National Aeronautics and Space Administration

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Announcement of Opportunity

Earth Venture Mission - 2

Earth System Science Pathfinder Program

Amended October 15, 2015. Two changes have been made to the solicitation: Requirement 90 and associated text in Section 5.9.4.1 Non-NASA Launch Services, on pages 41-42, and Program Specific Document #2 on page D-1. New text is in bold and deleted text is struckthrough. The due date for proposals is unchanged, it remains December 4, 2015.

OMB Approval Number 2700-0087

ANNOUNCEMENT OF OPPORTUNITY
EARTH VENTURE MISSION - 2
EARTH SYSTEM SCIENCE PATHFINDER PROGRAM
NNH15ZDA011O

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 science investigations for the Earth Venture Mission - 2 (EVM-2) element of the Earth System Science Pathfinder (ESSP) Program.

The AO Cost Cap for an EVM-2 mission is $166M in Fiscal Year (FY) 2018 dollars, not including contributions. NASA will not retain Unallocated Future Expenses (UFE) for the selected mission(s) to cover any activities or products funded under the PI Managed Mission Cost. NASA expects to select at least one mission with all requiring a Launch Readiness Date of no later than June 30, 2022, or five years after the contract is in place, whichever is earlier.

There were no significant changes from draft to the final version of this EVM-2 solicitation, except the final version provided more specific language to emphasize that International Space Station payloads will not be allowed in this solicitation.

Proposers should be aware of the following major changes in this AO from the previous EV-2 (now referred as EVM-1) AO.

- AO Cost Cap
- Launch services.
- Applied sciences requirement.
- International Space Station payloads are not solicited.
- Other special or new rules.

This AO is based on NASA SMD's Standard PI-led Mission AO. In addition to the listed major changes, this AO incorporates a large number of additional changes relative to previous Earth Venture AOs and the NASA SMD's Standard PI-led Mission AO including both policy changes and changes to proposal submission requirements. All proposers are advised to read this AO carefully, and all proposals must comply with the requirements, constraints, and guidelines contained within this AO.

ANNOUNCEMENT OF OPPORTUNITY
EARTH VENTURE MISSION - 2
EARTH SYSTEM SCIENCE PATHFINDER PROGRAM
NNH15ZDA011O
TABLE OF CONTENTS

1. Description of Opportunity 1
1.1 Introduction 1
1.2 NASA Safety Priorities 1

2. AO Objectives 1
2.1 NASA Strategic Goals 1
2.2 NASA Earth Science Goals 2
2.3 Earth Venture Program Background 4

3. Proposal Opportunity Period and Schedule 5

4. Policies Applicable to this AO 6
4.1 NASA Management Policies 6
4.1.1 NASA Flight Program and Project Requirements 6
4.1.2 NASA Program Management 7
4.1.3 NASA Center Role in Public Affairs and Outreach 7
4.1.4 Remediation, Termination, or Cancellation 8
4.2 Participation Policies 9
4.2.1 Eligibility to Participate in this AO 9
4.2.2 Restrictions Involving China 9
4.2.3 Constraints on Investigations that are Candidates for Selection 10
4.2.4 Responsibility of Principal Investigator for Implementation 10
4.2.5 NASA Concurrence for Replacement(s) of Key Management Team Members 10
4.3 Cost Policies 10
4.3.1 PI-Managed Mission Cost 10
4.3.2 Total Mission Cost 10
4.3.3 Mission Funding Profile 11
4.3.4 Availability of Appropriated Funds 11
4.4 Data Policies 11
4.4.1 Data Analysis 11
4.4.2 Data Rights 11
4.4.3 Delivery of Data to Archive 11
4.5 Project Management Policies 12
4.5.1 Independent Verification and Validation of Software 12
4.5.2 Earned Value Management Plan 12
4.5.3 Cost Analysis Data Requirement (CADRe) 13
4.5.4 Conjunction Assessment Analyses 13
4.5.5 End-of-Mission Plan and End-of-Prime-Mission Review 13

5. Requirements and Constraints 13
5.1 Science Requirements 13
5.1.1 Scope of Proposed Investigation 13

5.1.2 Traceability of Proposed Investigation 14
5.1.3 Mission Science Objectives and Requirements 14
5.1.4 Applications Requirements 15
5.1.5 Baseline and Threshold Science Missions 15
5.2 Technical Requirements 16
5.2.1 Complete Spaceflight Missions 16
5.2.2 Accepted Management Processes and Practices 16
5.2.3 Mission Category and Payload Risk Classification 17
5.2.4 New Technologies/Advanced Engineering Developments 17
5.2.5 Environmental Review and Launch Approval 18
5.2.6 Telecommunications, Tracking, and Navigation 19
5.2.7 Critical Event Coverage 20
5.2.8 Orbital Constellations 20
5.2.9 End-of-Mission Spacecraft Disposal Requirement 21
NPR8715.6A also includes a requirement for an End-of-Mission Plan (Section 2.2.2), which must be approved before launch. 21
5.2.10 Deviations from Recommended Payload Requirements 21
5.2.11 Mission Operations Tools and Services 21
5.3 Management Requirements 22
5.3.1 Principal Investigator 22
5.3.2 Project Manager 22
5.3.3 Project Systems Engineer 22
5.3.4 PI, PM, and PSE Roles 23
5.3.5 Management and Organization Experience and Expertise 23
5.3.6 Risk Management 23
5.3.7 Compliance with Procurement Regulations by NASA PI Proposals 24
5.4 Science Team, Co-Investigators, and Collaborators 24
5.4.1 Science Team 24
5.4.2 Co-Investigators 24
5.4.3 Collaborators 25
5.5 Small Business Participation and Education, Communications and Public Outreach 25
5.5.1 Small Business Participation 25
5.5.2 Education Program Plan and Communications and Outreach Program 26
5.5.3 Student Collaborations (optional) 26
5.6 Cost Requirements 27
5.6.1 PI-Managed Mission Cost and Total Mission Cost 27
5.6.2 Cost Estimating Methodologies and Cost Reserve Management 27
5.6.3 Work Breakdown Structure 28
5.6.4 Master Equipment List 28
5.6.5 Full Cost Accounting for NASA Facilities and Personnel 28
5.6.6 Contributions 30
5.7 Non-U.S. Participation Requirements 32
5.7.1 Overview of Non-U.S. Participation 32
5.7.2 General Guidelines Applicable to Non-U.S. Proposals and Proposals including Non-U.S. Participation 32
5.7.3 Agreements with Selected Non-U.S. Participants 33

5.7.4 Export Control Guidelines Applicable to Non-U.S. Proposals and Proposals including Non-U.S. Participation ... 34
5.8 Additional Proposal Requirements ... 34
5.8.1 Letters of Commitment ... 34
5.8.2 Export Controlled Material in Proposals ... 35
5.8.3 Classified Proposal Appendix Regarding Heritage ... 36
5.9 Program Specific Requirements and Constraints ... 37
5.9.1 Commitment for a Single-Step Selection ... 37
5.9.2 Schedule Requirements ... 38
5.9.3 NASA Provided Launch Services ... 38
5.9.4 Alternative Access to Space ... 39

6. Proposal Submission Information ... 44
6.1 Preproposal Activities ... 44
6.1.1 Preproposal Conference ... 44
6.1.2 Notice of Intent to Propose ... 44
6.1.3 Teaming Interest ... 45
6.1.4 EVM-2 Library and Acquisition Home Page ... 45
6.1.5 Point of Contact for Further Information ... 45
6.2 Proposal Preparation and Submission ... 46
6.2.1 Structure of the Proposal ... 46
6.2.2 Certifications ... 46
6.2.3 Submission of Proposals ... 46
6.2.4 Electronic Submission of Proposal Summary Information ... 47

7. Proposal Evaluation, Selection, and Implementation ... 47
7.1 Overview of the Proposal Evaluation and Selection Process ... 47
7.1.1 Evaluation Process ... 47
7.1.2 Categorization and Steering Process ... 48
7.1.3 Selection Process ... 49
7.2 Evaluation Criteria ... 49
7.2.1 Overview of Evaluation Criteria ... 49
7.2.2 Scientific Merit of the Proposed Investigation ... 50
7.2.3 Scientific Implementation Merit and Feasibility of the Proposed Investigation ... 51
7.2.4 TMC Feasibility of the Proposed Mission Implementation, Including Cost Risk ... 52
7.3 Selection Factors ... 54
7.4 Implementation of Selected Proposals ... 55
7.4.1 Notification of Selection ... 55
7.4.2 Principal Investigator-led Team Masters Forum ... 55
7.4.3 Award Administration and Funding ... 56
7.4.4 Confirmation of Investigations ... 56
7.5 Opportunity for Debriefing of Nonselected Proposers ... 57
7.6 Process for Appeals ... 57
7.6.1 Agency Procurement Ombudsman ... 57
7.6.2 Protests ... 57

8. Conclusion ... 58

APPENDICES

Appendix A: General Instructions and Provisions..... A-1

Appendix B: Requirements for Proposal Preparation.....B-1

Section A..... Proposal Summary Information and Graphic Page
Section B.....Fact Sheet
Section C.....Table of Contents
Section D..... Science Investigation
Section E. .....Science Implementation
Section F. ..... Mission Implementation
Section G.....Management
Section H..... Cost and Cost Estimating Methodology
Section I.…….....Communications and Outreach Program and Student Collaboration
Section J. .....Proposal Appendices

Appendix C: Glossary of Terms and Abbreviations..... C-1

Appendix D: EVM-2 Library D-1

Appendix E: Requirements for Subsequent Phases E-1

Appendix F: Compliance Checklist F-1

Appendix G: Requirements Crosswalk..... G-1

Appendix H: Certifications H-1

ANNOUNCEMENT OF OPPORTUNITY
EARTH VENTURE MISSION - 2
EARTH SYSTEM SCIENCE PATHFINDER PROGRAM
NNH15ZDA011O

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 the Earth Venture Mission – 2 (EVM-2) element of the Earth System Science Pathfinder (ESSP) Program. All investigations proposed in response to this solicitation must support the goals and objectives of EVM-2 (Section 2), must be implemented by Principal Investigator (PI) led investigation teams (Section 5.3.1), and must be implemented through the provision of complete spaceflight missions (Section 5.2.1).

Proposed investigations will be evaluated and selected through a single-step competitive process (Section 7). The single step competitive process entails the solicitation, submission, evaluation, and selection of proposals prepared in response to this AO. As the outcome of this solicitation, NASA intends to select at least one investigation for funding (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) through 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 contains additional requirements on the format and content of the proposal. Appendix D lists the EVM-2 Library documents that are intended to provide guidance for selected investigations; they are specifically not intended to impose requirements on proposals.

1.2 NASA Safety Priorities

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

2. AO Objectives

2.1 NASA Strategic Goals

Information on NASA's strategic goals may be found in NASA Policy Directive (NPD) 1001.0B, *The 2014 NASA Strategic Plan*, available through the EVM-2 Library (http://essp.larc.nasa.gov/EVM-2/evm-2_library.html). One of NASA's strategic goals is to "Advance understanding of Earth and develop technologies to improve the quality of life on our

home planet." The NASA Science Mission Directorate (SMD) is addressing this strategic goal by pursuing the Earth Science Goals described in Section 2.2 of this AO.

2.2 NASA Earth Science Goals

Further information on the goals and objectives of NASA's Earth science program may be found in the *2014 Science Mission Directorate Science Plan* available through the EVM-2 Library.

Our planet is changing on all spatial and temporal scales and studying the Earth as a complex system is essential to understanding the causes and consequences of climate change and other global environmental concerns. The purpose of NASA's Earth science program is to advance our scientific understanding of Earth as a system and its response to natural and human-induced changes, to improve our ability to predict climate, weather, and natural hazards and to develop and test products that build on observations and this understanding in order to deliver societal benefit.

NASA's ability to observe global change on regional scales and conduct research on the causes and consequences of change position it to address the Agency strategic goal for Earth science, which is to advance knowledge of Earth as a system to meet the challenges of environmental change, and to improve life on our planet. NASA addresses the issues and opportunities of climate change and environmental sensitivity by answering the following key science questions through our Earth science program:

- How is the global Earth system changing?
- What causes these changes in the Earth system?
- How will the Earth system change in the future?
- How can Earth system science provide societal benefit?

