portion of costs to be borne by the proposed investigation, with description of the nature and extent of any cost-sharing arrangements assumed.

Reserves — In that NASA maintains no reserves for science investigations or missions, reserves must include those funds that are not allocated specifically to estimated resources, but are held against contingencies or underestimation of resources to mitigate the investigation risk. Reserves must be reported according to the proposed reserve management strategy. For example, if the reserve is divided into funds to be preallocated to the flight system and instrument payload, with another portion held at the science investigation level, specific dollar amounts to fund each must be identified.

SEO Activities — Options for enlarging the science/technology impact beyond the baseline investigation, such as extended missions, guest investigator programs, or general observer programs are termed SEO activities. These costs do not count against the funding cap.

Spacecraft Bus — Spacecraft bus costs include costs incurred to design, develop, and fabricate (or procure) the spacecraft subsystems. Costs for integration and assembly are not included in this element. Component level test and burn-in is included in this cost element. System tests are included in Spacecraft IAT (see below).

Spacecraft Integration, Assembly, and Test (IAT) — Spacecraft integration, assembly and test is the process of integrating all spacecraft subsystems and payloads into a fully tested, operational satellite system. The total cost of IAT for a satellite includes research/requirements specification, design and scheduling analysis of IAT procedures, ground support equipment, systems test and evaluation, and test data analyses. Typical satellite system tests include thermal vacuum, thermal cycle, electrical and mechanical functional, acoustic, vibration, electromagnetic compatibility/interference, and pyroshock.

Tracking Services excluding DSN — This line item includes all costs associated with this service for the specific proposed mission profile. (Refer to *NASA' s Mission Operations and Communications Services* document, in the Program Library.)

Part C.3: ABBREVIATIONS AND ACRONYMS

AA	Associate Administrator
AO	Announcement of Opportunity
AOR	Authorized Organizational Representative
APPEL	NASA Academy of Program, Project, and Systems Engineering Leadership
ASIC	Application-Specific Integrated Circuits
CADRe	Cost Analysis Data Requirement
CARA	Conjunction Assessment Risk Analysis
CASP	Cross-Agency Support Programs
CBE	Current Best Estimate
CCR	Central Contractor Registry
CD-ROM	Compact Disc-Read Only Memory
CDR	Critical Design Review
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CM&O	Center Management and Operations
Co-I	Co-Investigator
CSCI	Computer Software Configuration Item
CTS	Cornell Technical Services
DAAC	Distributed Active Archive Center
DOR	Differential One-way Ranging
DOE	Department of Energy
DSN	Deep Space Network
EA	Environmental Assessment
EAR	Export Administration Regulations
EASSS	Evaluations, Assessments, Studies, Services, and Support
EBPOC	Electronic Business Point of Contact
EIS	Environmental Impact Statement
ELV	Expendable Launch Vehicle
EOSDIS	Earth Observing System Data and Information System
E&C	Education and Communication
E/PO	Education and Public Outreach
ESI	Engineering Science Investigation
ESSP	Earth System Science Pathfinder
EV	Earth Venture
EVM	Earned Value Management
FAQ	Frequently Asked Questions
FAR	Federal Acquisition Regulations
FASAB	Federal Accounting Standards Advisory Board
FFRDC	Federally Funded Research and Development Center
FONSI	Finding of No Significant Impact
FPGA	Field-Programmable Gate Array
FY	Fiscal Year

