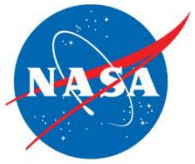
National Aeronautics and Space Administration



[NNH17ZDA005J] **Release Date April 7, 2017**

Announcement of Opportunity

DRAFT
Solar Terrestrial Probes Program - Interstellar Mapping and Acceleration Probe PI-led Mission AO

Comments on Draft Due:	**May 4, 2017**
Notification Proposal Due Date:	**TBD**
Proposal Due Date:	**TBD**

OMB Approval Number 2700-0085

ANNOUNCEMENT OF OPPORTUNITY
SOLAR TERRESTRIAL PROBES PROGRAM
NNH17ZDA005J

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 Solar Terrestrial Probes Program.

The AO Cost Cap for the Solar Terrestrial Probes #5 (STP-5) mission, hereafter Interstellar Mapping and Acceleration Probe (IMAP) mission, is $492M in NASA Fiscal Year (FY) 2017 dollars, not including the cost of the Expendable Launch Vehicle (ELV) standard services or any contributions. Application of AO-specified incentives will result in a proposal-specific Enhanced AO Cost Cap. 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. Proposed investigations are intended to be evaluated and selected through a two-step competitive process. However, if warranted by the evaluation process, NASA reserves the right to select through a single step. NASA intends to select approximately two Step-1 proposals for the conduct of Phase A concept studies and submission of concept study reports to NASA. NASA expects to select a single IMAP mission to proceed into Phase B and subsequent mission phases. The selected mission must be ready for launch no later than December 2024.

NASA is strongly committed to offering hardware experience to early-career scientists. NASA requires proposals to include a Student Collaboration. A Student Collaboration incentive will be provided.

NASA also strongly supports development of new technologies. The goal of a Technology Demonstration is to provide a pathway for new or enhanced capabilities to be introduced such that future investigations with enhanced scientific return may be realized. An incentive for Technology Demonstration is being offered through this AO.

NASA recognizes that the routine provision of space weather data from Heliophysics science missions is invaluable to the research and operational communities. NASA successfully provided, at marginal cost, a subset of observations in real time from a number of past and current operating missions, including ISEE-3, ACE, STEREO, SDO, and Van Allen Probes. NASA offers – independent from the proposed mission architecture – an incentive for PIs to enable continuous downlink to Earth of near real time relevant observational IMAP data that can be utilized to forecast or nowcast space weather phenomena.

Taking advantage of the expected launch vehicle capability, the Heliophysics Division plans on providing an Evolved Expendable Launch Vehicle Secondary Payload Adapter (ESPA) ring as a ride-along with the IMAP launch that will aid addressing Heliophysics science objectives and will serve the needs of SMD-wide technology demonstration. However, usage of the ESPA ring is not solicited through this AO, but through a Technology Demonstration Mission of

Opportunity that will be released by the end of calendar year 2017. IMAP proposals submitted through this AO must not depend on use of the ESPA ring.

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

- A Notification Proposal, replacing the Notice of Intent, is required.
- All Missions of Opportunity will be solicited through the Third Stand Alone Mission of Opportunity Notice (SALMON-3) AO.

This AO is based on SMD's Standard PI-led Mission AO that was modified to support the goals of the IMAP opportunity. Proposers should read the AO document and the Appendices carefully.

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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 Solar Terrestrial Probes (STP) Program. All investigations proposed in response to this solicitation must support the goals and objectives of the Solar Terrestrial Probes 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).

NASA intends for proposed investigations to 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 approximately two Step-1 proposals and issue awards (provide funding to NASA Centers and/or 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 and evaluation of the concept study reports. As the outcome of Step 2, NASA intends to continue up to one investigation into the subsequent phases of mission development for flight and operations.

Pending the Step-1 evaluation outcome, NASA reserves the right to select through a single step (Section 7). In this case, NASA would select one investigation and issue an award (provide funding to NASA Centers and/or the Jet Propulsion Laboratory (JPL), award contracts to non-NASA institutions, or utilize other funding vehicles as applicable) for all Phases (A-F) 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, Section A.3 contains requirements on team members applicable to a Notification Proposal and a Step-1 Proposal. Moreover, Appendix B provides guidance and additional requirements on the format and content of the Step-1 proposal. Appendix D lists the contents of the Program Library.

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 the selected investigation. These Program Library documents are intended to provide guidance for investigations selected in Step 1 and (if applicable) subsequently selected in Step 2, respectively; they are specifically *not* intended to impose requirements on Step-1 proposals.

NASA recognizes and supports the benefits of having diverse and inclusive scientific, engineering, and technology communities and fully expects that such values will be reflected in

the composition of all proposal teams as well as peer review panels (science, engineering, and technology), science definition teams, and mission and instrument teams.

NASA recognizes that technology and technological progress is critical for the future of the science program and its missions. As part of our goals of scientific discovery, we are identifying and enabling technologies with high impact. Often the breakthrough science required to answer the most pressing science questions requires significant technological innovation—e.g., instruments or platforms with capabilities beyond the current state of the art. NASA's Science Mission Directorate's (SMD's) targeted technology investments fill technology gaps, enabling NASA to build the challenging and complex missions that accomplish groundbreaking science. The directorate works to ensure that NASA actively identifies and invests in the right technologies at the right time to enable the Agency's science program. SMD technology development is part of a comprehensive Agency-wide strategy that involves important partnerships with the Space Technology Mission Directorate and leveraging technologies, when appropriate, with the Human Exploration Mission Directorate.

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 funding instruments), and (4) high-value equipment and property.

2. AO Objectives

2.1 NASA Strategic Goals

One of NASA's strategic goals is to "[e]xpand 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 1.4: "Understand the Sun and its interactions with Earth and the solar system, including space weather" – and, as a secondary strategic goal, through Strategic Objective 1.7: "Transform NASA missions and advance the Nation's capabilities by maturing crosscutting and innovative technologies."

With this AO, SMD is addressing the following three research objectives, as outlined in Chapter 4 of the *2014 Science Mission Directorate* (SMD) *Science Plan,* available through the Program Library:

- Explore the physical processes in the space environment from the Sun to the Earth and throughout the solar system
- Advance our understanding of the connections that link the Sun, the Earth, planetary space environments, and the outer reaches of our solar system

- Develop the knowledge and capability to detect and predict extreme conditions in space to protect life and society and to safeguard human and robotic explorers beyond Earth

Further information on the goals and objectives of NASA's Heliophysics program may be found in the recommendations to NASA in the *2013 National Research Council Decadal Strategy for Solar and Space Physics report, Solar and Space Physics: A Science for a Technological Society* (available through the Program Library).

2.2 Solar Terrestrial Probes Program Goals and Objectives

The goal of the STP program is to understand the physical processes that determine the mass, momentum and energy flow in the solar system from the Sun to planetary bodies including Earth, and to understand the interstellar boundary and its interaction with the local interstellar medium. Successive STP missions will focus on critical science targets that systematically advance understanding of the coupled solar-heliosphere-magnetosphere-ionosphere-upper atmosphere system.

The STP program develops missions and technology to address fundamental science questions about the physics of space plasmas and the flow of mass and energy through the solar system. STP program objectives are:

- To describe the system behavior of the variable magnetic variable star, our sun, and its interaction with the entire solar system;

- To understand the critical physics that link the sun, Earth, heliosphere, and the interstellar medium;

- To understand the processes and dynamics of the magnetosphere-ionosphere-upper atmosphere system, the near space electromagnetic plasma environment surrounding the Earth; and

- To develop and mature instrumentation and mission technologies with the potential of advancing STP science.

2.3 Solar Terrestrial Probes Program Background

The establishment of the Solar Terrestrial Probes program follows the success of international collaboration in the 1980s and early 1990s between NASA, the European Space Agency (ESA), and the Institute of Space and Astronautical Science (ISAS) of Japan that formed the International Solar-Terrestrial Physics (ISTP) program. ISTP was instrumental in conducting the closely coordinated missions Geotail, Wind, Polar, SOHO and Cluster. Coordination with other Federal Agencies (NOAA, DOE/LANL) led to the use of additional observational platforms such as GOES and LANL Geosynchronous Satellites to address open science questions in the solar-terrestrial physics realm. ISTP also supported ground-based observations and development of the theoretical basis for understanding the system as a whole.

In 1998, the NASA Solar Terrestrial Probes program arose as a critical element of the implementation of the 1998 Strategic Plan for the Office of Space Science (OSS). The STP program office is located at the Goddard Space Flight Center and provides oversight over the implementation of missions selected by SMD. All four currently operating STP missions were already foreseen to be implemented, or in the implementation phase, at that time when the STP program was established:

STP-1: TIMED, launched in 2001.

STP-2: JAXA/NASA Hinode/Solar-B, launched in 2006.

STP-3: NASA/ESA STEREO, also launched in 2006.

STP-4: MMS, launched in 2015.

TIMED and STEREO are operated by the Johns Hopkins University/Applied Physics Laboratory (JHU/APL), Hinode is operated by the Japanese Aerospace Exploration Agency (JAXA), and MMS is operated by the NASA Goddard Space Flight Center. TIMED, Hinode/Solar-B, and STEREO have already successfully completed their prime missions.

The STP program and its missions were supported by the two consecutive NRC *Decadal Surveys* conducted since implementation: *The Sun to the Earth - and Beyond: A Decadal Research Strategy in Solar and Space Physics* (2003) and *Solar and Space Physics: A Science for a Technological Society* (2013). The 2013 *Decadal Survey* provided prioritized new science targets, STP-5, 6 and 7, for the program and included a scientific rationale for the ordering. The Interstellar Mapping and Acceleration Probe (IMAP) was recommended to be implemented first, to be followed by Dynamical Neutral Atmosphere-Ionosphere Coupling (DYNAMIC), and by Magnetosphere Energetics, Dynamics, and Ionospheric Coupling Investigation (MEDICI).

2.4 Interstellar Mapping and Acceleration Probe Objectives

Proposals prepared in response to this AO must describe an investigation that addresses a preponderance (defined below) of the IMAP science objectives. These objectives, listed without priority order, are:

- Provide observations that guide understanding of the temporal and spatial evolution of the boundary region in which the solar wind and the interstellar medium interact.
- Provide observations of processes related to the interactions of the magnetic field of the Sun and the local interstellar medium.
- Measure and constrain the composition and properties of the local interstellar medium.
- Provide observations that guide understanding of particle injection and acceleration processes near the Sun, in the heliosphere and heliosheath.

Those responding to this opportunity must define clear traceability from their science objectives

to those listed above. Responders must also demonstrate linkages from their science objectives and associated investigations to the crosscutting themes and science goals in Chapter 1 of *Solar and Space Physics: A Science for a Technological Society*, the most recent *Decadal Survey*. These *Decadal Survey* Key Science Goals are:

1. Determine the origins of the Sun's activity and predict the variations in the space environment.

2. Determine the dynamics and coupling of Earth's magnetosphere, ionosphere, and atmosphere and their response to solar and terrestrial inputs.

3. Determine the interaction of the Sun with the solar system and the interstellar medium.

4. Discover and characterize fundamental processes that occur both within the heliosphere and throughout the universe.

NASA recognizes that the IMAP science objectives may include more scope than can be accomplished in the IMAP cost cap. Those responding to this opportunity should choose among the IMAP science objectives and defend those choices.

NASA does not prescribe how any missions or investigations responsive to the science objectives should be accomplished. However, NASA requires that any mission architecture achieve a preponderance of the IMAP science objectives. For the purpose of this AO, preponderance is defined to be superiority in influence or number. The requirement to address a preponderance of the IMAP science objectives (rather than a majority) recognizes that science objectives are not necessarily equally important. The proposal should include a justification of the choice of science objectives that makes clear why the set of selected science objectives addresses a preponderance of the IMAP science objectives.

Requirement 1. Proposals shall describe a science investigation that addresses a preponderance of the IMAP science objectives listed in Section 2.4, stating the science objectives for the proposed investigation and clearly justifying the choice of those science objectives.

Requirement 2. Proposals shall describe the traceability between the science objectives of the investigation to a) the IMAP science objectives stated above; and b) at least one of the *Decadal Survey* Science Goals.

3. Proposal Opportunity Period and Schedule

This solicitation has two submission deadlines. The following schedule describes the planned major milestones for this AO:

Final AO Release Date	June 2017 (target)
Pre-proposal Conference	AO Release + ~3 weeks
Electronic Notification Proposal Deadline	AO Release + ~4-6 weeks
Electronic Full Proposal Submittal Deadline at 11:59 p.m. Eastern Time	September XX, 2017 (AO Release + 3 months
Letters of Commitment Due (with Proposal)	AO Release + 3 months
Deadline for Receipt of Proposal on CD-ROMs at 5:00 p.m. Eastern Time	Electronic Proposal deadline +4 days
Step-1 Selection(s) Announced (target)	AO Release + 10 months
Initiate Phase A Concept Studies (target)	April 2018
Phase A Concept Study Reports Due* (target)	April 2019
Down-selection of Investigation(s) for Flight* (target)	October 2019
Launch Readiness Date	NLT December 2024

*Applicable in the two-step selection scenario

All proposals, U.S. and non-U.S., must be received before the proposal submittal deadlines. Those received after the deadlines will be treated in accordance with Appendix A, Section VII.

Requirement 3. Proposals submitted in response to this solicitation shall be submitted electronically no later than the Electronic Proposal Submittal Deadlines.

Requirement 4. In addition to electronic submission, CD-ROMs containing the proposal and relevant files described in Section 6.2.3 shall 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 Address 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 development 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 concept development. In a one-step AO process, projects enter Phase A after selection and the process becomes conventional, with KDP B representing the culmination of Concept and Technology Development. In a two-step AO process, projects are down-selected following evaluation of concept study reports and the down-selection serves as KDP B. 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. 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 NPR 7120.5E, NPR 8705.4, NPR 7123.1B, and in other NASA requirements documents available in the Program Library and/or in the NASA Online Directives Information System (NODIS, http://nodis3.gsfc.nasa.gov/). The Associate Administrator for SMD has established a Solar Terrestrial Probes Program Office at the NASA Goddard Space Flight Center to be responsible for project oversight. The Solar Terrestrial Probes Program Manager at the NASA Goddard Space Flight Center reports to the Heliophysics Division

Director at NASA Headquarters. Additional details about the program office staffing, structure, and goals can be found in the *Solar Terrestrial Probes 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 Solar Terrestrial Probes Program Office at the NASA Goddard Space Flight Center will retain the Technical Authority (TA), as described in NPR 7120.5E, which would otherwise be invested in an implementing Center or JPL.