These science questions translate into seven overarching science goals to guide the Earth Science Division's selection of investigations and other programmatic decisions:

1. Advance the understanding of changes in the Earth's radiation balance, air quality, and the ozone layer that result from changes in atmospheric composition (*Atmospheric Composition*)
2. Improve the capability to predict weather and extreme weather events (*Weather*)
3. Detect and predict changes in Earth's ecological and chemical cycles, including land cover, biodiversity, and the global carbon cycle (*Carbon Cycle and Ecosystems*)
4. Enable better assessment and management of water quality and quantity to accurately predict how the global water cycle evolves in response to climate change (*Water and Energy Cycle*)
5. Improve the ability to predict climate changes by better understanding the roles and interactions of the ocean, atmosphere, land and ice in the climate system (*Climate Variability and Change*)
6. Characterize the dynamics of Earth's surface and interior, improving the capability to assess and respond to natural hazards and extreme events (*Earth Surface and Interior*)

7. Further the use of Earth system science research to inform decisions and provide benefits to society (*Applied Sciences*)

Two foundational documents guide NASA's overall approach to the Earth science program: the National Research Council (NRC) 2007 Earth science decadal survey (*Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond* [The National Academies Press, 2007]) and NASA's 2010 climate-centric architecture plan (*Responding to the Challenge of Climate and Environmental Change: NASA's Plan for a Climate-Centric Architecture for Earth Observations and Applications from Space* [June 2010]).
The NRC decadal survey articulates a vision for Earth science research and applications in support of society:

> Understanding the complex, changing planet on which we live, how it supports life and how human activities affect its ability to do so in the future is one of the greatest intellectual challenges facing humanity. It is also one of the most important challenges for society as it seeks to achieve prosperity, health, and sustainability.

Since the decadal survey, the NASA Earth Science program has articulated that science implies research, applied research, and applications where the relative emphasis on each is unique to an individual investigation.

The 2007 decadal survey recommended a broad portfolio of missions to support the science that is needed to provide answers to the key science questions and accomplish the related science goals. Recognizing the pressing challenge of climate change, NASA addressed the need to ensure the continuity of key climate monitoring measurements in its 2010 climate-centric architecture plan. The plan reflects the need to collect key climate monitoring measurements, which are critical to informing policy and action, and which other agencies and international partners had not planned to continue. The plan also accelerated key decadal survey recommendations to address the nation's climate priorities.

The ability to develop and operate spaceborne missions and instruments enables NASA to provide a broad, integrated set of uniformly high-quality data covering all parts of the planet. NASA shares this unique knowledge with the global community including members of the science, government, industry, education, and policy-maker communities. For example, NASA plays leadership roles in a range of federal interagency activities, such as the U.S. Global Change Research Program (USGCRP) and the Committee on Environment, Natural Resources, and Sustainability of the National Science and Technology Council by providing global observations, research results, and modeling capabilities. USGCRP advances ways to inform decisions and supports means to strengthen the dialogue between the science and decision making communities through multidirectional information exchange. NASA also maintains an expansive network of partnerships with foreign space agencies and international research organizations to conduct activities ranging from data sharing to joint development of satellite missions. These interagency activities and international partnerships substantially leverage NASA's investments and provide knowledge essential for understanding the causes and consequences of climate change and other global environmental concerns.

2.3 Earth Venture Program Background

The National Research Council's decadal survey in Earth science recommended that NASA maintain a line of competitively selected, moderate size missions and opportunities in the Earth Venture (EV) mission portfolio. The Earth Venture element is being implemented in the broader context of NASA's Earth science program and has resulted in more frequent flight opportunities than afforded by the strategic and directed missions outlined in the decadal survey.

The following foci have been identified for the Earth Venture-class missions:

- Measurement and observation innovations;
- Demonstration of innovative ideas allowing the use of existing technologies or approaches;
- Establishment of new research avenues; and
- Demonstration of key application-oriented measurements.

NASA Earth Science defines science to include research, applied research, and applications. For this EVM-2 solicitation, NASA places a strong emphasis on research and innovation for Earth system science issues, while expecting appropriate attention to applications-oriented aspects to further the overall value of the mission.

The National Research Council's decadal survey in Earth science and applications outlined three types of Earth Venture-class missions. Through the Earth Venture mission portfolio, NASA has implemented a mix of suborbital, instrument, and complete spaceflight mission investigations. To achieve this mix, three different kinds of solicitations are being pursued under the Earth Venture-class line.

- *EV Suborbital* (i.e., EVS-1, 2, 3, …). These solicitations call for proposals for complete suborbital, PI-led investigations to conduct innovative, integrated, hypothesis or scientific question-driven approaches to pressing Earth system science issues. The first suborbital science investigations funded under the EV-1 element (or EVS-1 by the new EV naming scheme) are now in operations. As a result of the EVS-2 solicitation, investigations were selected in November 2014 and are now in development. <u>Not solicited in this AO.</u>

- *EV Mission* (i.e., EVM-1, 2, 3, …). These solicitations call for proposals for complete PI-led spaceflight missions to conduct innovative, integrated, hypothesis or scientific question-driven approaches to pressing Earth system science issues. The EV-2 (or EVM-1 by the new EV naming scheme) solicitation was the first of this series, with the selected mission (Cyclone Global Navigation Satellite System – CYGNSS) now in development. *This AO is the second solicitation in this series, with the selection(s) expected late FY2016*.

- *EV Instrument* (i.e., EVI-1, 2, 3, …). These solicitations call for developing instruments or CubeSats for participation on a NASA-arranged spaceflight mission of opportunity to conduct innovative, integrated, hypothesis or scientific question-driven approaches to pressing Earth system science issues. The NASA funded PI will retain a central role on

the instrument, instrument package, or CubeSat(s) development, integration and testing, calibration, and science operations. The EVI-1 solicitation was the first of this series, with the selected mission (Tropospheric Emissions: Monitoring of Pollution – TEMPO) now in development. As a result of the EVI-2 solicitation, two investigations were selected for flight (Global Ecosystem Dynamics Investigation - GEDI and ECOsystem Spaceborne Thermal Radiometer Experiment on Space Station -ECOSTRESS) and are now in development. Solicitations in this series are anticipated every 18 months (or shortly after the selection announcement of the previously solicited EVI). Not solicited in this AO.

Earth Venture-class spaceflight missions require a schedule for launch (or delivery for platform integration in the case of EVI) within four to five years of project initiation, and projects are cost-capped. It is possible and acceptable that a mission selected and developed through this solicitation could address significant portions of missions or measurements identified by the decadal survey.

This EVM-2 AO is the second solicitation in the Earth Venture series soliciting for Full Missions.

3. Proposal Opportunity Period and Schedule

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

AO Release Date	September 3, 2015
Preproposal Conference	September 17, 2015
Notice of Intent to Propose Deadline	October 2, 2015
Electronic Proposal Submittal Deadline at 11:59 p.m. Eastern Time	December 4, 2015
Letters of Commitment Due (with Proposal)	December 4, 2015
Deadline for Receipt of Proposal on CD-ROMs 5:00 P.M. Eastern Time	December 11, 2015
Selections Announced (target)	August 2016
Initiate Investigation (target)	NLT January 17, 2017
Launch Readiness Date	NLT June 30, 2022, or 5 years after the contract is in place, whichever is earliest.

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

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

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

on CD-ROMs." Proposals on CD-ROMs 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.

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* (found in the EVM-2 Library), 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-orbit 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.

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 EVM-2 investigations, KDP-A is the selection of a proposal to enter Phase A as a result of this AO, KDP-B is the gate to enter Phase B following Mission Definition Review, KDP-C is the culmination of the Confirmation process, KDP-D is a transition that occurs after the Systems Integration Review, KDP-E is the handoff from development to operations, and KDP-F is the decision to terminate operations after completion of the mission. Scientific and other analyses may continue under project funding in Phase F.

4.1.2 NASA Program Management

Owing to the significant expenditure of Government funds on these complete space flight investigations, NASA intends to maintain an essential degree of insight into mission development to ensure that the implementation is responsive to NASA requirements and constraints. NASA requirements and constraints are defined in NPR 7120.5E and in other NASA requirements documents available in the EVM-2 Library. The Associate Administrator for SMD has assigned the Earth System Science Pathfinder (ESSP) Program Office at NASA Langley Research Center (LaRC) to be responsible for project oversight. The ESSP Program Manager at NASA LaRC reports to the Associate Director for Flight Programs of the Earth Science Division at NASA Headquarters. Additional details about the program office staffing, structure, and goals can be found in the *ESSP Program Plan*, available through the EVM-2 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 ESSP Program Office at NASA LARC will retain the Technical Authority (TA), as described in NPR 7120.5E, which would otherwise be invested in an implementing Center or JPL.

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 NASA S&MA related documents. Although these institutional documents may impose requirements on selected investigations, they do not impose requirements, either implicitly or explicitly, on proposals.

In addition to its role as the site of the ESSP Program Office, NASA LaRC is eligible to submit and participate in proposals in response to this AO. The ESSP Program Office will have access to the AO before it is released; this is necessary so that the ESSP Program Office can review the AO and ensure that it correctly describes the postselection project management processes. Other than that, the ESSP 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 NASA Science Mission Directorate (SMD) at NASA Headquarters will manage the evaluation and selection process. In order to manage NASA LaRC's two roles, SMD has established functional and organizational firewalls between the ESSP Program Office and those parts of NASA LaRC that might participate in proposal generation. These firewalls ensure that personnel identified as supporting the ESSP Program Office and the AO process will protect all nonpublic information from all proposers, including those at NASA LaRC, and will be free of financial and other conflicts of interest with proposers.

4.1.3 NASA Center Role in Public Affairs and Outreach

Successful media relations activities require close cooperation between NASA and the selected investigations. NASA Centers and JPL have specific expertise in media relations and/or public affairs, especially as they pertain to Earth and space science missions. All selected investigations will coordinate media relations and/or public affairs with a NASA Center or JPL. If a selected

investigation does not include a NASA Center or JPL as part of their investigation team, the investigation will utilize the public affairs guidance and resources of the ESSP Program Office at NASA LaRC.

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

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

4.1.4 Remediation, Termination, or Cancellation

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

The proposal must include a commitment by the PI for the PI-Managed Mission Cost, schedule, and scientific performance of the investigation. If, at any time, the cost, schedule, or scientific performance commitments made in the proposal appear to be in peril, the investigation will be subject to termination or cancellation.

During Phase B, each selected PI will work with NASA to develop top-level science and technical performance requirements. Each PI will also work with NASA to establish a set of performance metrics for project evaluation with NASA. These metrics 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 even if any international or domestic partnerships have been established to enable the mission.

4.2 Participation Policies

4.2.1 Eligibility to Participate in this AO

Prospective investigators from any category of organizations or institutions, U.S or non-U.S., are welcome to respond to this solicitation. 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/or 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 unmitigatable organizational conflict of interest for CTS in the event that any business unit of CTS has a proposed role as prime contractor, subcontractor, or participating organization. Because of this organizational conflict of interest, CTS is precluded from participating in any capacity in support of a respondent under this AO.

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

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

4.2.3 Constraints on Investigations that are Candidates for Selection

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

4.2.4 Responsibility of Principal Investigator for Implementation

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

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 and the Project Manager (PM)) requires concurrence by NASA.

4.3 Cost Policies

4.3.1 PI-Managed Mission Cost

PI-Managed Mission Cost is defined as the cost for which funding will be budgeted to be provided to the PI's investigation team by the ESSP 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 (e.g., NASA-provided telecommunications and network services described in Section 5.2.6). The PI-Managed Mission Cost is capped at the AO Cost Cap (see Section 5.6.1).

Examples of costs to be included in the PI-Managed Mission Cost, unless contributed, are: development activities (e.g., instrument development, spacecraft development, management, software, testing); launch services; 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; and all labor, including contractor and Civil Servant (NASA and non-NASA).

4.3.2 Total Mission Cost

Total Mission Cost is defined as the PI-Managed Mission Cost (see Section 4.3.1), plus any Student Collaboration costs up to the student collaboration incentive (see Section 5.5.3), plus any

additional costs that are contributed or provided in any way other than through the ESSP Program (see Section 5.6.6). The Total Mission Cost will define the total value of the baseline investigation.

4.3.3 Mission Funding Profile

The ESSP Program's planning budget can accommodate a selection at the AO Cost Cap with a typical funding profile over a nominal 5-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 ESSP 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.