G&A	General and Administrative
GAO	Government Accountability Office
GDS	Ground Data System
GEO	Geosynchronous Orbit
GFE	Government Furnished Equipment
GFS	Government Furnished Service
HBCU	Historically Black Colleges and Universities
HBZ	HUB Business Zone
HEASERC	High Energy Astrophysics Science Archive Research Center
HiPACC	High-Performance AstroComputing Center
HUBZone	Historically Underutilized Business Zone
IAT	Integration, Assembly, and Test
ICD	Interface Control Document
IRD	Interface Requirements Document
ITAR	International Traffic in Arms Regulations
IV&V	Independent Verification and Validation
JPL	Jet Propulsion Laboratory
JSC	Johnson Space Center
KDP	Key Decision Point
MAST	Mikulski Archive for Space Telescopes
MEL	Master Equipment List
MEP	Mars Exploration Program
MMRTG	Multiple Mission Radioisotope Thermoelectric Generator
MO&DA	Mission Operations and Data Analysis
MOS	Mission Operations Services
MOU	Memorandum of Understanding
NAICS	North American Industry Classification System
NASA	National Aeronautics and Space Administration
NASA-STD	NASA-Standard
NEN	Near-Earth Network
NEPA	National Environmental Policy Act
NFS	NASA FAR Supplement
NISN	NASA Integrated Services Network
NLS	NASA Launch Services
NLSA	Nuclear Launch Safety Approval
NODIS	NASA Online Directives Information System
NOI	Notice of Intent
NPD	NASA Policy Directive
NPR	NASA Procedural Requirements
NRA	NASA Research Announcement
NRC	National Research Council
NRP	NASA Routine Payload
NSPIRES	NASA Solicitation and Proposal Integrated Review and Evaluation System
NSS	NASA Safety Standard
OCFO	Office of the Chief Financial Officer
OMI	Other Minority Institution

OSTP	Office of Science and Technology Policy
PDF	Portable Data Format
PDR	Preliminary Design Review
PI	Principal Investigator
PIC	Procurement Information Circular
P.L.	Public Law
PM	Project Manager
POC	Point of Contact
PS	Project Scientist
PSE	Project Systems Engineer
RFIC	Radio Frequency Integrated Circuit
RHU	Radioisotope Heater Unit
ROD	Record of Decision
ROM	Rough Order-of-Magnitude
ROSES	Research Opportunities in Space and Earth Sciences
RPS	Radioisotope Power System
RTG	Radioisotope Thermoelectric Generator
RY	Real Year
SALMON	Stand Alone Missions of Opportunity Notice
SB	Small Business
SC	Student Collaboration
SCaN	Space Communication and Navigation
SDB	Small Disadvantaged Business
SDVOSB	Service Disabled Veteran Owned Small Business
SE	System Engineer(ing)
SEO	Science Enhancement Option
SMD	Science Mission Directorate
SN	Space Network
SOW	Statement of Work
SPD	SMD Policy Document
SPG	Strategic Planning Guidance
TA	Technical Authority
TDO	Technology Demonstration Opportunity
TMC	Technical, Management, and Cost
TRL	Technical Readiness Level
UARC	University Affiliated Research Center
URL	Uniform Resource Locator
U.S.	United States
U.S.C.	United States Code
VOSB	Veteran Owned Small Business
WBS	Work Breakdown Structure
WOSB	Women Owned Small Business

APPENDIX D

DISCOVERY 2014 AO PROGRAM LIBRARY

Discovery 2014 Acquisition Homepage: http://discovery.larc.nasa.gov
Discovery 2014 AO Library: http://discovery.larc.nasa.gov/dpl.html

Strategic Documents

1. NPD 1001.0B, *2014 NASA Strategic Plan*
2. *2014 Science Mission Directorate Science Plan*

The National Research Council 2013 Planetary Decadal Survey, *Vision and Voyages for Planetary Science in the Decade 2013-2022*, may be accessed at http://www.nap.edu/catalog.php?record_id=13117.

Program Analysis Group Reports

1. *Goals, Objectives, and Investigations for Venus Exploration*
2. *The Lunar Exploration Roadmap: Exploring the Moon in the 21st Century: Themes, Goals, Objectives, Investigations, and Priorities, 2011*
3. *Mars Science Goals, Objectives, Investigations, and Priorities: 2010*
4. *Scientific Goals for Exploration of the Outer Solar System*