The Explorers & Heliophysics Projects Division Mission Assurance 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 Solar Terrestrial Probes Program Office, the NASA Goddard Space Flight Center (GSFC) is eligible to submit and participate in proposals in response to this AO. The Solar Terrestrial Probes Program Office will have access to the AO before it is released; this is necessary so that the Solar Terrestrial Probes Program Office can review the AO and ensure that it correctly describes the post-selection project management processes. Other than that, the Solar Terrestrial Probes 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 GSFC's two roles, SMD has established functional and organizational firewalls between the Solar Terrestrial Probes Program Office and those parts of GSFC that might participate in proposals. These firewalls ensure that personnel identified as supporting the Solar Terrestrial Probes Program Office and the AO process will protect all nonpublic information from all proposers, including those at GSFC, and will be free of financial and other conflicts of interest with proposers.

4.1.3 Roles and Responsibilities in Communications and Outreach

NASA is required to communicate the discoveries and results of its investigations to the American public. These efforts are intended to promote interest and foster participation in NASA's endeavors and to develop exposure to – and appreciations for – Science, Technology, Engineering, and Mathematics (STEM). Therefore, the PIs of selected investigations are required to work in conjunction with a NASA Center or JPL, and with NASA Headquarters to communicate mission updates, science, and new discoveries.

4.1.3.1 NASA Centers or Jet Propulsion Laboratory (JPL)

Each flight mission manages the communications plan and activities utilizing the communications office of a NASA Center or JPL. Missions managed by a NASA Center or JPL will request support of that Center's communications office. For missions not managed by a NASA Center or JPL, the Goddard Space Flight Center, where the Solar Terrestrial Probes Program Office resides, will fulfill the communications management role.

The communications offices will be responsible for coordinating and executing mission communications activities – along with the mission's Principal Investigator (PI) and Project Office for PI-led missions – and with the approval of Headquarters SMD and Office of Communications.

4.1.3.2 Principal Investigators

For PI-led missions, the PI fills a challenging, multidisciplinary role, which demands excellent communication, team building, and management skills. The PI is responsible for all aspects of the successful implementation of the mission. The PI is a key spokesperson for the mission – along with NASA officials – and is integral in communicating mission updates, science, and new discoveries.

The PI provides content, analysis, and context for communication campaigns and news stories. In keeping with NASA's communications goals, content should convey an understanding of the mission and its objectives, and the benefits to target audiences, the public, and other stakeholders.

As part of NASA's review and approval process, the PI, or his or her designee, 1) coordinates, 2) reviews, and 3) approves, with the designated NASA Center communications office, all mission-related communications activities. In case of incompatible views, NASA will have the final decision on release of public products, while ensuring that scientific and technical information remains accurate and unfiltered.

Selected PIs also must work with NASA to ensure their mission website follows NASA requirements for providing content on 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.

4.1.3.3 NASA Headquarters

NASA Headquarters and the program office personnel provide the necessary oversight and funding for communications in accordance with NASA and SMD policies for PI-led missions.

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 sets of achievable science objectives to ensure that the investigation remains at or above the Threshold Science Mission (see Section 5.1.4 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.

Proposals submitted to this AO must include a commitment by the PI for the PI-Managed Mission Cost, schedule, and scientific performance of the investigation. In the event that NASA chooses a mission through a one-step process and if, at any time, the cost, schedule, or scientific performance commitments made in the proposal appear to be in peril, the investigation will be subject to termination or cancellation.

However, if NASA chooses a two-step selection process, during Phase A, each selected PI will conduct a concept study. The Phase A Concept Study Report must include an updated 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, the selected PI will work with NASA to develop top-level science and technical performance requirements. The PI will also work with NASA to establish a set of performance metrics for project evaluation by 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. with some restrictions (see Section 4.2.2), are welcome to respond to this solicitation. 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.

The NASA Evaluations, Assessments, Studies, Services, and Support (EASSS) contract with Cornell Technical Services (CTS) for evaluation support under this AO creates an immitigable 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.

There are no plans to use The Aerospace Corporation for evaluation support. There is no limitation on the participation of The Aerospace Corporation in any capacity under this AO.

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 existing laws and regulations, 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.

Requirement 5. Proposals shall 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.

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. However, this responsibility will be exercised with essential NASA oversight to ensure that the implementation is responsive to the requirements and constraints of the IMAP Project.

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

Any replacement of Key Management Team members (including, but not limited to, the PI, the Project Manager (PM) and Project Systems Engineer (PSE)) 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 Solar Terrestrial Probes 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. It also includes any costs that are required to be counted against the PI-Managed Mission Cost, even though the PI is not directly responsible for those costs. The term does not imply that a contractual relationship between the PI's institution and other proposal team members is required. 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, as applicable, 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; NASA-provided telecommunications, tracking, and/or navigation support; 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 the 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 Solar Terrestrial Probes 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

The *Enhanced PI-Managed Mission Cost* is defined as the PI-Managed Mission Cost (see Section 4.3.1), plus the Student Collaboration costs up to the student collaboration incentive (see Section 5.5.3), plus the cost for the IMAP Active Link Incentive for Real Time (I-ALIRT) up to the I-ALIRT incentive (Section 5.9.4), plus any Technology Demonstration Opportunity (TDO)

up to the TDO incentive (see Section 5.9.5), plus any Science Enhancement Options (see Section 5.1.6).

4.3.4 Mission Funding Profile

The Solar Terrestrial Probes Program's planning budget can accommodate a selection at the AO Cost Cap with a typical funding profile over a nominal six-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 Solar Terrestrial Probes 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 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 and Intellectual Property

4.4.1 Increasing Access to the Results of Federally Funded Research

As a Federal Agency, NASA requires prompt public disclosure of the results of its sponsored research to generate knowledge that benefits the Nation. Thus, it is NASA's intent that all knowledge developed under awards resulting from this solicitation be shared broadly. In keeping with the *NASA Plan: Increasing Access to the Results of Scientific Research* (http://www.nasa.gov/sites/default/files/files/NASA_Data_Plan.pdf) new terms and conditions about making manuscripts and data publically accessible may be attached to awards that derive from this AO. Proposals are required to include a data management plan (DMP) in accordance with terms and conditions stated in the *NASA Plan: Increasing Access to the Results of Scientific Research* or to justify that one is not necessary given the nature of the work proposed (see Requirement 9). The kind of data that requires a DMP is described in the *NASA Plan: Increasing Access to the Results of Scientific Research*.

SMD anticipates that awards deriving from this AO will include terms and conditions requiring that as accepted manuscript versions of peer-reviewed publications (hereinafter "manuscripts") resulting from AO awards be uploaded into NASA's part of the PubMed Central (PMC) repository called NASA PubSpace at https://www.ncbi.nlm.nih.gov/pmc/funder/nasa/. This applies only to peer reviewed publications. Patents, publications that contain material governed by personal privacy, export control, proprietary restrictions, or national security law or regulations will not be covered by this requirement. The manuscript will appear in PMC for free public access following a maximum 12-month embargo period after the publication date. PMC will release the manuscript when the embargo has ended. For more details on public access to

scientific publications and digital scientific data resulting from NASA-funded research, please see: https://www.nasa.gov/open/researchaccess.

4.4.2 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 post-mission (Phase F) activities. Data analysis may be continued during Phase F.

4.4.3 Delivery of Data to Archive

The investigation team will make mission data fully available to the public through a NASA-approved data archive (*e.g.,* the Solar Data Analysis Center, and the Space Physics Data Facility, etc.), in 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 low-level (raw) data, key parameter (survey) data, high-level (scientific) data, and derived data products such as maps, ancillary data (including valid SPICE (spacecraft, planet, instrument, C-matrix, events) kernels related to spacecraft, instrument, and body information), calibration data (ground and in flight), documentation, related software, and/or other tools or parameters that are necessary to interpret the data. The PI will be responsible for generating data products that are documented, validated, and calibrated in physical units that are usable by the scientific community at large.

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 data archive. 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. This funding will be included in the PI-Managed Mission Cost.

4.4.4 Intellectual Property

4.4.4.1 Invention Rights

Recipients that are small businesses or nonprofit organizations may elect to retain title to any inventions made under a funding agreement pursuant to the Bayh-Dole Act (35 U.S.C. § 202). Large business recipients are subject to section 20135 of the National Aeronautics and Space Act (51 U.S.C. § 20135) relating to property rights in inventions. Title to inventions made under an agreement by a large business recipient initially vests with NASA. However, these recipients may request a waiver to obtain title to inventions made under the agreement. Such a request may be made in advance of the agreement or within 30 days thereafter. Even if a waiver request is not made, or denied, a large business recipient may request a waiver on individual inventions made during the course of the agreement.

4.4.4.2 Data Rights

All science data returned from investigations led by NASA-funded PIs will be made available to the public as rapidly as possible (see Section 4.4.1). Following a short latency period, all data will be made available to the user community, to the extent consistent with the approved data management plan and the data rights clause incorporated into the award instrument. No period of exclusive access is permitted. The Principal Investigator proposes and justifies any data product latency period for standard data products listed in the proposal, based primarily on the time required to produce, quality check, and validate the products. Barring exceptional circumstances, data product latency may not exceed six months.

4.5 Project Management Policies

4.5.1 Independent Verification and Validation of Software

The NASA Chief of Safety and Mission Assurance (CSMA) has the authority to select software projects to which Independent Verification and Validation (IV&V) shall be applied, as defined in NASA-STD-8739.8, *Standard for Software Assurance*, and NPR 7150.2B, *NASA Software Engineering Requirements*. All Category 1 and those Category 2 missions with a payload risk classification A or B will require IV&V to be performed. It is expected that the NASA IV&V Center will provide this function at no cost to the PI team. If the PI team proposes a Category 2, Class C mission, IV&V should still be performed, but may be provided externally. If the PI team uses the NASA IV&V Center in the Risk Class C case, it is expected to be paid for out of the PI-managed mission cost. Therefore, PI teams that propose Category 2, Class C missions must budget for IV&V service as part of the PI-managed mission cost. PI teams will be required to contact the Office of the Director at the NASA IV&V Program to gain a preliminary understanding of the potential level of safety and software risks. The Office of the Director can be contacted at (304) 367-8248. When a project is required to obtain IV&V, exemption will require an assessment of the software project by the NASA Office of Safety and Mission Assurance (OSMA) and approval by the CSMA.

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 1852.234-2.

4.5.3 Cost Analysis Data Requirement (CADRe)

NASA has established a Cost Analysis Data Requirement (CADRe) in NPR 7120.5E, Table I-4, which 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 conjunction assessment risk analysis requirements in NPR 8715.6B, Chapter 3 that will apply to investigations selected through this AO. Two organizations – the

Conjunction Assessment Risk Analysis (CARA) team at NASA Goddard Space Flight Center for Earth-orbiting missions and the MArs (and Moon) Deepspace Collision Avoidance Process (MADCAP) team at the Jet Propulsion Laboratory for Moon and Mars missions – are funded directly by NASA Headquarters and the Multi-Mission Ground Systems and Services (MGSS), respectively, to perform the actual analysis and risk assessment; the costs for these services need not be included in the mission PI-Managed Mission Cost. An investigation to which NPR 8715.6B, Section 3 is applicable will have to budget costs in their proposal PI-Managed Mission Cost to establish a working interface between the Flight Operations Team and the CARA or MADCAP team. This interface will be used to routinely share orbital ephemerides data and covariance data, any maneuvering plans, and to perform any maneuver planning activities required for collision avoidance once on orbit. Additionally, estimates of how many maneuver planning events may be required in a particular Earth orbit regime are available from the CARA team. The interface between the mission and CARA or MADCAP team should be agreed-to and documented one year prior to launch.

For additional information regarding CARA, proposers may contact Ms. Lauri Newman (Telephone: 301-286-3155; e-mail: lauri.k.newman@nasa.gov. For information regarding MADCAP, please contact Mr. Roby Wilson (Telephone: 818-393-5301; e-mail: roby.s.wilson@jpl.nasa.gov.

4.5.5 End-of-Mission Plan and End-of-Prime-Mission Review

The End-of-Mission Plan requirements may be found in NPR 7120.5E. This document is accessible from the Program Library.

A NASA Heliophysics End-of-Prime Mission (EOPM) review is a technical and scientific assessment by an independent panel of how well the mission met its Baseline Science Requirements or Threshold Science Requirements. The product of the review is documentation of actual mission performance, a formal assessment of mission success with respect to the science products available to the community, and a baseline for lessons-learned and predictions of future performance. The approach is to perform a systematic review of performance vs. specifications at the spacecraft and Mission Operations Center subsystem level for the technical engineering assessment, and at the data product level for the scientific assessment. A summary page/chart should be prepared for each subsystem/sensor that includes on-orbit performance over time (e.g. trending data). For data products, assessments of data maturity should include version history, release dates, accessibility, calibration and error estimates, in addition to estimates of community use and publication history. These subsystem and product assessments should be summarized and related to its Baseline Science Requirements or Threshold Science Requirements.

If the End-of-Prime-Mission Review is successful, the mission may propose to the NASA Heliophysics Division Senior Review for approval to enter into an extended mission phase. Information on the NASA Heliophysics Division Senior Review can be found in the *2017 Call for Heliophysics Senior Review Proposals.* This document is accessible from the Program Library.

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), 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). Proposed investigations must achieve their proposed objectives; however, the investigation might only make progress toward a goal without fully achieving it.

Requirement 6. Proposals shall describe a science investigation with goals and objectives. The objectives of the science investigation shall address a preponderance of the IMAP science objectives described in Section 2.4.

Requirement 7. Proposals shall demonstrate how the proposed investigation will fully achieve the proposed science objectives.

5.1.2 Traceability of Proposed Investigation

The Solar Terrestrial Probes Program is intended to perform focused science investigations that advance knowledge and 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 8. Proposals shall clearly state the relationship between the proposed 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 9. Proposals shall include a plan to calibrate (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 data latency period (see Appendix B, Section E, for additional detail). The data plan shall be in compliance with terms and conditions stated in the *NASA Plan: Increasing Access to the Results of Scientific Research* or a justification shall be provided that this is not necessary given the nature of the work proposed (see Section 4.4.1).

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 10. Proposals shall state the proposed 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 is necessary and sufficient to achieve these objectives (see Appendix B, Sections D and E, for additional detail).

Requirement 11. 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 proposed 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 that renders it unable to accomplish one or more of the Baseline Science Mission science objectives, but allows accomplishment of all Threshold Science Mission science objectives may be an acceptable descope.

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

Requirement 12. Proposals shall specify only one Baseline Science Mission and only one Threshold Science Mission.