4.3.4 Availability of Appropriated Funds

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

4.4 Data Policies

4.4.1 Data Analysis

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

4.4.2 Data Rights

By NASA policy, all science data returned from NASA missions are immediately in the public domain. Following a negotiated postflight checkout period, all data will be made available to the user community. There shall be no period of exclusive access. The PI will negotiate the data product latency period for standard products proposed, and a justification for it must be demonstrated. Barring exceptional circumstances, data product latency may not exceed six months.

4.4.3 Delivery of Data to Archive

Mission data will be made fully available to the public by the investigator team in usable form, in the minimum time necessary but, barring exceptional circumstances, not exceeding a negotiated latency period (typically 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 making it fully available. During Phase A, NASA will assign a specific data center, e.g., one of the Earth Observing System Data and Information System (EOSDIS)

Distributed Active Archive Centers (DAACs), to be the data archive for the selected mission; proposals should not be tailored to one specific data center. By the investigation closeout, the investigation must have delivered all data products, along with the scientific algorithm software, coefficients, ancillary data used to generate these products, and the algorithm and calibration documentation to a NASA-assigned data center. Information on EOSDIS and the DAACs is available at http://esdis.eosdis.nasa.gov/eosdis/overview.html and http://esdis.eosdis.nasa.gov/dataaccess/datacenters.html.

Archival data products will include low-level (raw) data, high-level (processed) data, and derived data products such as maps, ancillary data, 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.

As part of the applications aspect of a mission, data products may be proposed that serve users beyond the primary research field of the proposed mission. Proposals may include funding for generating data products in forms, units, and widely used formats to serve key applications communities of the mission.

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 NASA data archive(s) in the appropriate field. Proposers should contact an appropriate archive directly to obtain information regarding the applicable policies and practices. For information on NASA Earth Science data policy, nomenclature, standards, and EOSDIS, see http://science.nasa.gov/earth-science/earth-science-data/. 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 capped PI-Managed Mission Cost.

4.5 Project Management Policies

4.5.1 Independent Verification and Validation of Software

The NASA Chief Safety and Mission Assurance Officer has the authority to select software projects to which Independent Verification and Validation (IV&V) is to be applied, as defined in NASA-STD-8739.8, *Standard for Software Assurance*, and NPR 7150.2A, *NASA Software Engineering Requirements*. If the software assurance classification assessment determines IV&V is mandatory, proposal teams are encouraged 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 304-367-8200. 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 Chief Safety and Mission Assurance Officer.

4.5.2 Earned Value Management Plan

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

4.5.3 Cost Analysis Data Requirement (CADRe)

NASA has established a Cost Analysis Data Requirement (CADRe) in NPR 7120.5E, 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 Analyses

NASA has established a conjunction assessment analyses requirement in NPR 8715.6A, Section 3.4 that will apply to investigations selected through this AO. The Conjunction Assessment Risk Analysis (CARA) team at NASA Goddard Space Flight Center is funded directly by NASA Headquarters to perform the actual analysis and risk assessment; the costs for these services need not be included in the proposed PI-Managed Mission Cost. Investigations to which NPR 8715.6A, Section 3.4 is applicable will have to spend project funds only to establish a working interface between the Flight Operations Team and the CARA team to routinely share orbital ephemerides data and maneuvering plans and to perform any maneuver planning activities required for collision avoidance once on orbit. Estimates of how many maneuver planning events may be required in a particular orbit regime are available from the CARA team. The interface between the mission and the CARA team should be agreed-to and documented one year prior to launch.

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

NASA Earth science missions are required to develop an End-of-Mission Plan for approval and to support an End-of-Prime-Mission Review. The End-of-Prime-Mission Review is held to determine if the mission has met its Baseline Science Requirements or Threshold Science Requirements and discuss any lessons learned from the mission. If the End-of-Prime-Mission Review is successful, the mission may propose to the biennial NASA Earth Science Division Senior Review for approval to enter into an extended mission phase. The End-of-Mission Plan requirements may be found in NPR 7120.5E and in the *ESSP Program Plan.* Information on the biennial NASA Earth Science Division Senior Review can be found in the *2015 Call Letter for ESD Senior Review* and the *2015 ESD Senior Review Final Report.* These documents are accessible from the EVM-2 Library.

5. Requirements and Constraints

This section provides general requirements on 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 how and why the Earth's climate and the environment are changing), while an objective is understood as a more narrowly focused part of a strategy to achieve a goal (e.g., understand and improve predictive capability for changes in

the ozone layer, climate forcing, and air quality associated with changes in atmospheric composition). Proposed investigations must achieve their proposed objectives; however, the investigation might only make progress toward a goal without fully achieving it.

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

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

5.1.2 Traceability of Proposed Investigation

The Earth Venture 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). EV investigations may also result in enhanced products and services provided by NASA's partners using the EV-provided data that will improve the quality of life for Earth's inhabitants, including the protection of life, health, and/or property, as well as improved management and/or decision-making by NASA's partners.

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

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

5.1.3 Mission Science Objectives and Requirements

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

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

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

5.1.4 Applications Requirements

Among NASA's strategic goals is to enable the use of Earth system science to inform decisions, strengthen the economy, and improve the quality of life. The Earth Venture Program is intended to provide data and information products, to the extent possible, to key applications communities to increase the overall value and benefits of a mission. The ability to determine how a proposed mission can serve relevant applications communities depends on an on-going, multidirectional information exchange and an adequate plan and attention to applications-oriented issues, such as feedback on data products from skilled, sophisticated users outside the research community.

For this EVM-2, NASA places the highest priority on research and innovation for Earth system science issues. However, proposals must also articulate, to the extent possible, a plan to address applications-oriented users for their measurements, investigation, and data products. NASA recognizes that, in some science investigations, applications are not possible. In such cases, the proposer must explain and justify why there is no viable application dimension to the investigation.

Requirement 10. The proposal shall describe a plan and budget for the applications dimension of the mission. The proposal shall describe applications as part of the overall mission concept. The applications program plan shall address approach(es) and interaction with applications-oriented users and organizations. The ability to adapt to new opportunities and to coordinate with NASA shall also be addressed. Proposal teams are strongly encouraged to identify a point of contact for applications to coordinate with NASA. NASA recognizes that, in some science investigations, applications are not possible. In such cases, the proposer shall explain and justify why there is no viable application dimension to the investigation.

5.1.5 Baseline and Threshold Science Missions

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

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

The differences between the Baseline Science Mission and the Threshold Science Mission provide resiliency to potential cost and schedule growth in the proposed formulation and implementation plan. Any alteration of a mission 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 11. Proposals shall specify only one Baseline Science Mission and only one Threshold Science Mission.

Requirement 12. 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.

5.2 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 closeout (Phase F). The term "spaceflight missions" for this EVM-2 AO is defined as Earth orbital (from a spaceborne platform) and deep-space missions; it specifically excludes suborbital missions such as those flown via sounding rockets, balloons, and aircraft.

Requirement 13. Proposals submitted in response to this AO shall be for complete Science investigations requiring a spaceflight mission.

Requirement 14. Proposals shall describe the proposed mission architecture and the rationale for each mission element.

Requirement 15. Proposals shall describe the proposed mission design and mission operations concept.

Requirement 16. Proposals shall describe the proposed flight system concept, including the spacecraft bus and its major subsystems.

Requirement 17. Proposals shall describe the development approach for implementing the proposed mission within schedule and cost constraints, including a project schedule covering Phases A-F.

Proposals traditionally considered as "data buys" are not permitted in response to this EVM-2 AO. Proposals of instruments that may be hosted on the International Space Station (solicited in EVI) are not permitted in response to this EVM-2 AO.

See Appendix B, Section F, for additional detail.

5.2.2 Accepted Management Processes and Practices

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

be consistent with the principles of NPR 7120.5E. Any deviations from NPR 7120.5E will require a waiver during formulation.

Requirement 18. 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 19. 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 20. 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 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 thru 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.

Requirement 21. EVM-2 missions selected from this AO have been determined to be Category 3 missions (per NPR 7120.5E) with Class D payloads (per NPR 8705.4). Proposers shall incorporate appropriate work effort and support in their proposals accordingly.

5.2.4 New Technologies/Advanced Engineering Developments

This AO solicits flight missions, not technology or advanced engineering development projects. Proposed investigations are generally expected to have mature technologies, with systems at a Technology Readiness Level (TRL) of 6 or higher. 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 EVM-2 Library. TRLs are defined in NPR

7123.1B *NASA Systems Engineering Processes and Requirements*, Appendix E, which can be found in the EVM-2 Library.

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. The TRL state of systems may be validated by an independent team at PDR.

Requirement 22. 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).

5.2.5 Environmental Review and Launch Approval

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

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

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

Launch approval processes carry an estimated cost of $100K for routine NASA payload environmental assessment and $500K for nonroutine NASA payload environmental assessment.

Requirement 23. The costs of environmental review and launch approval shall be included in the PI-Managed Mission Cost. The key milestones for environmental review and launch approval shall be accounted for in the proposed schedule.

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

5.2.6 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 EVM-2 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.

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 24. Proposals shall include mission requirements for telecommunications, tracking, and navigation; proposals shall also include a plan for meeting those requirements, including a cost plan, where the cost of development and use of telecommunications, tracking, and navigation services must be included within the PI-Managed Mission Cost whether or not NASA networks are used.

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 EVM-2 mission. It is SMD policy that none of the DSN 70 meter antennas may be proposed to support normal operations of the selected EVM-2 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).

In order to better manage the Agency's transition to Ka-band service, proposed investigations shall consider the use of Ka-band for science data return. The Space Frequency Coordination Group (SFCG) has recommended (Recommendation 23-1, available at https://www.sfcgonline.org/) that X-band users be limited to using 12 MHz of spectrum in deep space. Where appropriate, these limits will be imposed on missions proposed to this AO.

Requirement 25. If use of NASA's network services is proposed, costs for services, as described in the *NASA's Mission Operations and Communications Services* document, must be included in the proposal's cost plan.

Requirement 26. If use of NASA's network services beyond the capabilities and capacities described in the *NASA's Mission Operations and Communications Services* document is proposed, the proposal shall include a Letter of Commitment from the NASA network provider; the Letter should confirm the ability of the network to provide the required capabilities and capacities and should include an estimate of the additional costs for these capabilities and capacities.

Requirement 27. Proposals shall consider the use of Ka-band for science data return in addition to other data return systems such as X-band.

Requirement 28. 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).

5.2.7 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 29. 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.

5.2.8 Orbital Constellations

If a mission has a need to fly in an orbital constellation, such as the Afternoon Constellation (A-train), the proposer should be aware that additional requirements may be levied on the mission by the constellation members. The *Operations Coordination Plan for the Morning and Afternoon Constellations* document can be found in the EVM-2 Library.

Requirement 30. Proposals for missions that need to fly in an orbital constellation shall acknowledge these requirements and demonstrate that the requirements will be accommodated if the mission is selected.

5.2.9 End-of-Mission Spacecraft Disposal Requirement

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

For hosted payloads, where the PI is not responsible for the host mission, information shall be included regarding the instrument's contributions to orbital debris and how the instrument will be passivated at end-of-mission. This will allow NASA to remain in compliance with NPR 8715.6A, *NASA Procedural Requirements for Limiting Orbital Debris*.

Requirement 31. As applicable for Earth and Moon orbiters, proposals shall demonstrate satisfaction of the orbit disposal requirement by providing a mission lifetime analysis and indicating whether disposal is in orbit or with a reentry, either controlled or uncontrolled (see Appendix B, Section J.7, for additional detail). For hosted payloads, where the PI is not responsible for the host mission, information shall be included regarding the instrument's contributions to orbital debris and how the instrument will be passivated at end-of-mission.

NPR8715.6A also includes a requirement for an End-of-Mission Plan (Section 2.2.2), which must be approved before launch.

5.2.10 Deviations from Recommended Payload Requirements

NASA missions are required to meet the requirements for safety, reliability, and quality assurance in Appendix C of NPR 8705.4 for the payload class specified in Section 5.2.3 (NPR 8705.4 is found in the EVM-2 Library).

Requirement 32. Proposals shall indicate any expected deviations from the recommended requirements in Appendix C of NPR 8705.4 for the payload class specified in Section 5.2.3.