Program Specific Documents

1. DISC-PLAN-001B, *Discovery Program Plan*
2. ~~*Discovery Safety, Reliability, and Quality Assurance Requirements*~~
3. *Guidelines and Criteria for the Phase A Concept Study*
4. *ELV Launch Services Information Summary*
5. *Launch Services Program (LSP) Advisory Services Plan*
6. *NASA's Mission Operations and Communications Services*
7. ~~*Advanced Multi Mission Operating System Services*~~
8. *SMD Mission Extension Paradigm*
9. *Microsoft Excel versions of the template tables in the AO:*
   Table B1: Example Science Traceability Matrix
   Table B2: Example Mission Traceability Matrix
   Table B3a: Total Mission Cost RY$ Profile Template
   Table B3b: Total Mission Cost FY$ Profile Template
   Table B5: Master Equipment List
10. *SPD-19, Meeting the 70% JCL Requirement in PI-led Missions*
11. *Draft Model Contract for Phases B/C/D/E*
12. *FY14 NASA New Start Inflation Indices (NNSI)*
13. *Sample Return Primer and Handbook*

14. *Lightweight Radioisotope Heater Unit (LWRHU) Information Summary*
15. *Entry, Descent and Landing (EDL) Instrumentation Engineering Science Investigation (ESI) Proposal Details and Programmatic Structure*
16. *Entry, Descent and Landing (EDL) Instrumentation Engineering Science Investigation (ESI) Goals and Objectives*
17. *Mars Relay Description for Discovery 2014 Proposals*
18. *Electra Mars Proximity-Link Communications and Navigation Payload Description*
19. *TRL 6 Examples*
20. *NASA's Evolutionary Xenon Thruster (NEXT) AO Guidebook*
21. ~~*Goals, Objectives, and Investigations for Venus Exploration*~~
22. *Developing a Data Pipeline and Planetary Data System (PDS)-Compliant Archive*
23. DISC-RQMT-002C, *Discovery Program Safety and Mission Assurance Guidelines and Requirements*
24. DISC-PLAN-006B, *Discovery Program Office Safety and Mission Assurance Implementation Plan*
25. *Overview of Heatshield for Extreme Entry Environments Technology (HEEET)*
26. *Overview of Mission Sizing For Heatshield for Extreme Entry Environments Technology (HEEET) Materials*
27. *Mission Characterization for HEEET Design*
28. *HEEET Systems Requirements and Verification Plan32. Deep-Space Optical Communications (DSOC) Factsheet*
29. *Deep-space Optical Terminals (DOT) Systems Engineering*
30. *Overview and Design of the DOT Flight Laser Transceiver*
31. *Deep-space Optical Terminals (DOT) Ground Laser Transmitter (GLT) Trades and Conceptual Point Design*
32. Deep-Space Optical Communications (DSOC) Factsheet
33. *Deep-Space Optical Communications (DSOC) Project Images: Joint Cloud Cover Statistics for Palomar Mountain, CA and Table Mountain, CA*
34. *X–Ray Computed Tomography Inspection of the Stardust Heat Shield*
35. *Entry Performance of the Mercury Spacecraft Heat Shield*
36. *Analysis of the Heat-Shield Experiment on the Pioneer-Venus Entry Probes*
37. *DSOC Interface Definitions*
38. *HEEET Arcjet/Thermal Test Summary Report CY2013-14*
39. *Electra-Lite Mars Proximity Link Communications and Navigation Payload Description*
40. *Deep Space Atomic Clock: Information for Discovery Proposers September 2014*
41. ~~*Developing a Data Pipeline and PDS-Compliant Archive in Response to the Discovery Announcement of Opportunity (AO)*~~
42. *NASA's Evolutionary Xenon Thruster (NEXT) Long-Duration Test (LDT) Posttest Inspection Interim Report*

<u>NASA and Federal Documents</u>

1. NPR 7120.5E, *NASA Space Flight Program and Project Management Requirements*
2. NPR 7123.1B, *NASA Systems Engineering Processes and Requirements*
3. NPR 8020.12D, *Planetary Protection Provisions for Robotic Extraterrestrial Missions*