Requirement 13. 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

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;* NID 8020.109, *Planetary Protection Provisions for Robotic Extraterrestrial Missions*; and NASA-HDBK-6022, *NASA Handbook for the Microbiological*

Examination of Space Hardware, 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 NID 8020.109, *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 14. Proposals that include an encounter with another solar system body, via flyby, orbiter, lander, or end of mission impact shall address plans in draft form for contamination control, as required by NPD 8020.7G and NID 8020.109; such investigations shall bear all additional costs generated by any special planetary protection requirements.

Requirement 15. Proposals that include the return of extraterrestrial samples shall address plans to comply with planetary protection requirements as required by NPD 8020.7G and NID 8020.109; such investigations shall bear all additional costs generated by any special planetary protection requirements.

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

Curation of Returned Samples

All samples of extraterrestrial materials returned by NASA missions are NASA property (see NPD 7100.10F, *Curation of Institutional Scientific Collections*, in the Program Library). They must be delivered to, and processed by, the NASA Astromaterials Acquisition and Curation Office located at NASA's Johnson Space Center (JSC); contact Dr. Francis McCubbin, Astromaterials Curator (Telephone: 281-483-5126; e-mail: jsc-astromaterials-curator@mail.nasa.gov; 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, must be borne by the mission from inception to two years following sample return.

Requirement 16. Proposals that include the return of extraterrestrial samples shall provide a draft Sample Curation Plan. See Appendix B, Section J.7, for details. Note that a final and complete Sample Curation Plan – including (i.) the methods used to prevent sample contamination or degradation during collection and return to Earth and (ii.) the general

procedures for storage, subsampling, documentation, distribution, and security – will be required in the Phase A concept study.

Requirement 17. Proposals that include the return of extraterrestrial samples shall allocate funding for use of the JSC Curatorial Facility, including all aspects of curation.

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 Acquisition and Curation Office. 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.

Requirement 18. Proposals that include the return of extraterrestrial samples shall specify the terms and conditions of selection of a sample fraction no greater than 25% for transmission to the contributing country, if 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.

Curation of Space-Exposed Hardware

It is NASA policy 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 Acquisition and Curation Office 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 NASA Astromaterials Acquisition and Curation Office. 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, must be borne by the mission from inception to two years following sample return.

Requirement 19. Proposals that include the return of space-exposed hardware shall include the curation of this hardware in their draft Sample Curation Plan. See Appendix B, Section J.7, for details. Note that a final and complete Sample Curation Plan – including (i.) the methods used to prevent hardware contamination or degradation during return to Earth and (ii.) the general procedures for storage, sampling, documentation, distribution, and security – will be required in the Phase A concept study.

Requirement 20. Proposals that include the return of space-exposed hardware shall allocate funding for use of the NASA Astromaterials Acquisition and Curation Office to document, store and distribute hardware samples, including all aspects of curation.

5.1.6 Science Enhancement Option

Activities such as extended missions, guest investigator programs, participating scientist programs, interdisciplinary scientist programs, and/or archival data analysis programs, where appropriate, have the potential to broaden the scientific impact of investigations. These and other optional activities *may* be proposed as Science Enhancement Options (SEOs). Flight hardware *may not* be proposed as SEOs, but may be proposed as a Technology Demonstration Opportunity (TDO) (see Section 5.9.5) and/or Student Collaboration (see Section 5.5.3).

NASA considers any proposed SEO activities as optional. Inclusion of SEO activities in a proposal and a concept study report does not imply a commitment from NASA to fund them, even if the baseline investigation is selected. SEO activities need only to be described in proposals if they are atypical (*e.g.,* a guest investigator program that is envisioned to be significantly larger than the historical norm). 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, archival data analysts, and participating scientists) in such programs.

Costs for proposed SEO activities must be defined in Step-1 proposals, 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 baseline investigation, the science enabled by SEO activities is not considered as part of the scientific merit of the proposed investigation.

Requirement 21. If SEO activities are proposed, the proposal shall define and describe the proposed activities and their costs.

Requirement 22. If SEO activities are proposed, they shall be clearly separable from the Baseline Science Mission and Threshold Science Mission investigations.

Requirement 23. 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.

5.2 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, 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 24. Proposals submitted in response to this AO shall be for complete science investigations requiring a spaceflight mission.

Requirement 25. Proposals shall describe the proposed mission architecture and the rationale for each mission element.

Requirement 26. Proposals shall describe the proposed mission design and mission operations concept.

Requirement 27. Proposals shall describe the proposed flight system concept, including the spacecraft bus and its major subsystems.

Requirement 28. Proposals shall describe the development approach for implementing the proposed mission within schedule and cost constraints, including a project schedule covering Phases A-F.

See Appendix B, Section F, for additional detail.

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

Most NASA observations from space require stringent and well-defined calibration and validation plans. NASA expects each proposal to fully describe the requirements for calibration and validation. If some required validation data are not to be funded directly by the selected PI-led investigation, the proposal should provide information about the commitment to funding for those data in the time frame of five to ten years after selection of the investigation and describe the implications to meeting the requirements if such data do not become available.

Requirement 29. Each proposal shall fully describe the requirements for calibration and validation. If some required validation data are not to be funded directly by the selected PI-led investigation, the proposal shall provide information about the expectations for available calibration and validation instruments and/or data in the time frame of five to ten years after selection of the investigation and describe the implications to meeting the requirements if such activities do not become available.

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. Investigations are generally expected to have mature technologies, with systems at a Technology Readiness Level (TRL) of 6 or higher when proposed. For the purpose of TRL assessment, systems are defined as level 3 WBS payload developments (***i.e.***, individual instruments) and level 3 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 6 (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.

NASA Technology Infusion: Technology infusion is not offered as an opportunity through this AO.

Technology Demonstration Opportunities (TDOs): Section 5.9.5 of this AO provides guidelines for demonstration of technologies. TDOs are not a critical element that mission objectives depend on, and they shall not pose any risk to achieving IMAP baseline or threshold mission success. If the proposal includes a TDO, it is required that the proposal includes a maturation plan, and a plan for the demonstration of these technologies.

Requirement 33. Proposals that use systems currently at less than TRL 6 shall include a plan for system maturation to TRL 6 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). TDOs (see Section 5.9.5) are exempt from the requirement to mature systems to TRL 6 by PDR.

5.2.4 Environmental Compliance

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 to integrate environmental considerations into agency decisions before taking action. NASA actions include all programs or projects that are financed (even partially), assisted, conducted, regulated, approved or permitted by NASA.

NASA complies with the NEPA by following Council on Environmental Quality (CEQ) and internal agency regulations. NASA policy requires the preparation of an Environmental Management Plan to ensure the NEPA process is completed during the preliminary design and technology development phase of a mission. When responding to an announcement, proposers must include NEPA cost and schedule needs into their estimates. Please also note that proposers of missions conducted outside the U.S. must comply with Executive Order 12114 (*Environmental Effects Abroad of Major Federal Actions*).

Depending on the complexity of a proposal, the NEPA process will require preparation of one of three levels of NEPA documentation:

(1) Record of Environmental Consideration (REC) Routine Payloads;
(2) Environmental Assessment (EA); or
(3) Environmental Impact Statement (EIS).

As of 2011, NASA updated the NASA Routine Payloads EA that provides NEPA coverage for commonly used launch locations and expendable launch vehicles. The EA provides a checklist (available at www.nasa.gov/agency/nepa/NRPchecklist) that enables NASA to determine if a proposed mission can be considered “routine" based on the planned launch location, launch vehicle and envelope payload characteristics. If so, then a REC is prepared that describes the planned mission and includes the completed checklist to provide NEPA compliance. If the checklist reveals that the planned mission does not constitute a “routine” payload, then a mission-specific EA or EIS will be required. An EIS is typically required for payloads that use radioisotope power systems (RPS) and may be required for payloads that use radioisotope heater units (RHUs).

Depending upon the complexity of analysis required, NEPA documentation requiring an EA or EIS can be resource intensive. Contractor costs for an EA are often in the $150-200k range and can require one year to complete. Typical cost estimates to prepare an EIS involving a RPS or RHUs can reach $1M+ and can take more than one year to complete. NEPA compliance costs must be reflected as reductions to the AO Cost Cap and major NEPA milestones must be included in the proposed schedule.

This AO allows for investigations to baseline use of radiological sources for science instrumentation. No radioactive material may be used for supplemental power or heating.

The proposed use of radioactive materials of any quantity and any isotope, including radioactive sources for science instruments, will require review for environmental impact and Nuclear Launch Safety Approval (NLSA). The environmental review requirements flow from NEPA and are specified in NPR 8580.1, *Implementing the National Environmental Policy Act and Executive Order* 12114. 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 consists of concurrence from the NASA Office of Safety and Mission Assurance for low-level radioactive sources (***i.e.,*** with an A2 mission multiple less than 10, as defined in NPR 8715.3C, Chapter 6 and Appendix D).

Please contact the NASA NEPA Manager, by phone or e-mail if you have questions concerning NASA environmental compliance requirements. The NASA NEPA Manager phone or e-mail may be found at http://www.nasa.gov/agency/nepa/NEPATeam.html.

Requirement 34. If use of radioactive materials is proposed (***e.g.***, for radiological sources or other operational purposes), 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, nonradioactive alternatives if possible. The costs of environmental review and launch approval shall be reflected as reductions to the AO Cost Cap. 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.

A cost estimation algorithm for the DSN and persons to contact to obtain costs for other networks and various Government operated facilities are contained in the *NASA's Mission Operations and Communications Services* document or at the DSN Future Missions Planning Office website at http://deepspace.jpl.nasa.gov/advmiss/. For assistance with the cost calculation, contact the persons named on the website. Proposers to this AO 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 35. 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.

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 IMAP mission. It is SMD policy that none of the DSN 70 meter antennas may be proposed to support normal operations of the selected IMAP 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 space missions to the use of Ka-band for science data return (telemetry, tracking, and commanding (TT&C) data may still be transmitted using X-band or S-Band). In order to better manage the Agency's transition to Ka-band service, proposed investigations are required to baseline the use of Ka-band for science data return, unless it is inappropriate.

Radio frequency spectrum for telecommunications is allocated by service (*e.g.*, Earth Exploration-Satellite, Space Research, and Space Research (Deep Space)) and may be further constrained by maximum channel bandwidth limits (see the *Available Spectrum and Channel Limits By Allocated Service* document in the Program Library). Proposals are required to address conformance to applicable maximum channel bandwidth limit(s).

Requirement 36. 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 37. 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 shall include an estimate of the additional costs for these capabilities and capacities.

Requirement 38. Proposals shall baseline the use of Ka-band for science data return, unless it is inappropriate for the proposed investigation; proposal of an alternative communications approach shall be justified.

Requirement 39. Proposals shall address conformance to applicable maximum channel bandwidth limit(s).

Requirement 40. Proposals that propose the use of the DSN shall baseline the use of only one DSN 34 meter at any time for normal operations (not including periods of station hand-off emergencies, Delta-Differential One-Way Ranging 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 41. 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 Orbital Debris Assessment and End-of-Mission Spacecraft Disposal Requirement

NPR 8715.6B, *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.

Requirement 42. As applicable for Earth and Moon orbiters, proposals shall demonstrate satisfaction of requirements to limit the generation of orbital debris during mission operations and the disposal per NPR 8715.6B and NASA-STD-8719.14A (see Appendix B, Section J.8, 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, Heliophysics missions of a class and complexity of this AO have been determined to be Category 2 missions (per NPR 7120.5E) with Class B or Class C payloads (per NPR 8705.4).

Requirement 43. 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

Solar Terrestrial Probes missions are required to meet the requirements for safety, reliability, and mission assurance in the Explorers & Heliophysics Projects Division Mission Assurance Requirements document (see Program Library).

Requirement 44. Proposals shall indicate any expected deviations from the recommended requirements in the Explorers & Heliophysics Projects Division Mission Assurance Requirements document and in Appendix C of NPR 8705.4 for the proposed payload class.

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 http://ammos.jpl.nasa.gov/). AMMOS may be proposed, as appropriate. 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. Only mission-unique adaptations to the AMMOS must be funded by missions. Use of applicable AMMOS tools is expected, although not required. Points of contact and cost information for these services may be found on the AMMOS website specified above.

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 45. If a ground/operations system solution other than the AMMOS or mission-unique adaptations to the AMMOS is proposed, it shall be described and budgeted for in the proposal.

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, however is 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 46. 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 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 47. 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 48. 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 and PM and PSE Roles

Requirement 49. Proposals shall clearly define the respective roles of the PI, PM, and PSE.

5.3.5 Management and Organization Experience and Expertise

The qualifications and experience of the PI, PM, PSE, Project Scientist (PS) (if named), Project Manager Alternate (if named), and other key 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's 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, prior experience, and time commitment of the key members of the PI-led investigation team and of the implementing institutions will be assessed against the needs of the investigation.

Requirement 50. Proposals shall identify the management positions that will be filled by key management 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 (including the PI, PM, AND PSE per Requirement 46, Requirement 47, and Requirement 48), proposals shall describe the qualifications and experience of those team members who occupy those positions. For key 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. The time commitment of each Key Management Team member shall be provided by mission phase.

Requirement 51. 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; any nontrivial modifications or upgrades of existing technologies; 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 52. Proposals shall define and discuss the major risks to the formulation and implementation of the proposed investigation.

Requirement 53. 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 descope the mission. Any set of de-scopes, which still allows the investigation to satisfy the objectives of the Threshold Science Mission, may be proposed.

Requirement 54. If the proposed risk management approach includes potential de-scoping 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, the decision milestone(s) for implementing descopes, and the scientific impact of individual, as well as combined, de-scopes.

Requirement 55. 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).

Requirement 56. 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.10, for additional detail).

5.4 Science Team, Co-Investigators, and Collaborators

5.4.1 Science Team

Requirement 57. 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 58. 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 59. Proposals shall identify the funding source for each Co-I. If funded by the Solar Terrestrial Probes Program, 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 60. Proposals shall identify and designate all collaborators, and describe the role of each collaborator in the development of the mission.

Requirement 61. Proposals shall identify the funding source for each collaborator; the costs shall be included in the Total Mission Cost.

5.5 Small Business Participation and Education Program Plan

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 $700k, 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.

Proposals are *not* required to include small business subcontracting plans, however 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.

In case NASA chooses the two-step process, 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 (down-select) 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 Program Plan and Communications and Outreach 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, Education Program plans are not needed at this time. NASA may impose Education Program requirements during or subsequent to the Phase A concept study phase, and will negotiate any additional funding necessary to meet these requirements.

A Communications and Outreach Program (previously referred as Public Outreach program), is required. Mission-related communications will be negotiated and funded directly through a NASA Center. The communications plan must be developed during Phase B of the mission. The plan must include topline messaging, target audiences, and media processes linked to reaching target audiences and associated detailed budgets, milestones, metrics and timelines, and reporting requirements.