5.2.11 Mission Operations Tools and Services

NASA's Advanced Multi-Mission Operating System (AMMOS) comprises a set of tools and services that support the operations of robotic flight missions (see the AMMOS catalog at ammos.jpl.nasa.gov). AMMOS tools and services and their long-term sustaining engineering are fully funded by NASA, and are provided by NASA free of charge to all missions. Only mission-unique adaptations to the AMMOS must be funded by missions. Use of applicable AMMOS tools is expected, although not required. A point of contact and costing information for these services may be found in the *NASA's Mission Operations and Communications Services* document in the EVM-2 Library.

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

Requirement 33. If a ground/operations system solution other than the AMMOS or mission-unique adaptations to the AMMOS are proposed, it shall be described and budgeted 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, but not required.

The PI must be prepared to recommend project termination when, in her/his judgment, the minimum subset of science objectives identified in the proposal as the Threshold Science Mission (Section 5.1.5) is not likely to be achieved within the committed cost and schedule.

Requirement 34. A proposal shall identify and designate one, and only one, PI as the individual in charge of the proposed investigation.

5.3.2 Project Manager

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

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

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

Requirement 35. 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 36. A proposal shall identify and designate, one and only one, PSE as the individual responsible for the systems engineering process implementation of the proposed project.

5.3.4 PI, PM, and PSE Roles

Requirement 37. 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), Project Applications (PA) lead (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 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 38. Proposals shall identify the management positions that will be filled by Key Management Team members. These positions shall include, as a minimum, the PI, PM, PSE, Project Manager Alternate (if named), and, where appropriate, the PS, PA, 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 34, Requirement 35, and Requirement 36), proposals shall describe the qualifications and experience of those team members who occupy those positions. For management positions for which Key Management Team members are not named, proposals shall describe the qualifications and experience required of any candidate to occupy those positions. For all positions that will be filled by Key Management Team members, proposals shall demonstrate that the described qualifications and experience are commensurate with the technical and managerial needs of the proposed investigation. The time commitment of each Key Management Team member shall be provided by mission phase.

Requirement 39. Proposals shall describe the qualifications and experience of the primary implementing institutions and demonstrate that they are commensurate with the technical and managerial needs of the proposed investigation.

5.3.6 Risk Management

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

Requirement 40. Proposals shall define and discuss the major risks to the formulation and implementation of the proposed investigation.

Requirement 41. 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 5.1.5) 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 descopes, which still allows the investigation to satisfy the objectives of the Threshold Science Mission, may be proposed.

Requirement 42. If the proposed risk management approach includes potential descoping of mission capabilities, the proposal shall include a discussion of the approach to such descopes, including savings of resources (mass, power, dollars, schedule, etc.) by implementing descopes, and the decision milestone(s) for implementing descopes, and the scientific impact of individual, as well as combined, descopes.

Requirement 43. Proposals that include international participation shall address the risk resulting from any international contributions to the proposed mission (see Section 5.6.6 and Section 5.7).

5.3.7 Compliance with Procurement Regulations by NASA PI Proposals

Proposals submitted by NASA Centers are required to comply with regulations governing proposals submitted by NASA PIs (NASA FAR Supplement (NFS) 1872.308). Additional instructions may be found in Procurement Information Circular (PIC) 05-15 (available in the EVM-2 Library).

Requirement 44. Proposals submitted by NASA Centers shall contain any descriptions, justifications, representations, indications, statements, and/or explanations that are required by the regulations in NFS 1872.308 (see Appendix B, Section J.8, for additional detail).

5.4 Science Team, Co-Investigators, and Collaborators

5.4.1 Science Team

Requirement 45. Proposals shall clearly define the science team necessary to successfully conduct the science investigation. Science teams may include qualified representatives from applications communities.

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

5.4.3 Collaborators

A collaborator is an individual who is less critical to the successful development of the mission than a Co-I. A collaborator 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.

Requirement 48. Proposals shall identify and designate all collaborators.

5.5 Small Business Participation and Education, Communications and Public Outreach

5.5.1 Small Business Participation

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

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

However: proposals are not required to include small business subcontracting plans, but selected investigations will be required to provide them prior to negotiation and award (see Section 7.4.3). Failure to submit a subcontracting plan after selection will make the offeror ineligible for award of a contract. The subcontracting plans will be evaluated on the participation

goals and quality and level of work performed by small business concerns overall, as well as that performed by the various categories of small business concerns listed in FAR 52.219-9, 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 Phase A and will negotiate any additional funding necessary to meet these requirements. A Communications and Outreach program (previously referred as Public Outreach) is required for this solicitation as described below.

5.5.2.1 Communications and Outreach Program

Requirement 49. The proposal shall describe a plan and budget for communications and outreach to include print, electronic and visual media opportunities. This plan shall include participation at NASA booths during conferences and outreach activities during launch. The ability to adapt to new opportunities and to coordinate with/support NASA events shall also be addressed.

5.5.3 Student Collaborations (optional)

Proposals may define a Student Collaboration (SC) that enhances yet is a separate part of the proposed investigation. A SC can take the form of an instrument development, an investigation of scientific questions, analysis and display of data, development of supporting hardware or software, or other aspects of the investigation. The SC must be incorporated into the mission on a nonimpact basis. That is, the SC may not increase the mission development risk or impact the development or performance of the baseline science investigation in any way that would cause the baseline mission to be compromised in the event that the SC component is not funded; encounters technical, schedule, or cost problems; or fails in flight. A SC must be dependent upon the proposed mission being implemented, e.g., require the provision of flight elements and/or access to science/engineering data generated by the mission. SC elements that involve only analysis of archival data may not be proposed. A SC may, but is not required to, have the potential to add value to the science or engineering of the mission. A SC must include appropriate plans for the mentoring and oversight of students to maximize the opportunity for teaching, learning, and success in contributing to the mission.

A SC is not equivalent or associated with an Education Program. If a proposed investigation is selected, NASA retains the option to fund or not to fund any proposed SC.

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

student collaboration incentive, then the rest of the NASA cost of the SC must be within the PI-Managed Mission Cost.

A proposed SC will be evaluated only for its impact on mission feasibility. The merit of the proposed SC will be evaluated during Phase A as part of the reviews leading to KDP-B; see *The Explanatory Guide to the NASA Science Mission Directorate Educational Merit Evaluation Factors for Student Collaboration Elements* in the EVM-2 Library.

Requirement 50. If a proposal contains a SC, the proposal shall demonstrate that the proposed SC is clearly separable from the proposed Baseline and Threshold Science Mission investigations, to the extent that the SC will not impact the science investigation in the event that the SC is not funded; that the SC fails during flight operations; or that the SC encounters technical, schedule, or cost problems during development (see Appendix B, Section I.2, for additional detail).

Requirement 51. If a proposal contains a SC, the proposal shall identify the funding set aside for the SC; this funding may be outside the PI-Managed Mission Cost up to the student collaboration incentive, and any SC costs beyond the student collaboration incentive shall be within the PI-Managed Mission Cost.

5.6 Cost Requirements

5.6.1 PI-Managed Mission Cost and Total Mission Cost

The PI-Managed Mission Cost for this AO, including all mission phases, and including access to space (unless the access to space is contributed by a partner), is capped at $166M FY 2018 dollars.

Requirement 52. Proposals shall include the proposed PI-Managed Mission Cost and the proposed Total Mission Cost in all required AO cost tables (see Appendix B, Section H, for required AO cost tables).

Requirement 53. The proposed costs shall comply with the specified AO Cost Cap.

Requirement 54. No more than 25% of the PI-Managed Mission Cost may be spent prior to KDP-C (Confirmation).

5.6.2 Cost Estimating Methodologies and Cost Reserve Management

Proposals may use estimates derived from models or cost estimating relationships from analogous missions (see Appendix B, Section H, for additional detail). The credibility of proposed costs is likely to be enhanced, when they are supported by a conservative approach to costing.

Requirement 55. Proposals shall identify the methodologies (cost models, cost estimating relationships of analogous missions, etc.) and rationale used to develop the proposed cost.

Requirement 56. 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 cost risk and not selected. For the purpose of this AO, the unencumbered cost reserves on the PI-Managed Mission Cost are measured as a percentage against the cost to complete through Phases A/B/C/D. The numerator is the amount of unencumbered cost reserves for Phases A/B/C/D, not including funded schedule reserve. The denominator is the PI-Managed Mission Cost to complete Phases A/B/C/D, including the cost of technical design margin, including funded schedule reserve, and encumbered cost reserve, but not including unencumbered cost reserve.

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

Requirement 57. Proposals shall justify the adequacy of the proposed cost reserves. Proposals shall comply with the requirement for unencumbered cost reserves against the cost to complete and shall demonstrate an approach to maintaining required unencumbered cost reserves through subsequent development phases.

Requirement 58. Although minimum unencumbered cost reserves are not specified in this AO for Phases E and F, proposals shall establish, identify and justify adequate reserves for these phases of the mission.

5.6.3 Work Breakdown Structure

Requirement 59. Proposals shall provide a Work Breakdown Structure (WBS) that conforms to the standard prescribed in Appendix H 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).

5.6.4 Master Equipment List

Requirement 60. Proposals shall include a Master Equipment List (MEL) summarizing all spacecraft system element components and individual instrument element components to support validation of proposed mass estimates, power estimates, contingencies, design heritage, and cost (see Appendix B, Section J.9, for additional detail).

5.6.5 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 cost cap, to enable a level playing field for all proposers. Per Headquarters policy guidance signed in June 2010 by the Associate Administrator, Mission Support Directorate and by the Agency Chief Financial Officer, all Centers shall use an identical CM&O burden rate of $47K (FY 2018) per "equivalent head." Per NASA policy, this rate must be applied as a "cost per equivalent head" to all Civil Service Full Time Equivalents (FTEs) plus on/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 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 N-2 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 61. 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 62. 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 EVM-2 Library.

Requirement 63. Proposals including costs for non-NASA Federal Government agencies shall follow the applicable accounting standards.

5.6.6 Contributions

Contributions from sources other than the ESSP Program and other SMD programs, U.S. or non-U.S., are welcome. There are no limits on the value of contributions under this AO. Contributions may include, but are not limited to, labor, services, and/or contributions to the instrument complement, the spacecraft or access to space, however contributions of non-U.S. nuclear power sources are prohibited. 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).

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

The cost of contributed labor and services must be consistent with rates paid for similar work in the proposer's organization. The cost of contributions does not include funding spent before 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 64. If a proposal includes one or more contributions, the proposal shall separately identify all contributions, the organizations providing the contributions, and the organizations providing the funding for the contributions; the costs for the contributions shall be clearly identified within the Total Mission Cost.

Requirement 65. 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.

Letters of Commitment are required from each organization responsible for a contribution (for U.S. organizations, see Section 5.8.1.1 and Requirement 75; for non-U.S. contributing organizations, see Section 5.7.2 and Requirement 69).

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 proposal for collaborator support. The requirement for personal statements of commitment from collaborators is given in Section 5.8.1.3 and Requirement 77.

A contributed item that is essential for the success of the proposed investigation and/or is in the critical path of mission development is a risk factor. Risks include the failure of funding or contributions to materialize when they are outside the control of the PI. Mitigation may include, but is not limited to, descoping the contributed items and/or holding reserves to develop the contribution directly. Note that reserves held for this purpose will be considered by NASA to be encumbered. 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 66. 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.

For proposals with contributed access to space (Section 5.9.4), all requirements in Appendix B must be met. Where a resource is being contributed (e.g., launch services, host spacecraft), all of the information required might not be available to the proposer (e.g., Appendix B, Section F.2). Nevertheless, the proposal must provide sufficient information on the availability of that resource for NASA to assess whether the mission's resource requirements can be met and how the PI will assure the mission's success.

Requirement 67. If a proposal includes contributed access to space, it must provide sufficient information for NASA to assess whether the mission's resource requirements can be met and how the PI will assure the mission's success.

5.7 Non-U.S. Participation Requirements

5.7.1 Overview of Non-U.S. Participation

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

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

Owing to NASA's policy to conduct research with non-U.S. entities on a cooperative, no-exchange-of-funds basis, NASA does not normally fund non-U.S. research proposals or non-U.S. research efforts that are part of U.S. research proposals. Rather, cooperative research efforts are normally implemented via agreements between NASA and the appropriate non-U.S. entity. Non-U.S. proposers, 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, U.S. and non-U.S., must be typewritten in English and must comply with all submission requirements stated in this AO and in Appendix B of this AO.

Requirement 68. 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.

Requirement 69. 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 in a Letter of Commitment for a contribution are given in Section 5.8.1. 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 must sign these Letters of Commitment.