4. NPD 8020.7G, *Biological Contamination Control for Outbound and Inbound Planetary Spacecraft*
5. NPD 7100.10E, *Curation of Extraterrestrial Materials*
6. NASA-HDBK-6022b, *NASA Handbook for the Microbiological Examination of Space Hardware (DRAFT)*
7. NASA/CP-2002-211842, *A Draft Test Protocol for Detecting Possible Biohazards in Martian Samples Returned to Earth*
8. NASA/SP-2010-3404, *NASA WBS Handbook*
9. NPR 8715.6A, *NASA Procedural Requirements for Limiting Orbital Debris*
10. NASA-STD-8719.14, *NASA Process for Limiting Orbital Debris*
11. NPR 8715.3C, *NASA General Safety Program Requirements*
12. *Statement of Federal Financial Accounting Standards 4: Managerial Cost Accounting Standards and Concepts*
13. *Procurement Information Circular (PIC) 05-15*

Additional NASA and Federal Documents

All NASA Policy Directives (NPD) and NASA Procedural Requirements (NPR) documents referenced in this AO may be found in the NASA Online Directives Information System (NODIS) Library (http://nodis.hq.nasa.gov/)

NPD 1360.2B, *Initiation and Development of International Cooperation in Space and Aeronautics Programs*
NPR 7150.2A, *NASA Software Engineering Requirements*
NPD 5101.32E, *Procurement, Grants, and Cooperative Agreements*
NPR 8580.1A, *NASA National Environmental Policy Act Management Requirements*
NPD 8610.7D, *Launch Services Risk Mitigation Policy for NASA-Owned and/or NASA-Sponsored Payloads/Missions*
NPR 8705.4, *Risk Classification for NASA Payloads*

NASA technical standards documents may be found in the public access portion of the NASA Standards and Technical Assistance Resource Tool (START) (http://standards.nasa.gov/)

NASA technical reports may be found on the NASA Technical Reports Server (NTRS) (http://ntrs.nasa.gov/search.jsp)

NASA/SP-2007-6105 Rev 1, *NASA Systems Engineering Handbook*

The Federal Acquisition Regulations (FAR) may be accessed at http://www.acquisition.gov/far/. The following parts of the Federal Acquisition Regulations are referenced in this AO.

FAR 15.403-4, "Requiring certified cost or pricing data (10 U.S.C. 2306a and 41 U.S.C. 254b)"
FAR 15.406-2, "Certificate of Current Cost or Pricing Data"
FAR 33.101, "Protests Definitions"
FAR 52.219-8, "Utilization of Small Business Concerns"

FAR 52.219-9, “Small Business Subcontracting Plan”
FAR 52.222-26, “Equal Opportunity”
FAR 52.226-2, “Historically Black College or University and Minority Institution Representation”
FAR 52.227-11, “Patent Rights – Ownership by the Contractor”
FAR 52.227-14, “Rights in Data – General”
FAR 52.233-2, “Service of Protest”

The NASA FAR Supplement (NFS) may be accessed at http://www.hq.nasa.gov/office/procurement/regs/nfstoc.htm. The following parts of the NASA FAR Supplement are referenced in this AO.

NFS 1815.208, “Submission, modification, revision, and withdrawal of proposals”
NFS 1834.2, “Earned Value Management System”
NFS 1835.016-70, “Foreign participation under broad agency announcements”
NFS 1852.225-71, “Restriction on Funding Activity with China”
NFS 1852.225-72, “Restriction on funding Activity with China – Representation”
NFS 1852.227-11, “Patent Rights--Retention by the Contractor”
NFS 1852.227-70, “New Technology”
NFS 1852.227-71, “Requests for Waiver of Rights to Inventions”
NFS 1852.233-70, “Protests to NASA”
NFS 1872.308, "Proposals submitted by NASA investigators”
NFS 1872.403-1, "Advisory subcommittee evaluation process”
NFS 1872.705-1, “Appendix A: General instructions and provisions”

NASA Procurement Information Circulars (PICs) may be accessed at http://www.hq.nasa.gov/office/procurement/regs/pic.html. The following NASA Procurement Information Circulars are referenced in this AO.

The Code of Federal regulations (CFR) may be accessed at http://www.gpo.gov/fdsys/. The following parts of the Code of Federal Regulations are referenced in this AO.