5.5.3 Student Collaborations

Proposals are *required* to define a Student Collaboration (SC) that is a separate part of the proposed investigation.

PI-led missions potentially provide active research opportunities for aspiring undergraduate (as well as advanced high school and, on an exceptional basis graduate) students. SCs may involve students in multiple phases of a mission spanning scientific formulation; mission planning; systems engineering; design and development of flight hardware; qualification, test and integration; and mission operations and data analysis.

An ideal SC provides a hands-on experience for students that focuses on the unique demands of instrument development, flight systems, environments, and operations, and on the opportunity to acquire early knowledge of systems engineering techniques. SC provides the opportunity for authentic, real-world experiences that span development through the operational phases of a mission. Undergraduate SC is a priority because it is at this critical junction that individuals, including from groups traditionally underrepresented or underserved in STEM, make decisions to pursue and persist in degrees that will provide the skills required by the future space science workforce.

SC funds may be requested to purchase special equipment, modify equipment, or provide services required specifically for the work to be undertaken. For example, funds may be requested to provide prosthetic devices to manipulate a particular apparatus; equipment to convert sound to visual signals, or vice versa, for a particular experiment; access to a special site or to a mode of transportation (rental services only – no vehicle purchases permitted); a reader or interpreter with special technical competence related to the project; or other special-purpose equipment or assistance needed to conduct a particular project.

SC enhances, but does not reform or redesign individual undergraduate or graduate courses or degree requirements. SC is not a form of teaching or research assistantship. SC must not be proposed to provide whole year or multi-year tuition and stipends normally provided by scholarships or fellowships. SC may be proposed to include the cost of incentives, stipends, travel, equipment or services, etc. designed to enable a student to successfully participate in Research and Development (R&D). Students supported on SC are not *interns*, they are *associates* who work jointly on the proposed real R&D while receiving appropriate mentoring and other support.

If a proposed investigation is selected, NASA retains the option to fund or not to fund any proposed SC in full or in part. 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 SC incentive, will be outside of the PI-Managed Mission Cost. If the SC costs NASA more than the SC incentive, then the rest of the NASA cost of the SC must be within the PI-Managed Mission Cost. SC resources, as an addition to a mission's implementation, are not available to solve mission cost overrun issues. SC provides no cost-savings to a NASA mission.

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, or at the end of Phase A in case NASA chooses a one-step selection; see SMD Student Collaboration document in the Program Library. The three SC review criteria are:

- *Quality, Scope, Realism, and Appropriateness*. Student level and the project's SC research objectives are both clearly defined. SC mentors and supervisors are identified and have clear lines of responsibilities. A description of what constitutes, to the proposer, a successful SC effort.
- *Diversity*. SC participant recruitment and retention (R&R) practices or proposed inclusion strategies are described. Proposed R&R likely to reach disadvantaged individuals and/or those from groups underrepresented in STEM.
- *Evaluation*. The SC has proposed evaluation methodology based on techniques appropriate to the SC activities proposed. The evaluative processes will document outputs and intended outcomes and use metrics to demonstrate progress or explain the lack of achievement by the SC component.

To address the merit evaluation, SC proposals will be required to include appropriate plans and budgets for evaluation, participant recruitment and retention, mentoring and oversight of students to maximize their learning and describe R&D conduct, particularly design and development of

flight systems; assembly, integration and test; and mission operations and data analysis that enhances without interference the mission's success.

Requirement 62. The proposal shall include a student collaboration and 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 increase the mission development risk; 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, for additional detail).

Requirement 63. 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 PI-Managed Mission Cost, including all mission phases, excluding the cost of standard launch services (Section 5.9.3), is capped at the AO Cost Cap of $492M FY17 dollars.

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).

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

Requirement 66. No more than 25% of the PI-Managed Mission Cost shall be incurred prior to KDP C (Confirmation).

5.6.2 Cost of the Phase A Concept Study

If proposers are selected through a two-step process, they will be awarded a contract to conduct a Phase A concept study with a duration of approximately 12 months following the establishment of initial contracts. The cost of the Phase A concept study is capped at $2.5M in FY17 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; the cost shall be included within the PI-Managed Mission Cost, and shall not exceed $2.5M in FY17 dollars.

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

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.

5.6.3 Cost Estimating Methodologies and Cost Reserve Management

As the provision of 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 is likely to be enhanced by the application of methodologies that are typically employed for mature projects.

Requirement 69. Proposals shall identify the methodologies (cost models, cost estimating relationships of analogous missions, etc.) and 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.

Proposals that are unable to show adequate unencumbered cost reserves are likely to be judged a high 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. The calculation for Phases E/F is separate but uses the same methodology.

Adequate unencumbered cost reserves must be demonstrated at each of the following milestones: KDP A (demonstrated in the proposal), KDP B (if applicable, demonstrated in the Phase A Concept Study Report), KDP C (the independent cost estimate for Confirmation), KDP D (at the end of Phase C), KDP E (generally 30 days before launch), and KDP F (at the end of Phase E).

Requirement 71. Proposals shall identify and justify the adequacy of the proposed cost reserves. Proposals shall include a minimum of 25% of unencumbered cost reserves against the cost to complete Phases A/B/C/D and shall demonstrate an approach to maintaining required unencumbered cost reserves through subsequent development phases.

Requirement 72. Although minimum unencumbered cost reserves are not specified in this AO for Phases E or F, proposals shall establish, identify and justify adequate reserves for these phases of the mission.

5.6.4 Work Breakdown Structure

Requirement 73. Proposals shall provide a Work Breakdown Structure (WBS) that conforms to the standard prescribed in Appendix G of 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

Requirement 74. 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.11, 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 PI-Managed Mission Cost, 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 are to use an identical CM&O burden rate of $45K (Fiscal Year 2017) 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 2017 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).

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

	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

Requirement 75. 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 76. 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 77. 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 the Solar Terrestrial Probes Program and other SMD programs 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).

A contribution does not alleviate the responsibility of the PI and management team to exert penetrating and timely oversight on the development, delivery, and performance of the contribution. The PI remains accountable to NASA for the success of the entire investigation, including contributions, with full responsibility for its scientific integrity and for its execution within committed cost and schedule (Section 5.3.1).

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). If Government Furnished Equipment (GFE) is being contributed, then permission must be obtained from the appropriate Agency or Program; the permission must be included in the Letter of Commitment.

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 selection of the investigation. 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 78. 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 separately identified within the Total Mission Cost.

Requirement 79. 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.

Letters of Commitment are required from each organization responsible for a contribution (for U.S. organizations, see Section 5.8.1.1 and Requirement 88; for non-U.S. contributing organizations, see Section 5.7.2, Section 5.8.1, and Requirement 82).

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 5.8.2 and Requirement 90.

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, de-scoping 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 80. 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) with some restrictions (see Section 4.2.2).

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, whether as primary proposers or as participants in U.S. research efforts, 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.

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.

Requirement 81. 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.

Requirement 82. 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 0. In addition to these required elements, endorsements from foreign entities shall indicate that the proposal merits careful consideration by NASA and that, if the proposal is selected, sufficient funds will be made available to undertake the proposed activity. Officials who are authorized to commit the resources of the non-U.S. funding agencies shall 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 83. 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 shall be explicitly acknowledged and the rationale for accepting the unmitigated or residual risk shall be explicitly stated.

Mitigation may include, but is not limited to, de-scoping the contributed items and/or holding reserves to develop the contribution directly. Note that reserves held for this purpose should be weighted by likelihood and 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 down-select 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 81). 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 84. To the maximum extent practical, and allowing for any AO-specified exemptions (*e.g.,* Requirement 81) any proposed non-U.S. contribution shall be described at the same level of detail as those of U.S. partners.

Requirement 85. 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 any non-U.S. participation 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 shall 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 an exploded diagram. 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. In some cases, interim agreements may be put in place, after the conclusion of Phase A, until a more permanent arrangement is reached.

Requirement 86. 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 87. 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 Institutional 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.

5.8.1.1 Institutional Letters of Commitment for Contributions

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).

Requirement 88. 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 82.

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).

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.

Requirement 89. 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.

5.8.2 Personal Letters of Commitment

No Personal Letters 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's effort is contributed, the individual is part of the Proposal Team, and the individual is not a collaborator. The Proposal Team is defined to include, but not be limited to, all members of the Key Management Team, any Co-I who is not part of the Key Management Team, and any collaborator 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 more information). If applicable, requirements to provide personal and institutional Letters of Commitment in concept study reports are given in the *Guidelines and Criteria for the Phase A Concept Study* document (available in the Program Library).

Requirement 90. 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. By committing, Proposal Team members are certifying that their linked organization in NSPIRES is correct, for the purposes of the proposal.

5.8.3 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. Consideration must also be given to the Export Administration Regulations (EAR), 15 CFR Parts 730-774, issued by the United States Department of Commerce, Bureau of Industry and Security (BIS) under laws relating to the control of certain exports, re-exports, and activities.

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 of the U.S.) to review proposals submitted in response to this AO. In order to enable proper evaluation of proposals, any export-controlled information subject to ITAR or EAR must be marked with a notice to that effect.

Requirement 91. 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 numbers, section, and paragraph numbers, or other identification] 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."**

Note that it is the proposer's responsibility to determine whether any proposal information is subject to the provisions of ITAR or EAR. 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 and its location in the proposal marked as specified in Requirement 91.

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.

5.8.4 Classified Materials

Requirement 92. 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.

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 to include marking and declassification information and must comply with the applicable Security Classification Guide (SCG) or similar document.

When a proposer submits a classified appendix regarding heritage in addition to a complete proposal, the evaluation process (Section 7.1.1) will be supplemented. At least one evaluator with appropriate clearance and relevant expertise will review the classified appendix regarding heritage; this evaluator may be a member of the evaluation panel or this evaluator 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 as input for assessing the Technical, Management, and Cost (TMC) Feasibility of the Proposed 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. 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 delivery 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 93. 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 deadline for receipt for the CD-ROM in Section 3. 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 point-of-contact for the AO (Section 6.1.5) must be notified of the intent to submit a classified appendix regarding heritage, the level of classification to aid in receipt of the information, and any interest in submittal via a classified e-mail system in lieu of physical delivery.

The requirements on content, format, and length 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.12, 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: Mr. Paul Raudenbush, Chief, NASA Headquarters Security Office, 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 deadline for receipt of the classified appendix is the same as that for the CD-ROM in Section 3. The Heritage Appendix should indicate that a classified appendix has been submitted.

5.9 Program Specific Requirements and Constraints

5.9.1 Commitment for Allowing NASA to Execute the Single-Step Selection Option

For a single-step selection, unless otherwise stated in the selection letter, the selected PI managed mission cost will be set at the proposed PI managed mission cost plus any selected enhanced mission cost.

Requirement 94. Each proposal shall include a commitment by the PI for the cost, schedule, and scientific performance of the investigation.

5.9.2 Schedule Requirements

Requirement 95. Proposals shall propose a launch readiness date no later than December 2024.

5.9.3 Launch Services

The IMAP 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 2 or 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. There will nominally 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.

Co-manifested or secondary payloads on a U.S. or non-U.S. launch vehicle may not be proposed or considered under this AO, unless they are proposed in conjunction with the PI-proposed primary payload.

Requirement 96. Proposals shall define the required launch vehicle capability and demonstrate that the mission is compatible with the specified launch services.

Requirement 97. If nonstandard services not specified in *ELV Launch Services Information Summary* 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 must be funded out of the PI-Managed Mission Cost and, therefore, represent a cost threat to the PI-Managed Mission Cost that should be considered as a top risk.

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 vehicle procurement. Accordingly, proposers are advised to plan for compatibility with the enveloping launch vehicle characteristics and capabilities provided in the *ELV Launch Services Information Summary* in the Program Library.

Requirement 98. Proposals shall discuss compatibility with the enveloping launch vehicle characteristics and capabilities.

5.9.4 Incentive for Real-Time Observations

The *2013 National Academy Decadal Survey for Solar and Space Physics – A Science for a Technological Society* recognizes that the routine provision of space weather data from Heliophysics science missions is invaluable to the research and operational communities. NASA successfully provided, at marginal cost, a subset of observations in real time from a number of past and current operating missions, including ISEE-3, ACE, STEREO, SDO, and Van Allen Probes. Such real-time data offers the opportunity to:

1) Boost understanding of the science of space weather;
2) Test new space weather forecasting techniques driven for the first time by real-time observations that have so far not been available and that could, if successful, be transitioned for operational use;

3) Refine and improve skill scores of existing techniques; and
4) Make progress in understanding of the Heliophysics system more quantifiable over time through forecasting metrics.

In particular, the *Decadal Survey* recommends the IMAP mission for such a capability. Therefore, NASA offers – independent from the proposed mission architecture – the IMAP – Active Link Incentive for Real-Time (I-ALIRT) to PIs. I-ALIRT supports the identification and continuous downlink to Earth of near real time relevant observational IMAP data that can be utilized to forecast or nowcast space weather phenomena. In particular, the provision in near real time of space weather prediction data products would be of utility to NASA and other space environment effect prediction communities.

There is no minimum and no maximum allowable cost for I-ALIRT. NASA provides an I-ALIRT incentive of up to $3.0M (FY17), which includes support for development of hardware and software for use onboard the IMAP spacecraft that enables the downlink of real-time data to receiving stations on the ground. A proposal that pursues I-ALIRT should identify a list of products that the PI will be responsible to make publicly available via the spacecraft real-time transmitter, and the estimated on-board latency of the broadcast with respect to acquisition of the data for each product. The proposal should also develop a plan to provide a uniform format for real-time data products and standards for analysis software, and include those costs.

I-ALIRT does not provide funds for the operations of ground stations, but a list of ground stations with the necessary capabilities compatible with the proposed implementation of I-ALIRT should be identified in the proposal.

The proposed NASA cost of the capability, up to the I-ALIRT incentive, is outside of the PI-Managed Mission Cost Cap. If the capability costs NASA more than the I-ALIRT incentive, then the rest of the NASA cost of the capability must be within the PI-Managed Mission Cost Cap.

If I-ALIRT is proposed, the scientific value (Factor A-6), implementation merit (Factor B-7), and the TMC feasibility (Factor C) will be evaluated independent of the Baseline and Threshold missions, except for impact to the mission. If NASA selects the proposed mission, NASA may or may not choose to select I-ALIRT.

Requirement 99. If I-ALIRT activities are proposed, the proposal shall define and describe the proposed activities and their costs. The I-ALIRT section shall not exceed five pages in length.