Contributions from non-U.S. sources offer benefits but also represent complexity and risk to a project. The benefits of proposed contributions will be assessed as they contribute to scientific

and technical merit and feasibility. The stability and reliability of proposed partners, and the appropriateness of any proposed contribution, will be assessed outside of the evaluation process, as a programmatic risk element in the proposal.

Requirement 70. Proposals from U.S. proposers shall include a discussion of mitigation plans, where possible, for the failure of funding or contributions to materialize when they are outside the control of the PI. When no mitigation is possible, this should be explicitly acknowledged and the rationale for accepting the unmitigated or residual risk should be explicitly stated.

Mitigation may include, but is not limited to, descoping the contributed items and/or holding reserves to develop the contribution directly. Note that reserves held for this purpose will be considered by NASA to be encumbered. When no mitigation is possible, this must be explicitly acknowledged and the rationale for accepting the unmitigated or residual risk must be explicitly stated. In addition to budget and technical risk, non-U.S. contributions introduce schedule risk for implementing agreements, as well as for obtaining any necessary licenses for exchanges of goods and technical data. An adequate and realistic schedule must be allocated for having international agreements executed. NASA will not normally initiate development of any international agreements until after the selection decision is made.

Any proposed non-U.S. participation must be described at the same level of detail as that of U.S. partners, including the provision of technical, schedule, and management data. 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 71. Any proposed non-U.S. contribution essential to the success of the proposed investigation shall be described at the same level of detail as those of U.S. partners.

Requirement 72. Proposals with non-U.S. participation shall include a table listing: (i) non-U.S. participants (individuals, institutions), (ii) roles and responsibilities, (iii) funding organization, (iv) approximate value of contribution and method for estimating value (detailed budget not required), and (v) cross-reference to any Letters of Commitment in the proposal appendix. Proposals with non-U.S. participation must clearly describe the flow of design requirements (potentially export controlled information) and hardware between U.S. and non-U.S. participants. This description may take the form of a flowchart. See Section J.4 of Appendix B.

5.7.3 Agreements with Selected Non-U.S. Participants

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

It is the policy of NASA to establish formal agreements with non-U.S. partners in cooperation on flight missions. In some cases, interim agreements may be put in place, after the conclusion of Phase A, until a more permanent arrangement is reached.

Requirement 73. If applicable, proposals shall show how the Phase A 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 74. Non-U.S. proposals and U.S. proposals that include non-U.S. participation shall describe plans for compliance with U.S. export laws and regulations, e.g., 22 CFR Parts120-130 and 15 CFR Parts 730-774, as applicable to the circumstances surrounding the particular non-U.S. participation (see Appendix B, Section J.5, for additional detail).

5.8 Additional Proposal Requirements

5.8.1 Letters of Commitment

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

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

The required elements in an institutional Letter of Commitment for a major partner are: (i) a statement of commitment for the effort that is assigned to that participant in the proposal, (ii) a description of what is being provided, and (iii) a signature by an official authorized to commit the organization.

5.8.1.1 Letters of Commitment for Contributions

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

Requirement 75. 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.

The requirement for Letters of Commitment from non-U.S. organizations offering contributions is given in Section 5.7.2 and Requirement 69.

5.8.1.2 Letters of Commitment for Major Partners

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

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

Requirement 76. Unless otherwise explicitly exempted elsewhere in this AO (e.g., Section 5.2.6), proposals shall include a Letter of Commitment from each major partner in the proposal, regardless of source of funding. For major partners providing one or more contributions, only a single Letter of Commitment is required.

5.8.1.3 Personal Letters of Commitment

No personal Letters of Commitment are required in the proposal. No institutional Letters of Commitment are required for individuals in the proposal, unless the individual is contributed and part of the Proposal Team. The Proposal Team is defined to include, but not be limited to, all members of the Key Management Team and any Co-I who is not part of the Key Management Team. Proposal Team members are identified on the NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES) proposal cover page. Proposal Team members indicate their commitment to the proposed investigation through NSPIRES (see Appendix B, Section A.3, for instructions).

Requirement 77. Every Proposal Team member shall indicate his/her commitment to the proposed investigation and specifically to the role, responsibilities, and participating organization proposed for him/her, through NSPIRES.

5.8.2 Export Controlled Material in Proposals

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

While inclusion of export controlled material in proposals is not prohibited, proposers are advised that the inclusion of such material in proposals may complicate NASA’s ability to evaluate proposals, as NASA may employ the services of non-U.S. citizens, who are not 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 must be marked with a notice to that effect.

Requirement 78. If the proposal contains export controlled material, the following statement shall be prominently displayed in Section A of the proposal (following the Graphic Cover Page):

"The information (data) contained in [insert page 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."

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

5.8.3 Classified Proposal Appendix Regarding Heritage

In order to increase the capabilities of investigations proposed in response to this AO while minimizing the development and operations risks within the PI-Managed Mission Cost, proposers may choose to leverage technology that was developed by other institutions and agencies as well as technology developed by NASA and NASA-funded partners. It is recognized that some technology relevant to proposed missions may have classified heritage.

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

Requirement 79. Proposals submitted in response to this AO, as well as the proposed investigations and all proposed technologies, shall be unclassified. The proposal shall be complete including an unclassified appendix regarding heritage (see Appendix B, Section J.10, for further details).

When a proposer submits a classified appendix regarding heritage in addition to a complete proposal, the evaluation processes (Section 7.1.1) will be supplemented. At least one reviewer with appropriate clearance and relevant expertise will review the classified appendix regarding heritage; this reviewer may be a member of the review panel or this reviewer may be a specialist reviewer. All findings generated during the review of the classified appendix regarding heritage will be unclassified, and these findings will be provided to the Technical, Management, and Cost (TMC) Evaluation Panel as input for assessing the TMC feasibility of the proposed mission implementation, including cost risk. 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 panel. The evaluation panel will not have access to the classified appendix regarding heritage. Proposers are strongly encouraged to provide as much information and detail as possible on their technology heritage in the unclassified appendix regarding heritage.

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

If the proposer wishes to send a classified appendix regarding heritage to NASA, it must be provided to NASA Headquarters separately from the proposal and no later than the due date for the proposal. A single copy of the classified appendix regarding heritage must be submitted along with a cover letter referencing the submitted proposal by name, PI, and proposing organization. The proposer is responsible for obtaining any "need to know" permission for at least one reviewer with appropriate clearance and relevant expertise to evaluate the classified appendix regarding heritage; that permission should be discussed in the cover letter. The proposer assumes all responsibility for determining the appropriate security clearance and method of 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 80. Proposers that choose to submit a classified appendix regarding heritage shall submit the appendix and a cover letter to NASA Headquarters no later than the proposal due date. The proposer shall determine the appropriate security classification for the classified appendix, the proposer shall obtain any permission required for a reviewer to read the classified appendix, and the proposer shall ensure that all appropriate security requirements are followed in delivering the classified appendix to NASA Headquarters.

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

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

5.9 Program Specific Requirements and Constraints

5.9.1 Commitment for a Single-Step Selection

For each selection, and unless otherwise stated in the selection letter, the selected mission’s cost will be set at the proposed cost.

Requirement 81. Each proposal shall include a commitment by the PI for the cost, schedule, and scientific performance of the investigation.

This commitment statement must be placed in Section A of the proposal (see table titled "Proposal Structure and Page Limits" in page B-2 of Appendix B).

5.9.2 Schedule Requirements

Requirement 82. Proposals shall plan for an Investigation Start date no later than 1/17/17.

Requirement 83. Proposals shall plan for a Launch Readiness Date no later than 6/30/2022 or five years after the contract is in place whichever is earlier.

5.9.3 NASA Provided Launch Services

If the proposed EVM-2 investigation (including a CubeSat Investigation) requires NASA provided launch services, then the 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 a Risk Category allowable for Class D payloads per NPD 8610.7D, *NASA Launch Services Risk Mitigation Policy for NASA-Owned and/or NASA-Sponsored Payloads/Missions*, will be provided at a $55M charge to the PI-Managed Mission Cost. There will be an additional charge against the PI-Managed Mission Cost for any launch services beyond the standard launch services offered. Detailed information on launch vehicle performance options for this AO, including a description of standard launch services and the nominal costs for nonstandard services for this AO, is provided in the *EVM-2 AO ELV Launch Services Program Information Summary* document in the EVM-2 Library. NASA will not provide access to space for instruments that may be hosted on the International Space Station (solicited in EVI) for this EVM-2 solicitation.

NASA provides launch opportunities for CubeSats as secondary payloads on U.S. Government missions through the NASA CubeSat Launch Initiative (CSLI please refer to http://www.nasa.gov/directorates/heo/home/CubeSats_initiative.html) at no cost. If the PI proposes to launch through the NASA CSLI, a commitment from the NASA CSLI for launch within the schedule constraints of this AO will be required. NASA also plans to provide micro/small satellite class payload launch services for CubeSats as primary missions. If NASA provides launch services for a CubeSat investigation as a primary mission, there will be a $17M charge to the PI-Managed Mission Cost. The $17M charge is only applicable to launch services for no more than a total of 50kg (inclusive of any project deployment hardware). NASA will provide no more than 2 two launches to place the 50kg in orbit. For more information on requirements and constraints on the NASA CSLI launch services, please see http://www.nasa.gov/directorates/heo/home/CubeSats_initiative.html. For further information, please contact: Anne E. Sweet, Launch Services Program Executive, Phone: 202-358-3784, E-mail: anne.sweet-1@nasa.gov or Jason C Crusan, Director, Advanced Exploration Systems, Phone: 202-358-0635, E-mail: jason.crusan@nasa.gov

Requirement 84. Proposals shall define the required launch vehicle capability and demonstrate that it is compatible with the standard launch services offered.

Requirement 85. For NASA-provided launch services, if services beyond the standard launch services offered are required, the proposal shall include the additional cost of such services in the PI-Managed Mission Cost.

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

Due to the volatility of the launch services market, NASA cannot ensure which launch vehicles will be available at the time of the launch deadline specified in Section 5.9.1. Accordingly, proposers are advised to plan for compatibility with vehicle families that provide the required performance and are expected to be available through spacecraft Preliminary Design Review (PDR; see the *EVM-2 AO ELV Launch Services Program Information Summary* in the EVM-2 Library). It is recommended that payload designs accommodate launch environments for these vehicle families.

Requirement 86. Proposals shall discuss flexibility to be accommodated on multiple launch vehicle families.

The specified launch services cost charge to be used in the proposal is commensurate with the class of launch vehicle to be provided by NASA (see the *EVM-2 AO ELV Launch Services Program Information Summary* in the EVM-2 Library). If the actual contracted cost to NASA of the launch services is different than the cost charge provided for proposal purposes, then NASA will be responsible for the difference in cost (either positive or negative). The cost risk for NASA provided launch services is not included in the PI-Managed Mission Cost. Therefore, cost reserves are not required for NASA-provided launch services.

5.9.4 Alternative Access to Space

Alternative access to space, rather than the use of NASA-provided launch services, may be proposed or considered under this AO. Alternative access to space may include non-NASA launch services as primary, secondary (e.g., on a secondary payload adapter), or co-manifested payloads on a U.S.- or foreign-manufactured launch vehicle. Alternative access to space may include payload accommodations as a hosted payload (e.g., instrument package) on a U.S.- or non U.S.-provided spacecraft launching on a U.S.- or foreign-manufactured launch vehicle. Instruments that may be hosted on the International Space Station (solicited in EVI) are not solicited in this EVM-2 AO.

Proposed alternative access to space must be consistent with the National Space Transportation Policy(http://www.whitehouse.gov/sites/default/files/microsites/ostp/national_space_transportation_policy_11212013.pdf) and with any policies or requirements specified in this AO.

For proposals submitted in response to this AO, NASA will accept a Launch Vehicle Risk Category 1 (per NPD 8610.7D, *NASA Launch Services Risk Mitigation Policy for NASA-Owned and/or NASA Sponsored Payloads/Missions)* for non-NASA provided access to space.