14 CFR Part 1216.3, “Procedures for Implementing the National Environmental Policy Act (NEPA)”
14 CFR Part 1250, “Nondiscrimination in Federally-Assisted Programs of NASA”
14 CFR Part 1265, “Governmentwide Debarment and Suspension (Nonprocurement)”
15 CFR Parts 730-774, “Export Administration Regulations”
22 CFR Parts120-130, “International Traffic in Arms Regulations”
40 CFR Parts 1500-1508, “Regulations for Implementing the Procedural Provisions of NEPA”

The United States Code (USC) may be accessed at http://www.gpo.gov/fdsys/. The following parts of the United States Code are referenced in this AO.

42 USC 4321 *et seq*., "National Environmental Policy Act of 1969, as amended (NEPA)"
44 USC 3504(d)(1) and 3516

Executive Orders may be accessed at http://www.archives.gov/federal-register/executive-orders/. The following Executive Orders are referenced in this AO.

Executive Order 12114, "Environmental effects abroad of major Federal actions" (see http://www.archives.gov/federal-register/codification/executive-order/12114.html)

Homeland Security Presidential Directive HSPD-12 (see http://www.dhs.gov/homeland-security-presidential-directive-12)

APPENDIX E

REQUIREMENTS FOR SUBSEQUENT PHASES

This appendix provides references to documents that govern subsequent phases of mission development for selected investigations. These documents may contain requirements on selected missions; however they do not place requirements on proposals submitted in response to this AO. Proposed investigations should be implementable within the program and project management environment that these documents describe. These documents may be found in the Program Library (Appendix D).

E.1 Phase A Concept Study Reports and Confirmation of Investigation(s) for Phase B

Guidelines and Criteria for the Phase A Concept Study

E.2 Confirmation of Investigation(s) for Phases Subsequent to Phase B

NPR 7120.5E, *NASA Space Flight Program and Project Management Requirements*
Discovery *Program Safety and Quality Mission Assurance Guidelines and Requirements*
NPR 7123.1B, NASA Systems Engineering Processes and Requirements
NPR 8705.4, Risk Classification for NASA Payloads
NPR 8715.3C, NASA General Safety Program Requirements
SPD-19, Meeting the 70% JCL Requirement in PI-led Missions

APPENDIX F

COMPLIANCE CHECKLIST

This appendix contains a checklist with the list of items that NASA will check for compliance before releasing a proposal for evaluation. All other requirements will be checked during evaluation.

Administrative	
1. Electronic proposal received on time	Requirement 1
2. Proposal on CD-ROM received on time	Requirement 2
3. Original signature of authorizing official included	Requirement B-8
4. Meets page limits	Requirement B-4
5. Meets general requirements for format and completeness (one volume original easy to disassemble, maximum 55 lines text/page, maximum 15 characters/inch --approximately 12 pt font)	Requirement 102 Requirement B-1 Requirement B-2 Requirement B-3
6. Required appendices included; no additional appendices	Requirement B-57
7. Budgets are submitted in required formats	Requirement B-52
8. All individual team members who are named on the cover page indicate their commitment through NSPIRES	Requirement 91
9. All export-controlled information has been identified	Requirement 92
10. Restrictions Involving China acknowledged on Electronic Cover Page	Requirement 3
Scientific	
11. Addresses solicited science research programs	Requirement 4
12. Requirements traceable from science to instruments to mission	Requirement 6
13. Appropriate data archiving plan	Requirement 7
14. Baseline science mission and threshold science mission defined	Requirement 10
Technical	
15. Complete spaceflight mission (Phases A-F) proposed	Requirement 25
16. Team led by a single PI	Requirement 48
17. PI-Managed Mission Cost within AO Cost Cap	Requirement 65
18. Phase A costs within Phase A cost limit	Requirement 67
19. Contributions within contribution limits	Requirement 80
20. Co-investigator costs in budget	Requirement 60
21. Launch date prior to launch deadline	Requirement 95
22. Includes table describing non-U.S. participation	Requirement 86
23. Includes letters of commitment from funding agencies for non-U.S. participating institutions	Requirement 83
24. Includes letters of commitment from all U.S. organizations offering contributions	Requirement 89
25. Includes letters of commitment from all major partners	Requirement 90

APPENDIX G

REQUIREMENTS CROSSWALK

This appendix contains an approximate crosswalk between proposal requirements in the AO and proposal requirements in Appendix B. Proposal requirements in Appendix B expand upon the proposal requirements in the AO and provide further definition on the structure and content of the proposal. Some AO requirements do not require further definition by an Appendix B requirement. Not all possible crosswalk relations are shown.