5.9.5 Technology Demonstration Opportunity

As part of a new emphasis on innovation, NASA is encouraging the introduction of new technologies for selected mission opportunities. The goal of this effort is to provide a pathway for new capabilities to be introduced such that future investigations with enhanced scientific return may be realized. A Technology Demonstration Opportunity (TDO) may have a TRL of less than 6 when proposed, but must not be required by either the Baseline or the Threshold Science Mission. Proposers may choose to define a TDO that may be an 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 Heliophysics missions. The constraints on the proposed TDOs are that they may not include the demonstration of a radioisotope power system, that they may not be proposed in conjunction with the ESPA ring through this AO, and that they must be clearly separable from the proposed 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. Encouraged is the demonstration of technologies that have received or currently are receiving support from NASA/SMD instrument and technology development programs, including but not limited to, the Heliophysics Technology and Instrument Development for Science (H-TIDeS) Program, and its predecessors, the Solar & Heliospheric Physics and the Geospace Supporting Research & Technology (SR&T) programs. Information on and links to current and past abstracts of funded projects from Heliophysics instrument and technology development programs can be found in the Heliophysics Technology Demonstration Opportunities document in the IMAP Document Library.

There is no minimum and no maximum allowable cost for a TDO. NASA is providing a TDO incentive of up to $5.0M (FY17). Contributions to the TDO are permitted. The proposed NASA cost of the TDO, up to the TDO incentive, may be outside of the PI-Managed Mission Cost. If the TDO costs NASA more than the TDO incentive, then the rest of the NASA cost of the TDO must be within the PI-Managed Mission Cost.

If a TDO is proposed, the Scientific Merit (Factor A-6), Implementation Merit (Factor B-7), and the TMC Feasibility (Factor C) will be evaluated independent of the Baseline and Threshold Missions, except for separability from and impact to the mission. If NASA selects the proposed mission, NASA may or may not choose to select the TDO.

Requirement 100. If TDO activities are proposed, the proposal shall define and describe the proposed activities and their costs.

Requirement 101. If TDO activities are proposed, they shall be clearly separable from the Baseline Science Mission and Threshold Science Mission investigations.

Requirement 102. This section, which shall not exceed five pages in length, shall describe any proposed utilization of technology with the purpose of technology demonstration for future Heliophysics missions. 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 technology, as well as their understanding of inherent risks associated with its use.

2) Description of technology demonstration implementation plan with respect to utilization of the chosen 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 technology in the proposed investigation, including description of how this technology could enhance the proposed investigation's science return and/or that of future Heliophysics missions.

4) Description of how the offeror would engage with the NASA STP program offices' 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 technology.

5.9.6 Program Infrastructure Requirements and Opportunities

Taking advantage of the expected launch vehicle capability, the Heliophysics Division plans on providing an ESPA ring as a ride-along with the IMAP launch that will aid addressing Heliophysics science objectives and will serve the needs of SMD-wide technology demonstration. However, usage of the ESPA ring is not solicited through this AO, but through a Technology Demonstration Mission of Opportunity that will be released by the end of calendar year 2017. IMAP proposals submitted through this AO must not depend on use of the ESPA ring.

6. Proposal Submission Information

6.1 Preproposal Activities

6.1.1 Pre-proposal Conference

A Pre-proposal Conference will be held via web/teleconference, in accordance with the schedule in Section 3. Further information will be available at the IMAP 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.

The purpose of this Conference will be to address questions about the proposal process for this AO. Questions should be sent to the IMAP 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 Pre-proposal Conference, including answers to all questions addressed at the conference, will be posted on the IMAP 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 Required Notification Proposal

To facilitate planning of the proposal evaluation, in particular to avoid conflicts in the peer review process, and to inform prospective proposers of any changes to this AO, NASA *requires* all prospective proposers to submit a Notification proposal through the Authorized Organizational Representative (AOR) of the PI institution. The Notification proposal submission requires the confirmation in NSPIRES of all identified team members as explained in Appendix B, Section A.3. The Notification Proposal replaces the Notice of Intent for this AO.

Notification Proposals are due by 11:59 pm Eastern Time on the date given in Section 3 of this AO. Full proposals will not be accepted without prior submission of a Notification Proposal. Those who submitted Notification Proposals will be informed via NSPIRES no later than four weeks before the Full (Step-1) Proposal due date that they are invited to submit a Full Proposal.

A Notification Proposal is submitted electronically at http://nspires.nasaprs.com/. Registration on the NSPIRES website is required for all identified team members, and the proposing organization, to submit the Notification Proposal. Proposers who experience difficulty in using the NSPIRES site should contact the Help Desk by e-mail at nspires-help@nasaprs.com for assistance.

Material in a Notification Proposal is deemed confidential and will be used for NASA planning purposes only. The following information is required content for the Notification Proposal:

(a) Name, address, telephone number, e-mail address, and institutional association(s) of the PI, Project Manager and Project System Engineer.

(b) Full names and institutional associations of each additional Proposal Team member, and their role such as Co-Investigator, Collaborator or Consultant. 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 Notification Proposal.

(c) A brief statement (4000 characters or less) covering the following:
   - (i) science objectives of the proposed mission;
   - (ii) general design or architecture of the mission;
   - (iii) instruments that may be included in the payload;
   - (iv) identification of new technologies that may be employed as part of the mission.

(d) 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.

Additional questions will require a yes/no answer in the program specific data section:

(a) whether or not radioactive sources will be proposed as part of the mission;

(b) whether or not use of the I-ALIRT incentive from Section 5.9.4 will be proposed as part of the mission;

(c) whether a technology demonstration from Section 5.9.5 will be proposed as part of the mission.

Budget data will not be requested as part of the Notification Proposal.

The science objectives of the proposed mission, and investigators cannot be changed between submissions of the Notification and the Full proposals. The Notification Proposal is a prerequisite for submission of a Full Proposal, but it does not commit the offerors to submit a Full Proposal later.

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 IMAP Teaming Interest page of the IMAP Acquisition Homepage (see address given in Section 6.1.4) have expressed interest in teaming with other organizations on IMAP 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 Acquisition Home Page and Program Library

An IMAP Acquisition Homepage, available at https://soma.larc.nasa.gov/STP/IMAP/, will provide updates and any AO addenda during the IMAP 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 IMAP Program Library provides additional regulations, policies, and background information on the Solar Terrestrial Probes Program. Information on the Program Library is contained in Appendix D. The Program Library is described in Appendix D and is accessible at https://soma.larc.nasa.gov/STP/IMAP/imap-program-library.html.

Updates to the AO and any amendments will be posted on the NSPIRES website and will be announced by e-mail to all subscribers to the SMD general information list in NSPIRES. For other updates proposing teams should check the NSPIRES website periodically. A link will be provided on the IMAP 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 IMAP Program Scientist:

Dr. Arik Posner
Heliophysics Division
Science Mission Directorate
National Aeronautics and Space Administration
Washington, DC 20546-0001
Telephone: 202-358-0727
E-mail: arik.posner@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 103. 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 104. 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 http://nspires.nasaprs.com/. This data site is secure and all information entered is strictly for NASA's use only. The proposal submittal deadlines are specified in Section 3.

Requirement 105. In addition to electronic submission, two identical, clearly labeled CD-ROMs that contain electronic Step-1 (full) 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.

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

Telephone for commercial delivery: 202-479-9030

NSPIRES will notify proposers virtually immediately upon successful submission of the electronic proposal. NASA will notify proposers that their CD-ROMs have been received within two weeks of the submittal. Proposers who have not received this confirmation within two weeks after submittal of their proposals should contact the IMAP 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 System for Award Management (SAM).

Requirement 106. The proposing organization and all individuals named as Proposal Team members on the Electronic Cover Page shall be registered in NSPIRES.

Requirement 107. All Proposal Team members must indicate their commitment to the proposed investigation through NSPIRES (see Requirement 90).

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 Step-1 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). Panel members will be instructed to evaluate every proposal independently without comparison to other proposals. These panels may be augmented through the solicitation of non-panel (mail in) reviews, which the panels have the right to accept in whole or in part, or to reject. Proposal Evaluation Plans will be/were posted upon the release of the final version of this AO.

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 Scientific Merit (see Section 7.2.2), Scientific Implementation Merit and Feasibility (see Section 7.2.3), and TMC Feasibility of the Proposed Mission Implementation (see Section 7.2.4), NASA will request clarification on specific, potential major weaknesses in Scientific Merit, Scientific Implementation Merit and Feasibility, and TMC Feasibility of the Proposed 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 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 a Categorization 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 Committee 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.

NASA will convene a Steering Committee, composed wholly of Civil Servants and Intergovernmental Personnel Act appointees (some of whom may be from Government agencies other than NASA), appointed by the Associate Administrator for the Science Mission Directorate. The Steering Committee will then review the results of the evaluations and categorizations. The 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 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.

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, 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 rating. The adjectival summary rating 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, TMC feasibility, 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.
- Factor A-5. Scientific value of any Science Enhancement Options (SEOs), if proposed. This factor includes assessing the potential of the selected activities to enlarge the impact of the investigation. Although evaluated by the same panel as the balance of Scientific Merit factors, this factor will not be considered in the overall criterion rating.
- Factor A-6. Scientific value of any PI-developed I-ALIRT and Technology Demonstration Opportunities (TDOs), if proposed. This factor includes assessing the potential of the I-ALIRT and TDO to enlarge the impact of the investigation and/or the value to future investigations of demonstrating the selected technology. Although evaluated by the same panel as the balance of Scientific Merit factors, this factor will not be considered in the overall criterion rating.

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, data availability, and data archiving plan and/or sample analysis plan. This factor includes the merit of plans for data analysis and/or sample analysis, data archiving, 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 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 de-scoping 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 and collaborator will be evaluated for necessary contributions to the proposed investigation; the inclusion of Co-Is and/or collaborators who do not have a well-defined and appropriate role may be cause for downgrading during evaluation.
- Factor B-6. Scientific Implementation Merit and Feasibility of any Science Enhancement Options (SEOs), if proposed. This factor includes assessing the appropriateness of the selected activities to enlarge the science impact of the mission and the costing of the selected activities. Although evaluated by the same panel as the balance of Scientific Implementation Merit and Feasibility factors, this factor will not be considered in the overall criterion rating.

- Factor B-7. Scientific Implementation Merit and Feasibility of any PI-developed I-ALIRT and Technology Demonstration Opportunities (TDOs), if proposed. This factor includes assessing the appropriateness of the I-ALIRT and TDO to enlarge the impact of the investigation and/or add value to future investigations. Although evaluated by the same panel as the balance of Scientific Implementation Merit and Feasibility factors, this factor will have no impact on the overall criterion rating.

Student Collaboration proposals will be evaluated only for the impact they have on science implementation feasibility to the extent that they are not separable; Student Collaboration and Technology Demonstration proposals will not be penalized in Step 1 for any inherent higher cost, schedule, or technical risk, as long as the Student Collaboration and Technology Demonstration are shown to be clearly separable from the implementation of the Baseline 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 implementation merit and feasibility of the scientific investigation.

7.2.4 TMC Feasibility of the Proposed Mission Implementation

The technical and management approaches of all submitted investigations, including I-ALIIRT and TDO if 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 for the Baseline Mission, plans for advanced engineering developments, and 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 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, 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.
- 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 de-scoping of mission capabilities will be assessed against the potential science impact to 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 and 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 Factor C evaluation will not consider I-ALIRT or TDO to be part of the Baseline Science Mission implementation. However, a separate evaluation of the feasibility of the proposed I-ALIRT and TDO implementation will be performed. The TDO has to be shown to be clearly separable from the implementation of the Baseline Science Mission.

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 these provisions in the preparation or processing of proposed instruments, the development of the flight system, in project management, and to proposed costs will be included in the evaluations of Factors C-1, C-3, C-4, and C-5, as appropriate.

Student Collaboration proposals will be evaluated only for the impact they have on overall TMC 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.

Programmatic risks may be assessed but are not included in the TMC risk rating. Examples include but not limited to; Stability and reliability of proposed partners and their contributions, environmental assessment approvals, and late/non-delivery of NASA provided project elements.

This evaluation will result in narrative text, including specific major and minor strengths and weaknesses, as well as an appropriate risk rating for the TMC feasibility of the 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 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, SMD programs are evolving activities that ultimately depend 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 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, or below the AO Cost Cap that would allow a more rapid release of the next AO. Proposers are encouraged to propose 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 selected investigations will be notified by telephone, followed by formal written notification which 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 must 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 single 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, Project Systems Engineer, and Project Resource Control Manager) and the NASA Headquarters Program Scientist and Program Executive (where assigned) is required as soon as practical after proposal selection. Funds to attend the PI-led Team Masters Forum must be budgeted for in the PI-Managed Mission Cost.

7.4.3 Award Administration and Funding

Oversight management responsibilities have been assigned to the Solar Terrestrial Probes Program Office at the Goddard 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, as stated in Section 5.6.2; this award to perform a 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. In order to place Phase A awards, Statements of Work (SOWs), certified cost and pricing data (as applicable), and small business subcontracting plans (as applicable) will be required for Phase A.

Proposals are *not* required to include SOWs, certified cost and pricing data for Phase A and subsequent phases (as applicable), or small business subcontracting plans (as applicable). These will be required *only* for investigations that are selected. If more than one contractual arrangement between NASA and the proposing team is required, a separate SOW will be required for each organization.

For those investigations that are selected, it will be in the best interest of their PI-led mission management teams to provide SOWs, certified cost and pricing data (as applicable), and small business subcontracting plans (as applicable) 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.

For Phase A contracts that exceed $750k (FY17), the contractor will be required to provide certified cost and pricing data to support the Phase A cost estimate, in the format specified in the *Budget Summary, Exhibit A* document posted in the Program Library accessible at the IMAP Document Library, and to execute a Certificate of Current Cost or Pricing Data in accordance with FAR 15.406-2.

Offerors are advised that, by law, for NASA prime contracts resulting from this solicitation which (1) offer subcontracting possibilities, (2) exceed $700k (FY17), and (3) 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 $700k (FY17) 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.

The following paragraph applies only if NASA chooses the option of a two-step selection process.

Each Phase A contract will be amended to include a priced option for a bridge phase, to be exercised upon investigations down-selected to proceed into Phase B. 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 that is chosen during the Step-2 down-selection process to continue beyond the Phase A concept study. The Bridge Phase option will allow the Government to continue work under the contract after a Step-2 down-selection decision is made. The five-month Bridge Phase period will be used to begin the negotiation of the remaining phases of the contract with the successful PI down-selected following Phase A.

7.4.4 Conduct of the Phase A Concept Study

This section applies only if NASA chooses the option of a two-step selection process.

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 the 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 twelve 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 PI-Managed Mission Cost 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 Solar Terrestrial Probe Program's budget. A funding profile for the selected mission will be negotiated during Phase B.