Non-NASA launch services and hosted payloads will be handled by NASA consistent with existing policy and regulations. The demonstrated reliability and the resultant probability of mission success for non-NASA launch services and hosted payloads will be evaluated by NASA consistent with National Space Transportation Policy (*National Space Transportation Policy*, Section IV) and NASA's Launch Services Risk Mitigation Policy (NPD 8610.7D, *NASA Launch Services Risk Mitigation Policy for NASA-Owned and/or NASA-Sponsored Payloads/Missions*). The proposed launch service will be assessed in conjunction with NASA stakeholders as part of the selection process. A charge to the PI-Managed Mission Cost of $2.0M will be levied for the expected NASA launch vehicle monitoring functions and advisory services. The functions, operating structure, and policies of NASA Launch Services Program (LSP) with regards to defining and executing advisory services or consulting for government or commercial entities are defined in the *Launch Services Program (LSP) Advisory Services Plan* that can be found in the EVM-2 Library. The NASA Flight Planning Board will approve final mission assignment assuring consistency with Agency risk strategy. Information on the reliability of ELVs may be obtained from the point of contact listed in the *EVM-2 AO ELV Launch Services Program Information Summary* document.

This AO permits proposals where the proposer has arranged alternative access to space and where the proposed mission may not be the primary payload for the arranged launch vehicle or for the arranged spacecraft. Nevertheless the proposed investigation must be a complete Earth science investigation (Requirement 13) and the PI must remain in charge of the development, launch, and successful operation of the EVM-2 investigation (Requirement 34).

Requirement 87. In a proposed arrangement for alternative access to space, the proposal shall demonstrate that the proposed EVM-2 mission is a complete and compelling science investigation and that the PI remains in charge of the investigation within the proposed partnership environment.

Requirement 88. In a proposed arrangement for alternative access to space, the proposal shall demonstrate how the proposed mission requirements (including cost, schedule, and margins) will be met by the host partner for those areas of mission implementation that are not under the PI's control.

The stability and reliability of the proposed relationship with the host organization will be assessed as a programmatic risk element in the proposal.

Requirement 89. For proposed secondary or co-manifested missions, or for missions proposed as hosted payloads, the PI assumes all risk for any delays in the implementation of the parent mission and shall, therefore, propose appropriate reserves for such schedule contingencies.

Participation of EVM-2 investigators as a contributor to a larger mission, what NASA SMD has traditionally called a "Partner Mission of Opportunity" in prior AOs, is not permitted in response to this AO.

5.9.4.1 Non-NASA Launch Services

Alternative access to space may include the provision of non-NASA launch services as primary, secondary, or co-manifested payloads on a U.S.- or foreign-manufactured launch vehicle.

- Under this AO, purchased launch services must be obtained on a U.S.-manufactured launch vehicle only. The *National Space Transportation Policy* (Section IV) prescribes the use of U.S.-manufactured launch vehicles for the launch of U.S. Government-sponsored payloads.
- Launches of secondary payloads are permitted on foreign-manufactured launch vehicles only for which no U.S. launch service is available.
- Contributed launch services may be obtained on a U.S.- or foreign-manufactured launch vehicle; contributed launch services must be provided on a no-exchange-of-funds basis.
- If a foreign-manufactured launch vehicle is contributed, then that contribution must be part of a legitimate scientific collaboration.

Alternative Access to Space Options involves several complex issues at this stage of project maturity. It is in the proposer's best interest to clearly support the maturity of their plan and access to space possibilities. The minimum expectations for access to space arrangements must be included in the proposal to the level of detail outlined in Requirement 90 (iv). Any additional evidence of maturity or commitment provided will be used to support risk evaluation.

~~Requirement 90. Proposals that include non-NASA launch services (purchased or contributed) obtained from a U.S. or non-U.S. partner shall meet the following requirements:~~

~~(i) The proposer must secure the Launch Services Provider when flying as a primary.~~

~~(ii) The proposer must secure the commitment of the proposed co-manifested mission organization(s) or, when flying as a secondary, of the primary mission organization(s) providing the launch services.~~

~~(iii) The proposal must identify the launch opportunity and must provide evidence in the proposal that the launch service provider agrees to manifest the EVM-2 mission should the proposal be selected and confirmed for flight by NASA.~~

~~(iv) The proposal must describe the launch services, demonstrate compatibility with the proposed launch vehicle and show how the provider will fulfill the mission requirements.~~

~~(v) The proposal must describe the approach for NASA's insight for launch services, and the proposal budget must include a $2.0M charge for NASA launch vehicle monitoring functions and advisory services.~~

Requirement 90. **Proposals that include non-NASA launch services (purchased or contributed) obtained from a U.S. or non-U.S. partner shall meet the following requirements:**

(i) The proposer must demonstrate a commitment from the organization(s) that will provide the launch services.

(ii) The proposer must demonstrate a commitment from the launch services provider when flying as a primary.

(iii) The proposer must demonstrate a commitment for the proposed co-manifested mission organization(s) or, when flying as a secondary, of the primary mission organization(s) utilizing the launch services; these commitments must be documented in a Letter from the appropriate organization(s).

(iv) The proposal must identify the launch opportunity and must provide evidence in the proposal that the launch service provider agrees to manifest the mission should the proposal be selected and confirmed for flight by NASA. This evidence must include a Letter from the launch service provider containing, at a minimum, the following information:

a. Evidence that the launch service provider will provide the services described in the proposal under the conditions (cost, schedule) described in the proposal;

b. A description of the opportunity (or opportunities, if more than one under consideration) that the launch service provider can offer for consideration by the PI; and

c. A description of the process that the launch service provider will use in order to commit to the PI to provide specific launch services for the proposed investigation, should NASA select the proposed investigation; this process description must include a notional schedule for identifying the specific launch opportunity and definitizing the cost.

(v) The proposal must describe the launch services, demonstrate compatibility with the proposed launch vehicle, and show how the provider will fulfill the mission requirements.

(vi) The proposal must describe the approach for the proposer and for the launch service provider to work with NASA to enable NASA's insight for launch services, and the proposal budget must include a $2.0M charge for NASA launch vehicle monitoring functions and advisory services. [Amended 10/15/2015]

Contributed launch services launching a NASA payload on a foreign-manufactured launch vehicle as part of a legitimate scientific collaboration will require a Memorandum of Understanding between NASA and the foreign space agency providing the launch services, as well as coordination within the U.S. Government.

The launch of a NASA payload on a contributed foreign-manufactured launch vehicle is subject to certain U.S. Government review and approval processes. Selection of any proposal that includes the contribution of launch services on a foreign-manufactured launch vehicle is conditional until approval has been obtained.

Requirement 91. Proposals that include non-NASA launch services on a foreign-manufactured launch vehicle shall meet the following requirements:

(i) The proposal must demonstrate that the launch services are being contributed on a no-exchange-of-funds basis.

(ii) The proposal must demonstrate that the provision of launch services on a foreign-manufactured launch vehicle is part of a legitimate scientific collaboration.

5.9.4.2 Hosted Payloads

Alternative access to space may include purchased or contributed payload accommodations as a hosted payload (e.g., instrument package) on a U.S.- or foreign-provided spacecraft launching on a U.S.- or foreign-manufactured launch vehicle.

- Purchased payload accommodations may be obtained on a U.S.- or a foreign-provided spacecraft. Launch may subsequently occur on a U.S.- or foreign-manufactured launch vehicle.
- Contributed payload accommodations may be obtained on a U.S.-provided spacecraft on a no-exchange-of-funds basis.
- Contributed payload accommodations may be obtained on a foreign-provided spacecraft only if the accommodations are provided as part of a legitimate scientific collaboration on a no-exchange-of-funds basis.

Requirement 92. Proposals that include payload accommodation as a hosted payload shall meet the following requirements:

(i) The proposer must secure the organization(s) that will provide the payload accommodations.

(ii) The proposal must identify the mission opportunity or opportunities and must provide evidence in the proposal that the mission provider agrees to manifest the EVM-2 investigation should the proposal be selected and confirmed for flight by NASA.

(iii) The proposal must describe the accommodation, demonstrate compatibility with the proposed spacecraft and show how the host will fulfill the mission requirements.

(iv) The proposed EVM-2 investigation must be self-sufficient (with exception of any critical resources provided by the host platform) and the success of the EVM-2 investigation must not depend on the other science payloads accommodated on the host platform. The NASA PI is responsible for the entire EVM-2 investigation including mission assurance. The proposal shall describe how mission assurance will be met for those areas that are not under the PI's control.

(v) The proposal must describe the approach for NASA’s insight for launch services, and the proposal budget must include a $2.0M charge for NASA launch vehicle monitoring functions and advisory services.

When the provision of accommodations on foreign-provided spacecraft or launch services is contributed on a no-exchange-of-funds basis and as part of a legitimate scientific collaboration, it will require a formal agreement between NASA and the foreign entity providing the accommodation or launch services (Section 5.7), as well as coordination within the U.S. Government.

The launch of a NASA hosted payload on a non-U.S.-provided spacecraft is subject to certain U.S. Government review and approval processes. Selection of any proposal that includes hosted payload accommodations non-U.S.-provided spacecraft is conditional until approval has been obtained.

Requirement 93. Proposals that include contributed accommodations on a foreign-provided spacecraft shall meet the following requirements:

(i) The proposal must demonstrate that the accommodations are being contributed on a no-exchange-of-funds basis.
(ii) The proposal must demonstrate that the accommodations are being contributed as part of a legitimate scientific collaboration.

6. Proposal Submission Information

6.1 Preproposal Activities

6.1.1 Preproposal Conference

A Preproposal Conference will be held via Teleconference/Webex in accordance with the schedule in Section 3. Further information will be available at the EVM-2 Acquisition Homepage (see Section 6.1.4) prior to the Preproposal Conference.

The purpose of this conference will be to address questions about the proposal process for this AO. Questions should be sent to the EVM-2 Program Scientist at the address given in Section 6.1.5. NASA personnel will address all questions that have been received no later than five working days prior to the Conference. Questions submitted after this date may be addressed at the Conference as time permits and as appropriate answers can be generated. Anonymity of the authors of all questions will be preserved. Presentations made at the Preproposal Conference, including answers to all questions addressed at the conference, will be posted on the EVM-2 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.

6.1.2 Notice of Intent to Propose

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

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

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

(a) Name, address, telephone number, fax number, E-mail address, and institutional affiliation of the PI.
(b) Full names and institutional affiliations of each known Proposal Team member. If any Proposal Team members are from non-U.S. institutions, the vehicle by which these people expect to be funded should be identified in the comments box on the NOI form.
(c) Anticipated access to space (NASA-provided launch services, contributed or purchased alternative launch services, contributed or purchased alternative accommodations, etc.).

(d) A brief statement (150 words or less) for each of the following:
  (i) science objectives of the proposed mission;
  (ii) identification of new technologies that may be employed as part of the mission.
(e) The name of the organizational lead from each organization (industrial, academic, nonprofit, and/or Federal) included in the proposing team, and the organization's role in the proposed investigation, as may be known at the time of the NOI.

NASA SMD requests that proposers communicate any changes to the investigation team, between NOI and proposal submission, to the EVM-2 Program Scientist identified in Section 6.1.5 of this AO. Submitting an NOI does not commit the team to submitting a proposal.

6.1.3 Teaming Interest

As a result of recent AOs similar to this one, commercial aerospace and technology organizations have requested a forum to inform potential proposers of their services and/or products. NASA is willing to offer this service with the understanding that the Agency does not endorse any information thus transmitted and does not accept responsibility for the capabilities or actions of these organizations. The organizations listed on the EVM-2 Teaming Interest page of the EVM-2 Acquisition Homepage (see address given in Section 6.1.4) have expressed interest in teaming with other organizations on EVM-2 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 EVM-2 Library and Acquisition Home Page

The EVM-2 Library provides additional regulations, policies, and background information on EVM-2. Information on the EVM-2 Library is contained in Appendix D. The EVM-2 Library is described in Appendix D and is accessible at http://essp.larc.nasa.gov/EVM-2/evm-2_library.html.

A EVM-2 Acquisition Homepage, available at http://essp.larc.nasa.gov/EVM-2/, will provide updates and any AO addenda during the EVM-2 AO solicitation process. It will provide links to the EVM-2 Library, information about the Preproposal Conference, a list of potential teaming partners, and questions and answers regarding the AO.