AO Reqmt	**AO Section**	**AO Reqmt Topic**	**Appendix B Reqmt**
1	3	Proposal submission deadline	
2	3	Electronic submission & CD-ROMs	B-6, B-9, B-11
3	4.2.2	Restrictions involving China	
4	5.1.1	Science scope	B-15, B-18
5	5.1.1	Science traceability	B-16, B-18, B-22
6	5.1.2	Measurement traceability	B-16, B-18, B-22, B-28
7	5.1.2	Data plan	B-15, B-18, B-23
8	5.1.3	Data sufficiency	B-15, B-18, B-21
9	5.1.3	Instrumentation rationale	B-15, B-18, B-19, B-20
10	5.1.4	Baseline and threshold mission	B-18
11	5.1.4	Threshold mission and descopes	B-18
12	5.1.5.1	Planetary protection (encounters)	B-65
13	5.1.5.1	Planetary protection (samples)	B-65
14	5.1.5.2	Sample curation	B-66
15	5.1.5.2	Sample curation funding	B-66
16	5.1.5.3	Sample allocation	B-66
17	5.1.5.4	Returned hardware curation	B-66
18	5.1.5.4	Hardware curation funding	B-66
19	5.1.6	SEO Description	B-25
20	5.1.6	SEO Separable	B-25
21	5.1.6	Extended mission	
22	5.1.7	TDO Description	B-26
23	5.1.7	TDO Separable	B-26

AO Reqmt	AO Section	AO Reqmt Topic	Appendix B Reqmt
24	5.1.8	Engineering Science Investigation	B-77
25	5.2.1	Complete Missions	B-27, B-28, B-29, B-30
26	5.2.1	Mission architecture	B-22, B-27, B-28, B-29, B-30, B-35, B-37
27	5.2.1	Mission design and operations	B-22, B-27, B-28, B-29, B-30, B-31, B-32, B-35, B-36, B-37, B-42, B-67, B-68
28	5.2.1	Flight systems design	B-27, B-28, B-29, B-30, B-32, B-34, B-35, B-36
29	5.2.1	Development approach	B-27, B-28, B-29, B-30, B-32, B-34, B-35, B-36, B-38, B-39, B-40, B-41, B-73, B-74, B-76
30	5.2.2	Management approach	B-27, B-28, B-29, B-30, B-32, B-34, B-35, B-36, B-38, B-39, B-40, B-41, B-44, B-47, B-48
31	5.2.2	System engineering approach	B-27, B-28, B-29, B-30, B-32, B-34, B-35, B-36, B-38, B-40, B-41, B-46, B-47, B-51, B-73, B-74, B-76
32	5.2.2	NPR deviations	
33	5.2.3	Technology maturation	B-39, B-76
34	5.2.4.2	Radioactive material	B-38
35	5.2.4.2	RHUs	
36	5.2.4.4	NEPA/NLSA	B-38, B-40, B-41, B-42
37	5.2.5	Space communications and tracking requirements	B-37
38	5.2.5	DSN aperture costs	
39	5.2.5	Efficient use of NASA telecommunications	
40	5.2.5	NASA non-standard space communications	B-59
41	5.2.5	Use of Ka-band	
42	5.2.5	Single 34m antenna use	
43	5.2.6	Critical events	