7.4.5 Down-selection of Investigations

This section applies only if NASA chooses the option of a two-step selection process.

The SMD Associate Administrator will make down-selection 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, of the proposed investigation; and
- Quality of plans for small business subcontracting plans, as applicable, and student collaboration.

The evaluation criteria and down-selection factors are described in the *Guidelines and Criteria for the Phase A Concept Study* document in the Program Library. Any substantial changes to science contained in the Phase A Concept Study Report will result in its re-evaluation; if no substantial changes are found to have been made to science, the Step-1 evaluation of the first criterion will be maintained.

Proposers may be asked for specific information at the time of selection for a competitive Phase A. This requested information will need to be included in the Phase A Concept Study Report and will be considered at the time of down-selection for flight.

At the conclusion of Phase A, it is anticipated that the Selecting Official will select a single investigation to proceed into the subsequent phases of mission development for flight and operation. The target date for this continuation decision (*i.e.* "down-selection") is given in Section 3.

Investigations may be down-selected to enter Phase B or may be down-selected 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 down-selected to enter Phase B immediately, the down-select serves as the Key Decision Point (KDP) B; an investigation down-selected for an Extended Phase A must subsequently pass a KDP B with the SMD Program Management Council (PMC) before entering Phase B. There is no guarantee that an investigation down-selected 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, which includes the clause "Advanced Agreement to Add Additional Phases," 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% the agreed to Phase A/B fraction 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. Following Confirmation, no re-phasing between 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*, *Financial Assistance*, will take action to resolve concerns, disagreements, and recommendations submitted by interested parties that cannot be resolved at the Center level, or those having NASA-wide implications, refer Center-specific issues to the appropriate Center Procurement Ombudsman for action, and periodically communicate with Center Procurement Ombudsmen on common

NASA-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 and Grant Policy 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 Solar Terrestrial Probes 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 IMAP investigations in response to this Announcement.

Steven W. Clarke
Director
Heliophysics Division

Dr. Thomas H. Zurbuchen
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

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 cost information in accordance with FAR 15.403-5. Submission of certified cost or pricing data, as defined in FAR 15.403-4, will be required if the Phase A cost, or the combined Phase A and Bridge Phase costs, exceed $750k (FY17). Certified cost or pricing data will also be required for proposals for subsequent mission phases.

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. INTELLECTUAL PROPERTY

a. Patent Rights

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.

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.

b. Rights in Data

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

XII. 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 $700k (FY17), 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 $700k (FY17) 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.

XIII. 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 provides further definition of the proposal requirements in the AO and contains the specific requirements for the format and content of Step-1 proposals. Some AO requirements do not require further definition by an Appendix B requirement, however they must be addressed in the proposal. 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. 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 103.

Requirement B-1. A proposal shall consist of one volume 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 on average over a block of text). 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	As per NSPIRES
	Graphic Cover Page	1
	Export controlled material statement (Section 5.8.3)	0.5
	Optional Restriction on Use statement (see Appendix A, Section V)	0.5
	PI Commitment	1
B	Fact Sheet	2
C	Table of Contents	None
D E	Science Investigation Science Implementation, including optional I-ALIRT, SEO and TDO	25 + 2 pages / additional instrument + 2 pages for SEO ** + 5 pages each for I-ALIRT and/or TDO
F	Mission Implementation Schedule Foldout(s)	25 + 2 pages / additional flight element ** (3 Schedule Foldouts do not count against limit)
G	Management	
H	Cost and Cost Estimating Methodology Cost Table B3a and Table B3b	15 (Cost Table Foldout(s) do(es) not count against limit)
I	Student Collaboration Plan	5
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.6	Planetary Protection Plan	None
J.7	Draft Sample and Space-Exposed Hardware Curation Plan	None
J.8	Discussion of End-of-Mission Spacecraft Disposal Requirements	None
J.10	Compliance with Procurement Regulations by NASA PI Proposals	None

J.11	Master Equipment List (MEL)	None
J.12	Heritage	30
J.13	List of Abbreviations and Acronyms	None
J.14	List of References (optional)	None

** Total extra pages limited to 24 + 5 each for I-ALIRT and/or TDO as described in Requirement B-4; extra pages may be distributed between Sections D-G as desired.

Requirement B-4. Proposals shall conform to the page limits specified in the *Proposal Structure and Page Limits* table. Two extra page(s) each is (are) allotted for each additional separate, non-identical science instrument in the Science Section (Sections D and E), two extra page(s) each is (are) allotted for each additional separate, non-identical flight element (*e.g.,* cruise element, sample return element, additional spacecraft) (*e.g.,* additional spacecraft are allotted two extra pages, but only non-identical spacecraft) in the Mission Implementation and Management Sections (Sections F and G), and two extra page(s) is (are) allotted for all science enhancement options (SEOs) *combined*, if they are permitted by the AO, in the Science Implementation Section (Section E). Different instruments on identical spacecraft buses will-only be allotted extra pages for additional non-identical science instruments; no extra pages will be allotted for additional non-identical flight elements. The total number of such extra pages in the Science and Mission Implementation sections combined shall not exceed a maximum of 24 extra pages +5 for I-ALIRT + 5 for TDO 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-43 and Requirement B-54), 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 and unlocked (e.g., without digital signatures) Adobe Portable Document Format (PDF) file, comprised of the main proposal, all tables (see Requirement B-55 and Requirement B-77), and all applicable proposal appendices (see Section J of this appendix). Images (*e.g.*, figures and scans) shall be converted into machine-encoded text using optical character recognition. Electronic proposals shall be limited to 25 MB in size. Links to other parts of the proposal are permitted, but links to materials outside of the proposal are not. Once submitted, the document uploaded to NSPIRES will be considered the official submission.

Requirement B-6. 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-55 and Requirement B-77), Microsoft Project file of project schedule (see Requirement B-44), and trajectory files (see Requirement B-34). CD-ROMs of proposals may additionally include up to 100 MB, higher resolution but otherwise identical, versions of electronic proposals. In the event of a conflict between versions of electronic proposals, the version specified in Requirement B-5 shall take precedence.

A. PROPOSAL SUMMARY INFORMATION AND GRAPHIC COVER PAGE

A.1. Electronic Proposal.

The following expands requirements in the AO, in particular Requirement 103.

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 document 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; 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).

A.2. Electronic Cover Page (NSPIRES Submission).

The following expands requirements in the AO, in particular Requirement 106.

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, consultant, 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. Such participants are allowed only in minor supporting roles, and only from institutions that are listed already in the cover pages. 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, as 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 funds 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.

A.3. Proposal Team Member Commitment Through NSPIRES.

The following expands requirements in the AO, in particular Requirement 90 and Requirement 106. This section applies to the Notification proposal and the Step-1 proposal.

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 106. 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. 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 103.

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$) and in FY 2017 dollars (FY2017$) from Tables B3a and B3b respectively; and
- The proposed Total Cost, including a breakdown of any contributed costs by contributing organization, in real year dollars (RY$) and in FY 2017 dollars (FY2017$) from Tables B3a and B3b respectively.

C. TABLE OF CONTENTS

The following expands requirements in the AO, in particular Requirement 103.

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 1, Requirement 2, *and Requirement 6 through Requirement 27.*

D.1. Scientific Background, Goals, and Objectives.

Requirement B-15. This section shall describe the goals and objectives of the investigation; upward traceability to a preponderance of the IMAP science objectives as stated in Section 2.4, and to at least one of the *Decadal Survey* goals as stated in Section 2.4; 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.

D.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 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 de-scoping or losses of elements, and facilitate identification of any resulting degradation to the science.

D.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 10 through Requirement 102.

E.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.*, individual instruments), instrument subsystems, instrument components, and sample collection and preservation systems as applicable, 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 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 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, latitudinal and longitudinal resolution, signal-to-noise (S/N) calculations, etc. It shall also discuss environmental effects, such as radiation, temperature, 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.*, ion path).
- Characteristics of relevant instrument components (*e.g.*, listing of size of aperture) in the MEL.

E.2. Data Sufficiency.

Requirement B-21. This section shall discuss the quality and quantity of data delivered and processed by the ground data system.

E.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 shall be included in this discussion.

E.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 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. The data plan shall be in compliance with terms and conditions stated in the *NASA Plan: Increasing Access to the Results of Scientific Research* or a justification shall be provided that this is not necessary given the nature of the work proposed. The data management plan (DMP) (see Section 4.4.1) shall be addressed as part of the Data Plan.

Requirement B-24. The data plan shall describe and define a set of key parameter data that cover the most essential measurements of each scientific instrument at a resolution that is appropriate for intercomparisons with investigations on other Heliophysics system observatory spacecraft. Care shall be taken in defining products that are easy to use by scientists who are not team members. These key parameters shall be delivered to a data archive within 6 months of acquisition.

E.5. Science Team.

Requirement B-25. This section shall identify each member 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 the PI, and each Co-investigator (Co-I) shall be explicitly defined, the necessity of that role shall be justified, and the funding source (NASA or contributor) shall be noted; the role of each collaborator shall be described and the funding source shall be noted.

E.6. Plan for Science Enhancement Options (SEO).

Requirement B-26. If an SEO is proposed, this section shall define and describe the proposed activities (see Section 5.1.6 of this AO).

E.7. Plans for use of the IMAP Active Link Incentive for Real Time (I-ALIRT) and/or a Technology Demonstration Opportunity (TDO).

Requirement B-27. If use of the IMAP Active Link Incentive for Real Time (I-ALIRT) is proposed and/or a Technology Demonstration Opportunity (TDO) is proposed, this section shall define and describe the proposed activities (see Section 5.9.4 and Section 5.9.5 of this AO).

F. MISSION IMPLEMENTATION

The following expands requirements in the AO, in particular AO Requirement 1, Requirement 2, and Requirement 6 through Requirement 102.

F.1. General Requirements and Mission Traceability.

Requirement B-28. 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-29. 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 de-scoping or losses of mission elements, and facilitates identification of any resulting degradation to the science.

Requirement B-30. NASA recognizes that the full depth of information requested in Requirement B-31 through Requirement B-43 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 formulation and implementation of the mission.

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-30 will apply to all cases where the required information cannot, for whatever reason, be provided.

F.2. Mission Concept Descriptions.

Requirement B-31. 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-32. 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;
- Launch date flexibility;
- Mission duration;
- Orbit type (Earth orbit, Earth-Sun L1, heliocentric, etc.) and orbit information (semimajor axis, eccentricity, inclination, node time of day, argument of perigee, altitude, allowable dispersions), 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-33. Launch Services and Launch Vehicle Compatibility: Any non-NASA launch services shall be described. For NASA- provided launch services, compatibility with the launch vehicle class 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). Any known nonstandard requirements such as additional fairing doors, cleanliness and purge requirements, planetary protection, etc. shall be described.

Requirement B-34. 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-35. 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); (ix) spacecraft bus voltage, and (x) expected power requirement for each mission phase.

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 post-processing 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 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.

(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 Auto-generated, (iv) development method (spiral, waterfall, agile, etc.), and (v) development language.

Requirement B-36. 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-37. 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:

- Dry Mass;
- Launch Mass not available to the proposed mission;
- 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. If internal documents such as Flight Project Practices are referenced, an externally accessible URL shall be provided to download them.

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-38. 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 plans, including nominal sequence planning and commanding, team training, availability of spacecraft experts for operations, and operations center development.

F.3. Development Approach.

Requirement B-39. This section shall describe the systems engineering development approach. This description shall include the following items:

- Roles and responsibilities for the interface management process – as specified in NPR 7123.1B – and product development responsibilities;
- A description of how the interface management process will be developed and maintained;

- Mission assurance approach, including (i) fault tolerance and fault management, (ii) product assurance, and (iii) reliability;
- Essential trade studies to be conducted in Phase A including the considered options and driving requirements;
- Identification of the key Technical Performance Measures (TPMs) – as specified in NPR 7123.1B – and descriptions of 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 the associated reserves and margins;
- Descriptions of when contracts are required, the acquisition strategy, including any incentive strategy.

F.4. New Technologies/Advanced Engineering Developments.

Requirement B-40. This section shall describe any proposed new technologies and/or advanced engineering developments and the approaches that will be taken to reduce 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 components and subsystems to derive each full system TRL as proposed, appropriately considering TRL states of integration (see NASA/SP-2007-6105 Rev 2, *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 (staffing, 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.

F.5. Assembly, Integration, Test, and Verification.

Requirement B-41. 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-42. 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 included. 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.

F.6. Schedule.

Requirement B-43. A project schedule foldout(s) covering all phases of the investigation shall be provided to at least WBS level 3, except where greater detail is necessary to identify critical paths, as well as significant TRL or engineering development activities and events. The first 3 foldouts 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(s) and accompanying narrative (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 National Environmental Policy Act (NEPA) and Nuclear Launch Safety 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-44. 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-43 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-43 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 31, Requirement 32, Requirement 46 through Requirement 63, Requirement 80, and Requirement 83.

Requirement B-45. This section shall describe the investigator's proposed management approach. The management organization (including an organization chart) and decision-making authority, and the teaming arrangement and responsibilities 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-46. 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. The time commitment of each Key Management Team member shall be provided by mission phase. 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-47. This section shall describe the project risks and project resiliency considering these risks.

- Provide 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 resources for these risks have been included in the basis of estimate, indicate so. Alternatively, reserves held to account for these risks shall be considered encumbered. If cost risks are in this list, they shall be described here and then discussed in Section H (see Requirement B-53).
- 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.

Requirement B-48. 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-49. 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, (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 any increase in the PI-Managed Mission Cost is constrained during the Phase A Concept Study (if applicable, see Section 7.4.4) and/or may subsequently subject the investigation to termination or cancellation (see Section 4.1.4). 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 62 through Requirement 81, Requirement 99, and Requirement 100.

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-50. 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.

Requirement B-51. These costs shall be consistent with the policies and requirements described in Sections 4 and 5 of this AO.

Requirement B-52. 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 Table 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.12 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-53. This section shall include a discussion of cost risks.

Requirement B-54. 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$) in Table B3a and FY2017 dollars (FY2017$) 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 or sample return capsules and any unique flight system elements such as coordinating science ground stations, DSN, or nonstandard 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$) and totals in Fiscal Year 2017 dollars (FY2017$). Proposers shall use their own forward pricing rates to translate between real year dollars (RY$) and Fiscal Year 2017 dollars (FY2017$). For organizations that are without approved forward pricing rates, proposers shall use the NASA inflation/deflation indices in Table B4 to translate between real year dollars (RY$) and Fiscal Year 2017 dollars (FY2017$).