Updates to the AO and any amendments will be posted on the NSPIRES website. A link will be provided on the EVM-2 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 EVM-2 Program Scientist:

Dr. Ramesh Kakar
Earth Science Division
Science Mission Directorate
National Aeronautics and Space Administration
Washington, DC 20546-0001
Telephone: 202-358-0240
E-mail: ramesh.k.kakar@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 94. 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 95. 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 deadline is specified in Section 3. [Partially repeats Requirement 1]

Requirement 96. In addition to electronic submission, two identical, clearly labeled CD-ROMs that contain electronic proposal file(s) and Microsoft Excel files of tables (see Appendix B), shall be delivered to the following address by the "Deadline for Receipt of Proposal on CD-ROMs" specified in Section 3. [Partially repeats Requirement 2]

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

Telephone for commercial delivery: 202-479-9030

NASA will notify proposers that their proposals have been received. Proposers who have not received this confirmation within two weeks after submittal of their proposals should contact the EVM-2 Program Scientist at the address given in Section 6.1.5.

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

6.2.4 Electronic Submission of Proposal Summary Information

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

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

Requirement 97. The proposing organization and all individuals named as Proposal Team members on the Electronic Cover Page shall be registered in NSPIRES.

All Proposal Team members shall indicate their commitment to the proposed investigation through NSPIRES (see Requirement 77).

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

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

7. Proposal Evaluation, Selection, and Implementation

7.1 Overview of the Proposal Evaluation and Selection Process

7.1.1 Evaluation Process

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

Compliant proposals will be evaluated against the criteria specified in Section 7.2 by panels of individuals who are peers of the proposers. Proposals will be evaluated by more than one panel, e.g., a Science Panel and a Technical, Management, and Cost (TMC) Panel. Each panel will evaluate proposals against different criteria. Panel members will be instructed to evaluate every

proposal independently without comparison to other proposals. These panels may be augmented through the solicitation of nonpanel (mail in) reviews, which the panels have the right to accept in whole or in part, or to reject.

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

7.1.2 Categorization and Steering Process

NASA will convene a Categorization Committee composed solely 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.

A SMD AO Steering Committee will then review the results of the evaluations and categorizations. This AO Steering Committee will conduct an independent assessment of the

evaluation and categorization processes regarding their compliance to established policies and practices, as well as the completeness, self-consistency, and adequacy of all supporting materials.

7.1.3 Selection Process

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

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

7.2 Evaluation Criteria

7.2.1 Overview of Evaluation Criteria

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

- Scientific merit of the proposed investigation;
- Scientific implementation merit and feasibility of the proposed investigation; and
- Technical, Management, and Cost (TMC) feasibility of the proposed mission implementation, including cost risk.

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

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

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

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

Summary Evaluation	Basis for Summary Evaluation
LOW Risk	There are no problems evident in the proposal that cannot be normally solved within the time and cost proposed. Problems are not of sufficient magnitude to doubt the Proposer's capability to accomplish the investigation well within the available resources.
MEDIUM Risk	Problems have been identified, but are considered within the proposal team's capabilities to correct within available resources with good management and application of effective engineering resources. Investigation design may be complex and resources tight.
HIGH Risk	One or more problems are of sufficient magnitude and complexity as to be deemed unsolvable within the available resources.

7.2.2 Scientific Merit of the Proposed Investigation

The information provided in a proposal will be used to assess the intrinsic scientific merit of the proposed investigation. Scientific merit will be evaluated for the Baseline Science Mission and the Threshold Science Mission. For this EVM-2 solicitation, emphasis and consideration of research objectives outweighs applications. 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 research and applications 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; how well the mission may support key applications communities and inform decisions; and the necessity for a space mission to realize the goals and objectives.
- Factor A-3. Likelihood of scientific success. This factor includes how well the anticipated measurements support the goals and objectives; the adequacy of the anticipated data to complete the investigation and meet the goals and objectives; and the appropriateness of the mission requirements for guiding development and ensuring scientific success.
- Factor A-4. Scientific value of the Threshold Science Mission. This factor includes the scientific value of the Threshold Science Mission using the standards in the first factor of this section and whether that value is sufficient to justify the proposed cost of the mission.

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

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

7.2.3 Scientific Implementation Merit and Feasibility of the Proposed Investigation

The information provided in a proposal will be used to assess merit of the plan for completing the proposed investigation, including the scientific implementation merit, feasibility, resiliency, and probability of scientific success of the proposed investigation. For this EVM-2 solicitation, emphasis and consideration of research objectives outweighs applications. The factors for scientific implementation merit and feasibility include the following:

- Factor B-1. Merit of the instruments and mission design for addressing the research and applications 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. This factor includes the merit of plans for data analysis and data archiving to meet the goals and objectives of the investigation; to result in the publication of science discoveries in the professional literature; to serve and support key applications communities; and to preserve data and analysis 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 research community and interested applications communities; assessment of adequate resources for physical interpretation of data and reporting scientific results in the professional literature (e.g., refereed journals); and assessment of the proposed plan for the timely release of the data to the public domain for enlarging its science impact.
- Factor B-4. Science resiliency. This factor includes both developmental and operational resiliency. Developmental resiliency includes the approach to descoping the Baseline Science Mission to the Threshold Science Mission in the event that development problems force reductions in scope. Operational resiliency includes the ability to withstand adverse circumstances, the capability to degrade gracefully, and the potential to recover from anomalies in flight.
- Factor B-5. Probability of science team success. This factor will be evaluated by assessing the experience, expertise, and organizational structure of the science team and the mission design in light of any proposed instruments. The role of each Co-Investigator will be evaluated for necessary contributions to the proposed investigation; the inclusion of Co-Is who do not have a well defined and appropriate role may be cause for downgrading during evaluation.

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

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

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

The technical and management approaches of all submitted investigations 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, 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 (if applicable). 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, PSE, 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, PSE, other named Key Management Team

members, and implementing organization, mission management team, and known partners against the needs of the investigation; the commitments of partners and contributors; and the team's understanding of the scope of work covering all elements of the mission, including contributions. Also evaluated under this factor is the adequacy of the proposed risk management approach, including any risk mitigation plans for new technologies, any long-lead items, and the adequacy and availability of any required manufacturing, test, or other facilities. The approach to any proposed descoping of mission capabilities will be assessed against the proposed Baseline Science Mission. The plans for managing the risk of contributed critical goods and services will be assessed, including the plans for any international participation, the commitment of partners and contributors, as documented in Letters of Commitment, and the technical adequacy of contingency plans, where they exist, for coping with the failure of a proposed cooperative arrangement or contribution. This factor also includes assessment of elements such as the relationship of the work to the project schedule, the project element interdependencies, the associated schedule margins, and an assessment of the likelihood of launching by the proposed launch date. Also evaluated under this factor are the proposed project and schedule management tools to be used on the project.

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

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

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

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

7.3 Selection Factors

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

Considering the critical role of the PI, PM, PSE, and their institutions, prior experience (especially in meeting cost and schedule constraints) will be an important 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 and in selecting among top-rated proposals, including, but not limited to, planning and policy considerations, available funding, programmatic merit and risk of any proposed partnerships, and maintaining a programmatic and scientific balance across SMD. While SMD develops and evaluates its program strategy in close consultation with the scientific community through a wide variety of advisory groups, the SMD program is an evolving activity that ultimately depends upon the most current Administration policies and budgets, as well as program objectives and priorities that can change quickly based on, among other things, new discoveries from ongoing missions.

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

7.4 Implementation of Selected Proposals

7.4.1 Notification of Selection

Following selection, the PIs of the 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. 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 will be discussed, as well as instructions for attending the Project Initiation Conference.

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

7.4.2 Principal Investigator-led Team Masters Forum

One step toward successful execution of PI-led missions is to ensure that PI-led mission management teams receive the instruction necessary to enable them to better execute their missions for NASA. SMD, in conjunction with the NASA Academy of Program, Project, and Systems Engineering Leadership (APPEL), has established a 2.5 day PI-led Team Masters Forum for newly selected PI-led mission management teams. The purpose of the PI-led Team Masters Forum is to facilitate knowledge sharing in areas that are deemed necessary to successfully execute PI-led SMD science missions. Course attendance by the leaders of newly

selected PI-led mission management teams (PI, Project Manager, Project Scientist, and Project Systems Engineer) and the NASA Headquarters Program Scientist and Program Executive (where assigned) is required as soon as practical after proposal selection.

7.4.3 Award Administration and Funding

Oversight management responsibilities have been assigned to the ESSP Program Office at NASA Langley Research 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; this award 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 awards in place, Statements of Work (SOWs) cost and pricing data, and small business subcontracting plans will be required.

Proposals are not required to include SOWs, cost and pricing data, or small business subcontracting plans. 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, cost and pricing data, and small business subcontracting plans in as timely a manner as possible. The process of awarding contracts cannot begin until SOWs, cost and pricing data, and small business subcontracting plans have been received, and funds cannot be provided to the implementing organizations until this process has been completed.

SOWs will be required for selected investigations regardless of whether a proposing organization is Governmental or non-Governmental. SOWs will include task statements for Phases A 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 contracts that exceed $700K, the contractor will be required to provide cost and pricing data to support the cost estimate, in the format specified in NPR 5800.1, *Grant and Cooperative Agreement Handbook*, Section A, Exhibit A, and to certify the costs proposed for the contract in accordance with FAR 15.406-2.

7.4.4 Confirmation of Investigations

Per NPR 7120.5E, at the end of Phase B, NASA will conduct an independent review of the investigation's readiness to proceed. This review must be completed before the project will be authorized to spend more than 25% of the PI-Managed Mission Cost. The results of the independent review and the project status will be presented to the SMD Program Management Council (PMC) at the Confirmation Review (KDP-C) for Confirmation to enter Phase C. If the project is classified Category 1 according to NPR 7120.5E, the Confirmation results will need

subsequent approval from the Agency PMC. Following Confirmation, no rephasing between fiscal years of Phase E costs to Phase C/D will be permitted.

7.5 Opportunity for Debriefing of Nonselected Proposers

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

7.6 Process for Appeals

7.6.1 Agency Procurement Ombudsman

The Agency Procurement Ombudsman, designated in NPD 5101.32E, *Procurement, Grants, and Cooperative Agreements*, will take action to resolve concerns, disagreements, and recommendations submitted by interested parties that cannot be resolved at the Center level, or those having 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 Management Division
Office of Procurement
NASA Headquarters
Washington, DC 20546
USA

7.6.2 Protests

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

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

8. Conclusion

The ESSP 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 EVM-2 investigations in response to this Announcement.

Michael H. Freilich
Director
Earth Science Division

John Grunsfeld
Associate Administrator
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 the AO Section 5.7 shall also apply.

V. TREATMENT OF PROPOSAL DATA

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

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

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

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

VI. STATUS OF COST PROPOSALS

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

VII. LATE PROPOSALS

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

VIII. SOURCE OF SPACE INVESTIGATIONS

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

IX. DISCLOSURE OF PROPOSALS OUTSIDE THE GOVERNMENT

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

X. EQUAL OPPORTUNITY

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

XI. PATENT RIGHTS

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

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

XII. RIGHTS IN DATA

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

XIII. SMALL AND SMALL DISADVANTAGED BUSINESS SUBCONTRACTING

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

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

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

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

XIV. WITHDRAWAL OF PROPOSALS

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

APPENDIX B

REQUIREMENTS FOR PROPOSAL PREPARATION

INTRODUCTION

The following requirements apply to preparation of proposals in response to this Announcement of Opportunity (AO). While the body of the AO specifies the general policies and requirements for preparing proposals, as well as for implementing missions proposed in response to this opportunity, Appendix B contains the specific requirements for the format and content of proposals. 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 94.

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). There is no minimum requirement for fonts used within figures and tables, but all text in figures and tables shall be legible; fonts smaller than 8-point are often illegible.