AO Reqmt	AO Section	AO Reqmt Topic	Appendix B Reqmt
44	5.2.7	End-of-mission spacecraft disposal	B-67, B-68
45	5.2.8	Mission categorization and risk classification	B-46
46	5.2.9	Deviations from payload requirements	B-40, B-41
47	5.2.10	Justification for non-use of AMMOS	B-78
48	5.3.1	Principal investigator	B-24, B-44, B-45, B-60
49	5.3.2	Project manager	B-24, B-45, B-60
50	5.3.3	Project systems engineer	B-24, B-45, B-60
51	5.3.4	PI, PM, and PSE roles	B-24, B-45
52	5.3.5	Qualifications of institutions	
53	5.3.6	Risk identification	B-46, B-51
54	5.3.6	Risk mitigation	B-46, B-51
55	5.3.6	Descopes	B-44, B-46, B-51
56	5.3.6	Risks of international contributions	B-46, B-51
57	5.3.7	NASA PI proposals	B-69
58	5.4.1	Science team	B-24, B-45, B-58, B-60
59	5.4.2	Co-investigator roles	B-24, B-45, B-60
60	5.4.2	Co-investigator funding	
61	5.4.3	Collaborators	B-24, B-45
62	5.5.3	Student collaboration separable	B-56
63	5.5.3	Student collaboration funding	B-49, B-50, B-52, B-54, B-56
64	5.6.1	Cost tables	B-49, B-50, B-52, B-54
65	5.6.1	PI-Managed Mission Cost	B-49, B-50, B-52, B-54
66	5.6.1	Limit on pre-Confirmation spending	B-49, B-50, B-52, B-54
67	5.6.2	Phase A cost	B-49, B-50, B-52, B-54
68	5.6.2	Phase A teaming	B-44, B-45
69	5.6.3	Cost methodologies	B-49, B-50, B-54, B-73, B-74
70	5.6.3	Cost control	B-49, B-50, B-51, B-52
71	5.6.3	Parametric model inputs	B-49, B-50, B-54, B-55

AO Reqmt	AO Section	AO Reqmt Topic	Appendix B Reqmt
72	5.6.3	Cost reserves	B-49, B-50, B-51, B-52, B-54
73	5.6.3	Phase E/F Cost Reserves	B-49, B-50, B-51, B-52, B-54
74	5.6.4	Work Breakdown Structure	B-49, B-50, B-52
75	5.6.5	Master Equipment List	B-49, B-50, B-70, B-71, B-72
76	5.6.6	Full cost accounting	B-49, B-50, B-54
77	5.6.6	NASA contributions	B-47, B-49, B-50, B-52, B-71
78	5.6.6	Applicable accounting standards	B-49, B-50, B-54
79	5.6.7	Contribution identification	B-47, B-61, B-62
80	5.6.7	Contribution value caps	B-47, B-49, B-50, B-52, B-54, B-61, B-62
81	5.6.7	Contribution risk management	B-46, B-47, B-51, B-61, B-62
82	5.7.2	Non-U.S. cost plan	B-54
83	5.7.2	Non-U.S. letters of commitment	B-59
84	5.7.2	Non-U.S. contribution risk management	B-44, B-47, B-51
85	5.7.2	Non-U.S. contribution detail	B-47, B-71
86	5.7.2	Non-U.S. participation table	B-47, B-61, B-62
87	5.7.3	Phase A study and international agreements	
88	5.7.4	ITAR requirements	B-63, B-64, B-70
89	5.8.1.1	US contribution letters of commitment	B-59
90	5.8.1.2	Major partner letters of commitment	B-59
91	5.8.1.3	NSPIRES commitment for team members	
92	5.8.2	Declaration of export controlled proposal material	
93	5.8.3	Unclassified nature of proposals	
94	5.8.3	Provision of a classified heritage appendix	B-73, B-74

AO Reqmt	AO Section	AO Reqmt Topic	Appendix B Reqmt
95	5.9.1	Launch by date	B-42
96	5.9.2	Launch vehicle capabilities	B-33
97	5.9.2	Costs for nonstandard launch services	B-33, B-49, B-50, B-51, B-52, B-54
98	5.9.2	Compatibility with multiple launch vehicles	B-33
99	5.9.4	Mars communications planning	
100	5.9.4	Mars relay	
101	5.9.4	Mars lander communications	
102	6.2.1	Proposal format	B-1, B-2, B-3, B-4, B-5, B-7, B-8, B-13, B-14, B-56, B-55, B-57, B-75
103	6.2.3	Electronic submission of proposals	B-9, B-11
104	6.2.3	CD-ROMs	B-6, B-43, B-53, B-72
105	6.2.4	Team members registered in NSPIRES	B-12, B-24

APPENDIX H

CERTIFICATIONS

Included for reference only. Submission of the signed proposal including Section V of the Proposal Summary Information certifies compliance with these certifications.