Requirement B-55. Tables B3a and B3b shall be provided additionally in Microsoft Excel format on each CD-ROM submitted. Microsoft Excel format templates of tables B1, B2, B3a, B3b, and B5 are available for download in the Program Library.

Requirement B-56. 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$) and Fiscal Year 2017 dollars (FY2017$) in Table B3.

I. STUDENT COLLABORATION PLAN

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

Requirement B-57. This section shall provide details of the development schedule of the Student Collaboration (SC), as described in Section 5.5.3 of this AO, 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-58. 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, except as noted in the Proposal Structure and Page Limits table. The proposer shall *not* include in these Appendices material required in the page-limited sections in the body of the proposal. Any additional information *not* specifically required in a given appendix will not be considered by the evaluation panel and may result in reduced ratings during the evaluation process or, in some cases, could lead to rejection of the proposal without review. No other appendices are permitted.

J.1. Table of Proposal Participants

The following expands requirements in the AO, in particular Requirement 89.

Requirement B-59. 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 (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, non-hardware 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 37, Requirement 82, and Requirement 88 through Requirement 90.

Requirement B-60. 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 participants in the proposal regardless of source of funding. Major partners are the organizations 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 46 through Requirement 48, and Requirement B-25.

Requirement B-61. This section shall include resumes or curriculum vitae for the PI, PM, PSE, all Co-Is identified in the science section, and for any other Key Management Team member. 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, 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.

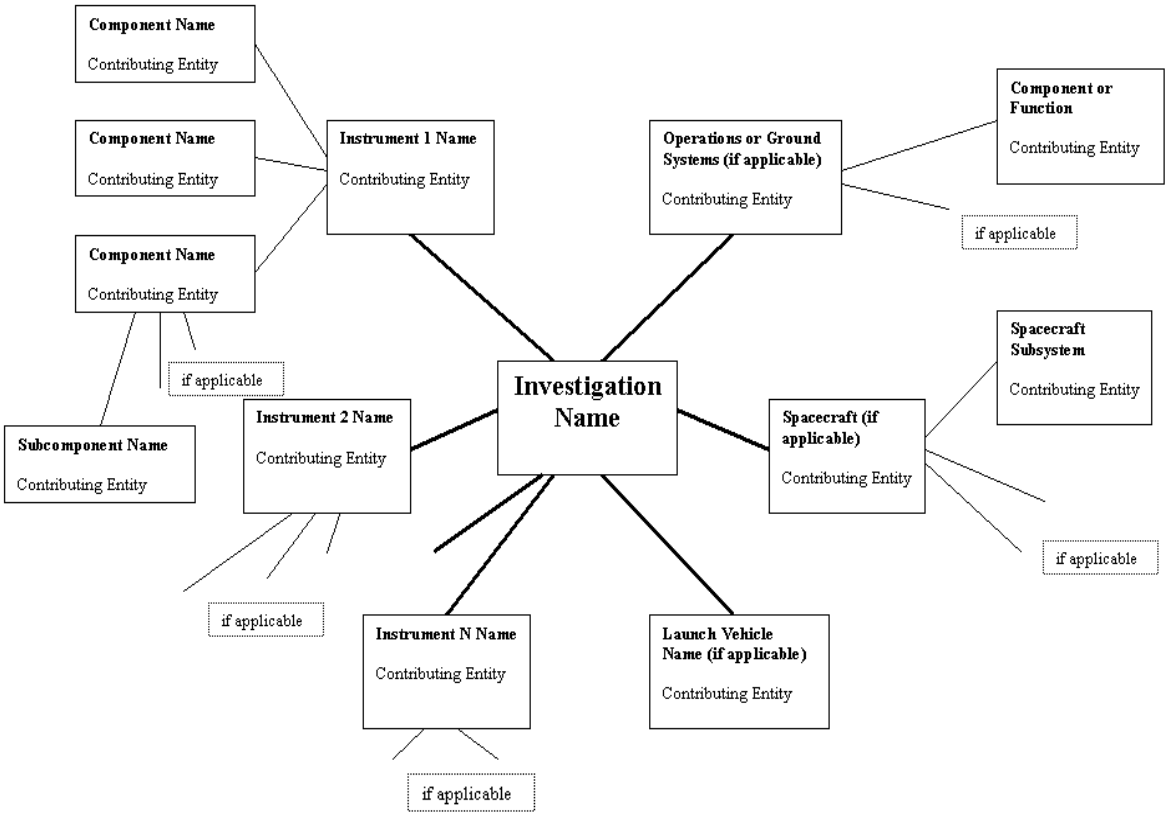
J.4. Summary of Proposed Program Cooperative Contributions.

The following expands requirements in the AO, in particular Requirement 78 through Requirement 80 and Requirement 84.

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 must 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-62. 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 shall not be shown:

(i.) If there are no cooperative contributions of spacecraft, launch vehicle or services, or ground operations or facilities, these boxes shall 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, shall not be shown.

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

b. A supporting table of collaborative contributions

Requirement B-63. 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 87.

Requirement B-64. 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-65. 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.

J.6. Planetary Protection Plan

The following expands requirements in the AO, in particular Requirement 14 and Requirement 15.

Requirement B-66. 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;
(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; and
(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.7. Draft Sample and Space Exposed Hardware Curation Plan

The following expands requirements in the AO, in particular Requirement 16 through Requirement 20.

Requirement B-67. If applicable, this section shall describe the draft plan for sample and space-exposed hardware curation at the NASA JSC Astromaterials Acquisition and Curation Office in accordance with the requirements in Section 5.1.5.2. At a minimum, this draft plan shall describe:
(i.) the nature of samples expected to be returned,
(ii.) the environmental conditions required of the sample curatorial facility,
(iii.) the preliminary examination of the samples, and
(iv.) the preparation (within 6 months of return) of a sample catalog sufficient for other scientists to request samples.

The draft plan shall demonstrate that at least no more than 25% of the returned sample shall be consumed by the mission-team during the funded period of curation (two years following sample return). The draft plan shall also demonstrate that the remaining portion of the sample will remain in as undisturbed a condition as possible for future studies that may be carried out in the indefinite future.

If non-U.S. partners are to receive fractions of the returned sample, they shall contribute proportionately to the sample allocated to the mission team.

Example: The proposed mission requires 10 g of returned sample to accomplish its science requirements; thus the mission must demonstrate that it will return at least 40 g of sample to ensure that the mission consumes no more than 25%. Country A is contributing 20% of the mission costs, and thus is to be allocated 20% of the returned sample. Therefore, Country A would be expected to provide 20% of the sample to be used for accomplishing mission science requirements, i.e., 2 g (20% of 10 g); the remainder of the sample to be used for mission science (8 g) would come from the US portion of the total sample. Notes: 1) in the event that the actual sample return were to exceed the baseline requirement of 40 g, the mission would still be expected to accomplish its science goals without exceeding the planned 10 g allotment for mission science; 2) in the event that the actual sample return were to fall short of the baseline requirement of 40 g, the sample available to accomplish mission science would still be limited to 25% of the actual return. In the latter case, allocations of samples to partners would scale down as well, in proportion to the size of the actual return.

In the case if a nominal sample return of 40 g, with a 20% contribution from Country A, the sample would be allocated as follows:

Country A:

- Up to 2 g allocated to mission science, with any unused portion transferred to Country A;
- 6 g transferred to Country A under an international agreement with NASA.

US:

- Up to 8 g allocated to mission science, with any unused portion retained for future use by NASA;
- 24 g retained for future use by NASA.

J.8. Discussion of Limiting the Generation of Orbital Debris and End of Mission Spacecraft Disposal Requirements.

The following expands requirements in the AO, in particular Requirement 42.

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-68. This section shall discuss briefly how the mission meets the NPR 8715.6B and NS 8719.14 orbit debris requirements applicable to its proposed orbit. A mission analysis to control debris released during normal operations, limit accidental explosions, limit intentional breakups, and limit collisions with large and small debris shall be provided.

Requirement B-69. For LEO missions, this section shall briefly discuss the lifetime of the mission and whether it meets the 25-year post-mission (or 30-year from launch – whichever comes first) requirement. An orbital lifetime analysis addressing all assumptions and inputs contributing to the analysis shall be provided and describe, 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.

A vehicle reentry human casualty risk assessment shall also be provided.

Requirement B-70. 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-71. 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 8715.6B, *NASA Procedural Requirements for Limiting Orbital Debris*; and
- NASA-STD-8719.14, *NASA Process for Limiting Orbital Debris.*

J.9. Technology Infusion

Technology infusion is not offered as an option through this AO.

J.10. Compliance with Procurement Regulations by NASA PI Proposals.

The following expands requirements in the AO, in particular Requirement 56.

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).

Requirement B-72. For NASA Center proposals, this section shall include any descriptions, justifications, representations, indications, statements, and/or explanations that are required by the regulations.

J.11. Master Equipment List.

The following expands requirements in the AO, in particular Requirement 74.

Requirement B-73. 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-74. Contributed flight element subsystem components and individual instrument element components that are a part of the PI's proposed hardware development shall be included in the MEL. This does not include the spacecraft when the spacecraft is external to the PI's proposed hardware development. This does not include the launch vehicle.

Requirement B-75. 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.12. Heritage.

The following expands requirements in the AO, in particular Requirement 52, Requirement 53, Requirement 74, Requirement 92, and Requirement 93.

Requirement B-76. 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.

The length of this Appendix is limited. See the Proposal Structure and Page Limits table.

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-77. 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.13. List of Abbreviations and Acronyms.

The following expands requirements in the AO, in particular Requirement 103.

Requirement B-78. This appendix shall provide a list of abbreviations and acronyms.

J.14. List of References (optional).

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.

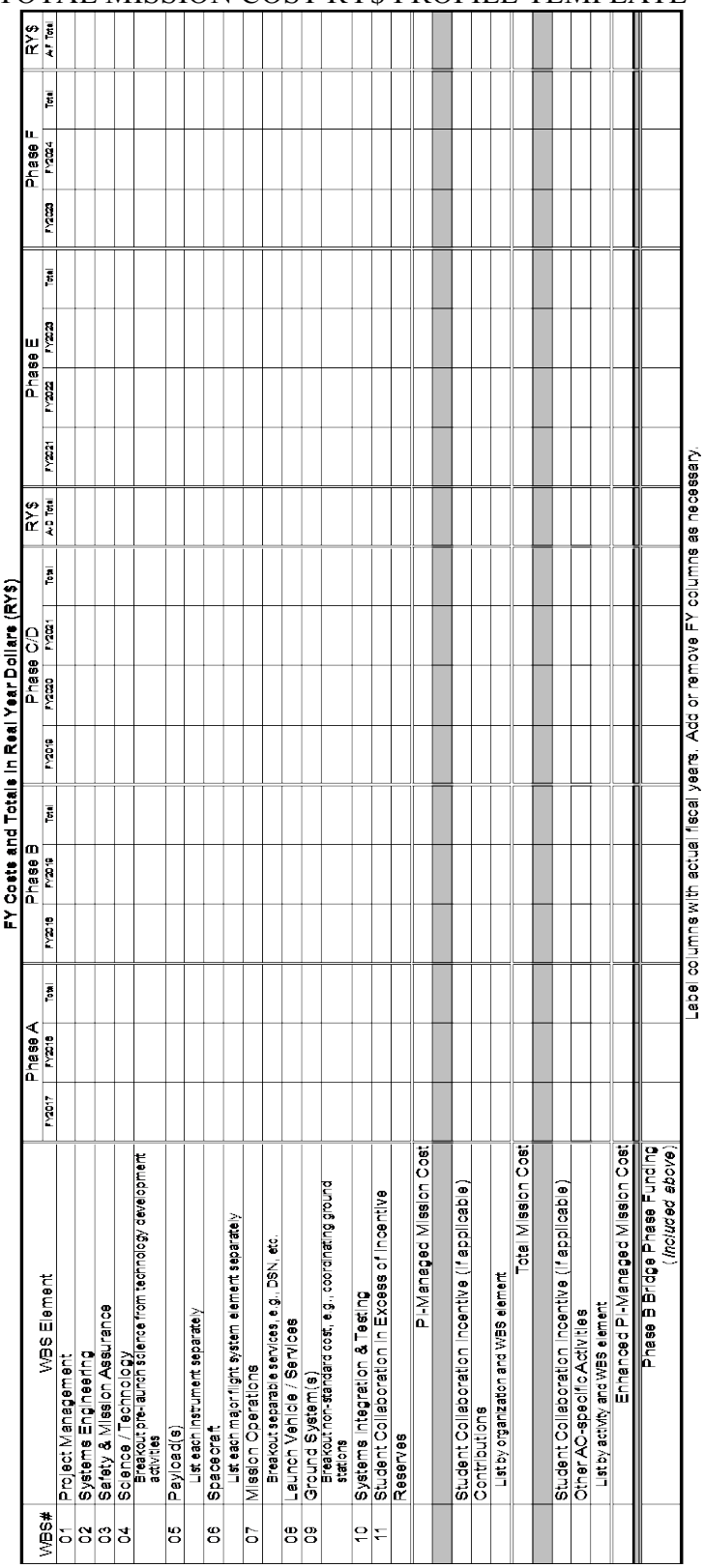
TABLE B1
EXAMPLE SCIENCE TRACEABILITY MATRIX

Science Goals	Science Objectives	Scientific Measurement Requirements		Instrument Requirements		Projected Performance	Mission Requirements (Top Level)
		Physical parameters	Observables				
GOAL 1	Objective 1	Column Density of Absorber	Absorption Line	Alt. Range	XX km	ZZ km	Observing strategies: requires yaw & elevation maneuvers Launch window: to meet nadir and limb overlap requirement. Window applies day-to-day.
		Density and 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 of observation 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
Examples				
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