Assurance of Compliance with the National Aeronautics and Space Administration Regulations Pursuant to Nondiscrimination in Federally Assisted Programs

The *(Institution or organization on whose behalf this assurance is signed, hereinafter called "Applicant.")*

HEREBY AGREES THAT it will comply with Title VI of the Civil Rights Act of 1964 (P.L. 88-352), Title IX of the Education Amendments of 1972 (20 U.S.C. 1680 *et seq*.), Section 504 of the Rehabilitation Act of 1973, as amended (29 U.S.C. 794), and the Age Discrimination Act of 1975 (42 U.S.C. 16101 *et seq*.), and all requirements imposed by or pursuant to the Regulation of the National Aeronautics and Space Administration (14 CFR Part 1250) (hereinafter called "NASA") issued pursuant to these laws, to the end that in accordance with these laws and regulations, no person in the United States shall, on the basis of race, color, national origin, sex, handicapped condition, or age be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity for which the Applicant receives Federal financial assistance from NASA; and HEREBY GIVES ASSURANCE THAT it will immediately take any measure necessary to effectuate this agreement.

If any real property or structure thereon is provided or improved with the aid of Federal financial assistance extended to the Applicant by NASA, this assurance shall obligate the Applicant, or in the case of any transfer of which the Federal financial assistance is extended or for another purpose involving the provision of similar services or benefits. If any personal property is so provided, this assurance shall obligate the Applicant for the period during which it retains ownership or possession of the property. In all other cases, this assurance shall obligate the Applicant for the period during which the Federal financial assistance is extended to it by NASA.

THIS ASSURANCE is given in consideration of and for the purpose of obtaining any and all Federal grants, loans, contract, property, discounts or other Federal financial assistance extended after the date hereof to the Applicant by NASA, including installment payments after such date on account of applications for Federal financial assistance which were approved before such date. The Applicant recognizes and agrees that such Federal financial assistance will be extended in reliance on the representations and agreements made in this assurance, and that the United States shall have the right to seek judicial enforcement of this assurance. This assurance is binding on the Applicant, its successors, transferees, and assignees, and the person or persons whose signatures appear below are authorized to sign on behalf of the Applicant.

Certification Regarding Debarment, Suspension, and Other Responsibility Matters
Primary Covered Transactions

This certification is required by the regulations implementing Executive Order 12549, Debarment and Suspension, 14 CFR Part 1265.

A. The applicant certifies that it and its principals:

1. Are not presently debarred, suspended, proposed for debarment, declare ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;

2. Have not within a three-year period preceding this application been convicted or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State, or Local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

3. Are not presently indicted for or otherwise criminally or civilly charged by a government entity (Federal, State, or Local) with commission of any of the offenses enumerated in paragraph A.(b) of this certification;

4. Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State, or Local) terminated for cause or default; and

B. Where the applicant is unable to certify to any of the statements in this certification, he or she shall attach an explanation to this application.

C. Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion -- Lowered Tier Covered Transactions (Subgrants or Subcontracts)

1. The prospective lower tier participant certifies, by submission of this proposal, that neither it nor its principles is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any Federal department of agency.

2. Where the prospective lower tier participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

Certification Regarding Lobbying

As required by S 1352 Title 31 of the U.S. Code for persons entering into a grant over $100,000, the applicant certifies that:

1. No Federal appropriated funds have been paid or will be paid by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, in connection with making of any Federal grant, the entering into of any cooperative, and the extension, continuation, renewal, amendment, or modification of any Federal grant;

2. If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting an officer or employee of any agency, Member of Congress, or an employee of a Member of Congress in connection with this Federal grant, the undersigned shall complete Standard Form -- LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

3. The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subgrants, contracts under grants, and subcontracts), and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by S1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

National Aeronautics and Space Administration