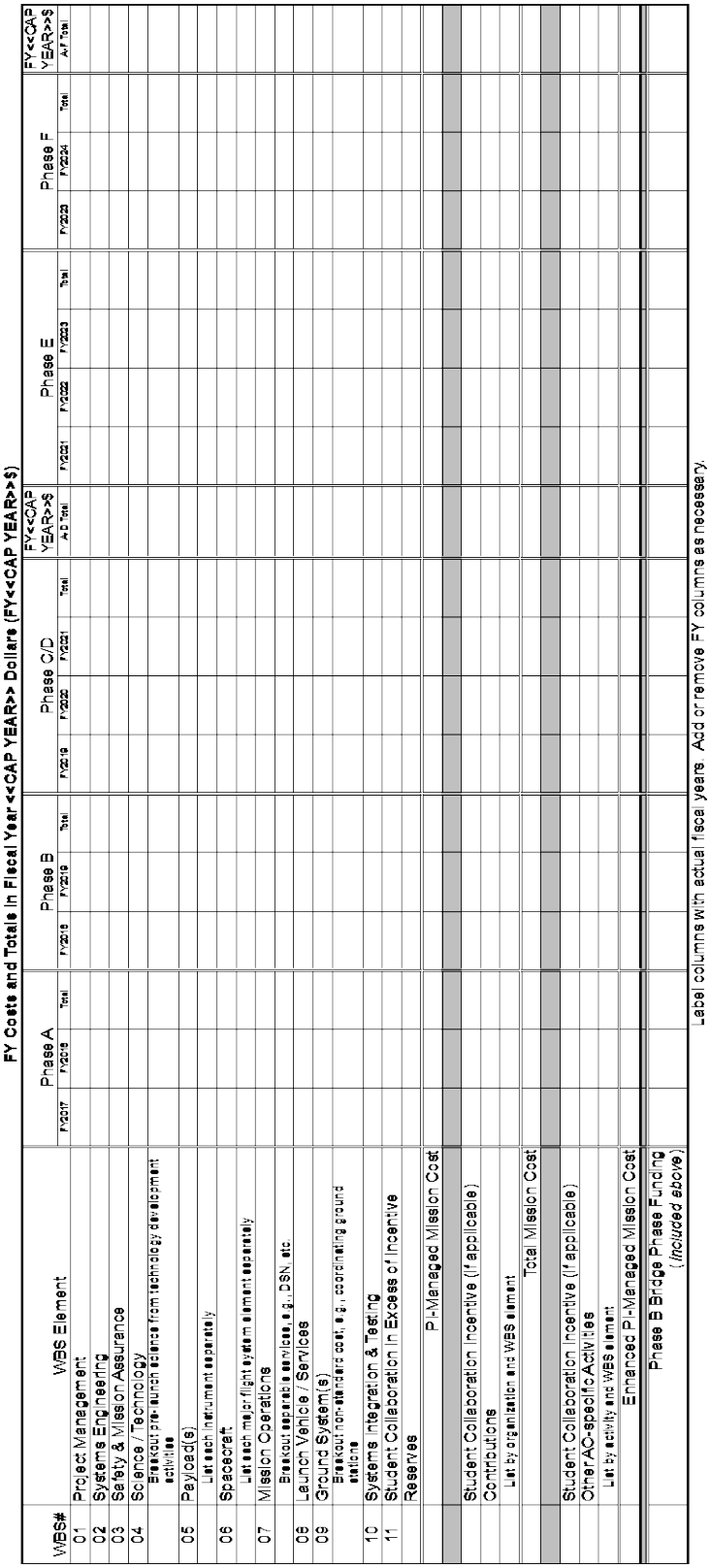
Total Mission Cost Profile Template
FY Costs and Totals in Real Year Dollars (RY$)

WBS#	WBS Element	Phase A			Phase B			Phase C/D				RY$	Phase E				Phase F			RY$
		FY2017	FY2018	Total	FY2018	FY2019	Total	FY2019	FY2020	FY2021	Total	All $ Total	FY2021	FY2022	FY2023	Total	FY2023	FY2024	Total	All $ 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 AC-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 FY17$ 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>>$
		FY2017	FY2018	Total	FY2018	FY2019	Total	FY2019	FY2020	FY2021	Add Total	FY2021	FY2022	FY2023	Total	FY2023	FY2024	Total	Add 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 separate 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 AC-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
2016 NASA NEW START INFLATION INDEX
FOR FY17 USE

Fiscal Year	2017	2018	2019	2020	2021	2022	2023	2024
Inflation Rate		2.8%	2.8%	2.8%	2.8%	2.7%	2.7%	2.6%
Cumulative Inflation Index	1.000	1.028	1.056	1.086	1.116	1.146	1.177	1.208

Use an inflation rate of 2.6% for all other years beyond 2024.

Note: Proposers must use their own forward pricing rates. For organizations that are without forward pricing rates, proposers must use the NASA New Start Inflation Index above.

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 Cost Cap — The nominal value that PI-Managed Mission Cost is limited to. Represents the publicly announced Program funding available to all proposers to an opportunity. Expressed in applicable Fiscal Year Dollars.

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 that 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 Committee — A 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 must not be identified as a collaborator but must 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, science, technology, engineering, and mathematics (STEM).

Consultant – An individual who is less critical to the successful development of the mission than a Co-I. A consultant may be funded through the proposal. A consultant may be committed to provide a focused contribution to the project for a specific task, such as consulting services.

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.

Data buy — An investigation based on data purchased using NASA funds, but was collected by an observational platform developed and operated without NASA support or oversight.

Data product latency — The period of time between data collection and release to the public. During this period the data may be in sole possession of the investigation team for checkout purposes only.

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.

Enhanced PI-Managed Mission Cost - The Enhanced PI-Managed Mission Cost is the PI-Managed Mission Cost, plus the Student Collaboration costs up to the student collaboration incentive, plus any Technology Demonstration Option costs up to the Technology Demonstration Option incentive, plus the I-ALIRT costs up to the I-ALIRT incentive, plus any Science Enhancement Options.

ESPA – Evolved Expendable Launch Vehicle Secondary Payload Adapter

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 — A payload composed of one or more sensors or instruments that is attached and/or integrated into a host space vehicle for the purpose of obtaining one or more ongoing resources from the host for the life of the hosted payload. Hosted payloads are 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.

Life-Cycle Cost — The total of the direct, indirect, recurring, nonrecurring, and other related expenses both incurred and estimated to be incurred in the design, development, verification, production, deployment, prime mission operation, maintenance, support, and disposal of a project, including closeout, but not extended operations. The Life-Cycle Cost of a project or system can also be defined as the total cost of ownership over the project or system's planned life cycle from Formulation (excluding Pre-Phase A) through Implementation (excluding extended operations). The Life-Cycle Cost includes the cost of the launch vehicle.

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 multi-party 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 cost proposed by the PI's implementation team to be funded by the Program sponsoring the AO 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 though the PI is not responsible for those costs (*e.g.*, NASA-provided telecom and network). The term does not imply that a contractual relationship between the PI's institution and other proposal team members is required. The PI-Managed Mission Cost is capped at the AO Cost Cap.

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.

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 Office — An office established to manage a 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 Systems Engineer (PSE) – The individual responsible to the PI for all systems engineering aspects of the mission per NPR 7123.1b.

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

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 (TDO) – Demonstration of technology in space is offered with NASA flight missions in order to enable new Heliophysics science investigations or enhance the investigation's science return. Proposers may choose to define a TDO that may be an instrument, investigation, new technology, hardware, or software that may be demonstrated on either the flight system or ground system. Success of baseline and threshold mission must not depend on the TDO, but may be enhanced by it.

Technology Infusion –Technology infusion is treated as a commercial procurement of a mature product from a proven vendor in the same manner as any spacecraft component (where the mission specific accommodations 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 Infusion is not offered as an option through this AO.

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 the Student Collaboration costs up to the student collaboration incentive, plus any Technology Demonstration costs up to the Technology Demonstration 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, flight 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 pre-allocated 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, general observer programs, or archival data analysis 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 including 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
AMMOS	Advanced Multi-Mission Operating System
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
CD-ROM	Compact Disc-Read Only Memory
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
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
EVM	Earned Value Management
FAQ	Frequently Asked Questions
FAR	Federal Acquisition Regulations
FFRDC	Federally Funded Research and Development Center
FPGA	Field-Programmable Gate Array
FY	Fiscal Year
GAO	Government Accountability Office
GDS	Ground Data System
GEO	Geosynchronous Orbit
GFE	Government Furnished Equipment
HBCU	Historically Black Colleges and Universities
HBZ	HUB Business Zone
HUBZone	Historically Underutilized Business Zone
IAT	Integration, Assembly, and Test
ICD	Interface Control Document
IMAP	Interstellar Mapping and Acceleration Probe
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
MEL	Master Equipment List
MO&DA	Mission Operations and Data Analysis
MOS	Mission Operations Services
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
NLSA	Nuclear Launch Safety Approval
NODIS	NASA Online Directives Information System
NOI	Notice of Intent

NPD	NASA Policy Directive
NPR	NASA Procedural Requirements
NRC	National Research Council
NRP	NASA Routine Payload
NSPIRES	NASA Solicitation and Proposal Integrated Review and Evaluation System
OMI	Other Minority Institution
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
RHU	Radioisotope Heater Unit
RPS	Radioisotope Power System
RTG	Radioisotope Thermoelectric Generator
RY	Real Year
SALMON	Stand Alone Missions of Opportunity Notice
SAM	System for Award Management
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
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

PROGRAM LIBRARY

IMAP Acquisition Homepage: https://soma.larc.nasa.gov/STP/IMAP/
IMAP AO Library: https://soma.larc.nasa.gov/STP/IMAP/library

Strategic Documents

1. NPD 1001.0B, *2014 NASA Strategic Plan*
2. *2014 Science Mission Directorate Science Plan*
3. *2013 National Research Council Decadal Strategy for Solar and Space Physics report, Solar and Space Physics: A Science for a Technological Society*

Program Specific Documents

1. STP Program Plan
2. Explorers & Heliophysics Projects Division Mission Assurance Requirements document
3. *Guidelines and Criteria for the Phase A Concept Study*
4. *ELV Launch Services Information Summary*
5. *NASA Launch Services Program (LSP) Advisory Services Plan*
6. *Space Communications and Navigation (SCaN) Mission Operations and Communications Services (MOCS)*
7. *The Explanatory Guide to the NASA Science Mission Directorate Educational Merit Evaluation Factors for Student Collaboration Elements*
8. *TRL 6 Examples*
9. *SMD Mission Extension Paradigm*
10. *Microsoft Excel version 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
11. *SPD-19, Meeting the 70% JCL Requirement in PI-led Missions*
12. *Draft Model Contract for Phases B/C/D/E*
13. *NASA/Heliophysics References List for Technology Demonstration Options*
14. *2017 Call Letter for Heliophysics Senior Review*

NASA and Federal Documents

1. NPR 7120.5E, *NASA Space Flight Program and Project Management Requirements*
2. NPR 7123.1B, *NASA Systems Engineering Processes and Requirements*
3. NID 8020.109, *Planetary Protection Provisions for Robotic Extraterrestrial Missions*
4. NPD 8020.7G, *Biological Contamination Control for Outbound and Inbound Planetary Spacecraft*
5. NPD 7100.10F, *Curation of Institutional Scientific Collections*

6. NASA-HDBK-6022, *NASA Handbook for the Microbiological Examination of Space Hardware*
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 8715.6B, *NASA Procedural Requirements for Limiting Orbital Debris*
10. NASA-STD-8719.14A, *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*NPR 8705.4, *Risk Classification for NASA Payloads*

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://nodis3.gsfc.nasa.gov/)

NPD 1360.2B, *Initiation and Development of International Cooperation in Space and Aeronautics Programs*
NPR 7150.2B, *NASA Software Engineering Requirements*
NPD 5101.32E, *Procurement, Financial Assistance*
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*
NASA-STD-8739.8, Standard for Software Assurance

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 https://www.acquisition.gov/?q=browsefar. 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 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 1852.234-2, “Earned Value Management System”
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.htm.

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 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”

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)"

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*
Explorers & Heliophysics Projects Division Mission Assurance Requirements document
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 proposals received on time	Requirement 3
2. Proposal on CD-ROM received on time	Requirement 4
3. Original signatures of PI and of authorizing official included	Requirement B-8
4. Meets page limits	Requirement B-4
5. Meets general requirements for format and completeness (maximum 55 lines text/page, maximum 15 characters/inch --approximately 12 pt font)	Requirement 103 Requirement B-1 Requirement B-2 Requirement B-3
6. Required appendices included; no additional appendices	Requirement B-58
7. Budgets are submitted in required formats	Requirement B-54
8. All individual team members who are named on the cover page indicate their commitment through NSPIRES	Requirement 90
9. All export-controlled information has been identified	Requirement 91
10. Restrictions Involving China acknowledged on Electronic Cover Page	Requirement 5
Scientific	
11. Addresses solicited science research programs	Requirement 6
12. Requirements traceable from science to instruments to mission	Requirement 8
13. Appropriate data archiving plan	Requirement 9
14. Baseline science mission and threshold science mission defined	Requirement 12
Technical	
15. Complete spaceflight mission (Phases A-F) proposed	Requirement 24
16. Team led by a single PI	Requirement 46
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 limit	Requirement 79
20. Co-investigator costs in budget	Requirement 59
21. Launch readiness prior to launch readiness date	Requirement 95
22. Includes table describing non-U.S. participation	Requirement 85
23. Includes letters of commitment from funding agencies for non-U.S. participating institutions	Requirement 82
24. Includes letters of commitment from all U.S. organizations offering contributions	Requirement 88
25. Includes letters of commitment from all major partners and non-U.S. institutions providing contribution of efforts of anyone on the Proposal Team.	Requirement 89

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 provide further definition of the proposal requirements in the AO and provide specific requirements for the format and content of the proposal. Some AO requirements do not require further definition by an Appendix B requirement, however they must be addressed in the proposal. Not all possible crosswalk relations are shown.

AO Reqmt	AO Section	AO Reqmt Topic	Appendix B Reqmt
1	2.4	Science objectives	B-15
2	2.4	Strategic science traceability	B-15
3	3	Proposal submission	
4	3	Electronic submission	
5	4.2.2	China regulations	
6	5.1.1	Upward science traceability	B-15
7	5.1.1	Science approach	B-16
8	5.1.1	Downward science traceability	B-16
9	5.1.2	Data plan	B-19, B-21, B-23, B-24
10	5.1.3	Measurement traceability	B-17, B-21
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12	5.1.4	Baseline and threshold mission	B-18, B-28
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APPENDIX H

REPRESENTATIONS AND CERTIFICATIONS

Submission of the signed proposal including Section V of the Proposal Summary Information indicates the prospective awardee's agreement with the requirement to submit and maintain representations and certifications, as mandated by the Federal Acquisition Regulation (FAR).

Prior to award of a contract or agreement, prospective awardees must (1) be registered in the System for Award Management (SAM) in accordance with FAR 4.1102, and (2) ensure that the representations and certifications submitted to SAM that are applicable to the Program Element Appendix (PEA) are current, accurate, and complete. The SAM is accessible at https://www.sam.gov.

Prospective awardees will be contacted by a Contracting Officer to discuss any additional information required for award. Any additional NASA FAR Supplement or contract-specific certification packages will be provided to the prospective awardee for completion prior to award. This may include representations and certifications, revised budgets or budget explanations, certificate of current cost or pricing data, subcontracting plan for small businesses, or other information as applicable to the proposed award. The anticipated award start date will be determined at this time. The appropriate award document, when signed by the Contracting Officer, is the authorizing award document.

National Aeronautics and Space Administration