Proposal Structure and Page Limits		
Section	Contents	Page Limits
A	Proposal Summary Information Graphic Cover Page Export controlled material statement (Section 5.8.2) Optional Restriction on Use statement (see Appendix A, Section V) PI Commitment Letter	As per NSPIRES 1 0.5 0.5 1
B	Fact Sheet	2
C	Table of Contents	None
D E	Science Investigation Science Implementation	26+2 pages/additional instrument**
F G	Mission Implementation Schedule Foldout(s) Management	25+2 pages/additional flight element ** (Schedule Foldout(s) do(es) not count against limit)
H	Cost and Cost Estimating Methodology Cost Tables B3a and B3b	8 (Tables B3a and B3b foldouts do not count against limit)
I	Communications and Outreach Program, Optional Student Collaboration Plan	2+2
J J.1 J.2 J.3 J.4 J.5 J.6 J.7 J.8 J.9 J.10 J.11 J.12	Proposal Appendices (no others permitted): Table of Proposal Participants Letters of Commitment Resumes Summary of Proposed Program Cooperative Contributions Draft International Participation Plan - Discussion on Compliance with U.S. Export Laws and Regulations Not Applicable to this AO Discussion of End-of-Mission Spacecraft Disposal Requirements Compliance with Procurement Regulations by NASA PI Proposals Master Equipment List Heritage List of Abbreviations and Acronyms List of References (optional)	 None None None None None Not Applicable None None None None None None

** Total extra pages limited to 10 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 pages each are allotted for each additional separate science instrument in the Science Sections (Sections D and E) and two extra pages each are allotted for each additional separate, nonidentical flight element (e.g., additional nonidentical spacecraft are allotted two extra pages, but no extra pages are allotted for additional identical spacecrafts) in the Mission Implementation and Management Sections (Sections F and G). The total number of such extra pages in the Science and Mission Implementation sections combined shall not exceed a maximum of 10 extra pages regardless of the number of science instruments and unique flight elements. Every page upon which printing appears will count against the page limits and, unless specifically exempted (e.g., Requirement B-39 and Requirement B-48), each foldout page will count as two pages against the page limits as appropriate for its area (e.g., a fold-out with the total area of two standard pages counts as two pages, etc.).

Requirement B-5. Electronic proposals shall be a single searchable Adobe Portable Document Format (PDF) file, comprised of the main proposal, all tables (see Requirement B-49 and Requirement B-65), and all applicable proposal appendices (see Section J of this appendix). Electronic proposals shall be limited to 20 MB in size. Once uploaded to NSPIRES, this document will be considered the official submission.

Requirement B-6. 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-49 and Requirement B-65). CD-ROMs of proposals may additionally include up to 100 MB, but otherwise identical, versions of electronic proposals. In the event of a conflict between versions of electronic proposals, the version specified in Requirement B-5 shall take precedence.

A. PROPOSAL SUMMARY INFORMATION AND GRAPHIC COVER PAGE

1. Electronic Proposal.

The following expands requirements in the AO, in particular Requirement 94.

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. Note that the Graphic Cover Page should be the first page of the PDF proposal document; when combined by NSPIRES with the Proposal Summary Information, the Graphic Cover page will follow that information.

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

- The proposal title;
- The name of the proposing organization;
- The name of the PI;
- The name and title of an official who is authorized to commit the proposing organization through the submission of the proposal;
- The signature of the PI and the authorizing official, and

Optionally, the Graphic Cover Page may also contain:

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

2. Electronic Cover Page (NSPIRES Submission).

The following expands requirements in the AO, in particular Requirement 97.

Electronic submission must be through the NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES) at http://nspires.nasaprs.com/.

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

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

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

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

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

3. Proposal Team Member Commitment Through NSPIRES.

The following expands requirements in the AO, in particular Requirement 97.

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 97.

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

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

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

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

<u>Requirement B-12.</u> 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 94.

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);
- Schedule summary;
- The proposed PI-Managed Mission Cost in real year dollars (RY$) and in FY 2018 dollars (FY18 $) from Tables B3a and B3b respectively; and
- The proposed Total Cost, including a breakdown of any contributed costs by contributing organization, in real year dollars (RY$) and in FY 2018 dollars (FY18 $) from Table B3a and B3b respectively.

C. TABLE OF CONTENTS

The following expands requirements in the AO, in particular Requirement 94.

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

D. SCIENCE INVESTIGATION

The following expands requirements in the AO, in particular Requirement 4 through Requirement 13.

1. Scientific Background, Goals, and Objectives.

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

2. Science Requirements.

Requirement B-16. This section shall describe the investigation to be performed, the types of measurements to be taken; the characteristics, precision, and accuracy required to attain the

scientific objectives; and the projected instrument performance. This section shall describe the data to be returned in the course of the investigation. The quality (e.g., resolution, coverage, pointing accuracy, measurement precision, etc.) and quantity (bits, images, etc.) of data that must be returned shall be described. The relationship between the proposed data products (e.g., flight data, ancillary or calibration data, theoretical calculations, higher order analytical or data products, 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. How the data obtained will support applications-oriented users to inform decisions shall be described and supported. 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, provides systems engineers with fundamental requirements needed to design the mission, shows clearly the effects of any descoping or losses of elements, and facilitates identification of any resulting degradation to the science. Applications dimensions of missions should be incorporated into the overall Science Traceability Matrix.

3. Threshold Science Mission.

Requirement B-18. This section shall identify the minimum acceptable data and scientific return for the mission (the Threshold Science Mission), below which the mission would not be worth pursuing. The Threshold Science Mission is identified with the "Threshold Science Requirements" in NPR 7120.5E. The scientific value of the Threshold Science Mission shall be discussed. NASA recognizes that, in some circumstances, the Threshold Science Mission may be identical to the Baseline Science Mission. In such cases, the proposer shall explain why there is no viable mission below the Baseline Science Mission.

E. SCIENCE IMPLEMENTATION

The following expands requirements in the AO, in particular Requirement 6 through Requirement 13 and Requirement 46 through Requirement 48.

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, and instrument components, including their characteristics and requirements, and indicate items that are proposed for development, as well as any existing instrumentation or design/flight heritage. It shall provide a clear understanding of how the concept will provide the required data, show how it can be accommodated by the spacecraft, demonstrate that instruments

have the necessary unobstructed fields-of-view over the measurement period required, and 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, vertical and horizontal resolution, signal-to-noise (S/N) calculations, etc. It shall also discuss effects, such as radiation and contamination, on each instrument's measurement capabilities as a function of mission time.

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

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

2. Data Sufficiency.

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

3. Science Mission Profile.

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

requirements drive the proposed mission design and operations plan should be apparent from this discussion.

4. Data Plan.

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

5. Science Team.

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

F. MISSION IMPLEMENTATION

The following expands requirements in the AO, in particular AO Requirement 13 through Requirement 22.

1. General Requirements and Mission Traceability.

Requirement B-25. 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-26. The mission requirements that the science goals and objectives impose on the mission design elements, including mission design, instrument accommodation, spacecraft design, required launch vehicle capability, ground systems, communications approach, and mission operations plan, shall be provided in tabular form and supported by narrative discussion. Table B2 provides an example of a tabular Mission Traceability Matrix, with examples of matrix

elements. Specific information that describes how the science investigation imposes unique requirements on these mission design elements shall be included.

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

Requirement B-27. NASA recognizes that the full depth of information requested in Requirement B-28 through Requirement B-39 may not be available for some aspects of mission implementation at this stage of mission design. In such cases, this section shall (i) describe the current design concept, (ii) explain why the design information is not complete, (iii) provide a time-based plan for completing the design, (iv) justify that the development of that aspect of the design is not required at this stage and that it is acceptable to develop details later, and (v) explain why the lack of information at this stage does not translate into a risk to the proposer's ability to implement the mission as proposed. The approach for developing the required depth of information, along with a corresponding development schedule, shall be included among the plans for future activity. In cases where a mission is proposed at or near the AO Cost Cap, but depth of technical implementation detail is deferred, the proposal shall justify the adequacy of the proposed cost reserves to prevent increases beyond the AO Cost Cap during Phase A and subsequent phases.

This requirement is levied to establish NASA's standard for completeness of information necessary to support a comprehensive assessment of implementation feasibility and risk. The quality of the proposal's response to this requirement contributes significantly to the quality of the TMC assessment. However, NASA recognizes the preliminary nature of Pre-Phase A proposals, and thus Requirement B-27 will apply to all cases where the required information cannot, for whatever reason, be provided.

2. Mission Concept Descriptions.

Requirement B-28. 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-29. Mission Design: This section shall address the following elements of mission design to the extent that they are applicable to the proposed mission and that they are known at the time of proposal submission. Any additional elements that are applicable to explaining the mission and demonstrating its feasibility shall also be addressed.

- Launch readiness date (including launch date flexibility);
- Mission duration;

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

Requirement B-30. Launch Services and Launch Vehicle Compatibility: Any non-NASA launch services shall be described. For both NASA- provided and non-NASA provided launch services, compatibility with the proposed launch vehicle shall be demonstrated by providing in the appropriate proposal section the launch site, fairing size, spacecraft mass, and mission orbit characteristics such as altitude (km – circular or apogee/perigee), inclination, C3, heliocentric and/or declination (DLA). Describe any known nonstandard requirements such as additional fairing doors, cleanliness and purge requirements, etc.

Requirement B-31. 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, including (i) expected power requirement for each mission phase; (ii) minimum power capability needed to meet all requirements; and (iii) associated battery Depth of Discharge (DOD).
  (d) Attitude Determination and Control, including system pointing requirements and capabilities. Describe or define the following: (i) each spacecraft operational mode, including the sensors and actuators used, control method, and safing and/or contingency modes; (ii) attitude determination methodology and estimate of accuracy, including identifying whether ground postprocessing is required to meet science needs; (iii) agility

requirements for slews or scanning; (iv) appendage pointing requirements, including articulation control methods and deployment accommodations; (v) sensor selection and performance, including identifying mounting location and field-of-view (FOV); (vi) actuator selection and sizing, including identifying mounting location(s); (vii) translational maneuver (Delta-V) control and accuracy; (viii) momentum management approach and mitigation of impacts on navigation accuracy, if applicable; (ix) on-orbit 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 Autogenerated, (iv) development method (spiral, waterfall, agile, etc.), and (v) development language.

Requirement B-32. Additional Mission Elements: This section shall address any other major mission elements (i.e., 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-33. Flight System Contingencies and Margins: This section shall summarize contingencies and margins of all key flight systems resources. For the driving mission element requirements derived from the Mission Functional Requirements, it should provide estimates of implementation performance and design margins with respect to the required performance. At a minimum, it shall include the following:

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

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

Definitions:

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

Margin is the difference between the maximum possible capability of a resource (the physical limit or the agreed-to limit) and the maximum expected value for a resource. Percent margin for a resource is the available margin divided by its maximum expected value.

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

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

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

Contingency = Max Expected Resource Value – current estimate of Resource Value

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

Margin = Max Possible Resource Value – Max Expected Resource Value

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

Requirement B-34. 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 and Earth Orbital missions, as well as missions that utilize telecom relay orbiters), including (i) downlink information data volume; (ii) uplink information; (iii) for all transmit and receive modes, provide mode

timeline, data rate(s), and durations; and (iv) ground network utilization plan, including ground stations, downlink parameters (frequencies, periods, capacities, margins, etc.), and retransmission capability;

- Description of approach for acquiring and returning critical event data, including clear identification of procurement and costing for supplemental resources (e.g., mobile ground stations) if such are needed; and
- A high-level discussion of operations plan, including nominal sequence planning and commanding, team training, availability of spacecraft experts for operations, and operations center development.

3. Development Approach.

Requirement B-35. This section shall describe the development approach. This description shall include, at a minimum, the following items:

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

4. New Technologies/Advanced Engineering Developments.

Requirement B-36. 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 EVM-2 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 1, *NASA Systems Engineering Handbook*);
- Rationale for the stated TRL value of an element that is an adaptation of an existing element of known TRL;
- The approach for maturing each of the proposed systems to a minimum of TRL 6 by PDR:
    - Demonstration (testing) in a relevant environment can be accomplished at the system level or at lower level(s);

    - If applicable, justify what demonstration(s) in a relevant environment at lower level(s) (subsystem and/or subsystem-to-subsystem) would be sufficient to meet system level TRL 6, considering (i) where any new technology is to be inserted, (ii) the magnitude of engineering development to integrate elements, (iii) any inherent interdependencies between elements (e.g., critical alignments), and/or (iv) the complexity of interfaces – see the EVM-2 Library for examples;
    - Include discussion of simulations, prototyping, demonstration in a relevant environment, life testing, etc., as appropriate;
- An estimate of the resources (manpower, cost, and schedule) required to complete the technology and/or advanced engineering development; and
- Approaches to fallbacks/alternatives that exist and are planned, a description of the cost, decision date(s) for fallbacks/alternatives, relevant development schedules, and performance liens they impose on the baseline design, and the decision milestones for their implementation.

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

5. Assembly, Integration, Test, and Verification.

Requirement B-37. 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-38. The project's verification approach shall be described briefly in this section. Flow diagrams, narrative text, and/or other relevant data may be used to convey this information. Elements of the approach that pose special challenges for the project (e.g., mission critical performance or functional requirements that can't be tested on the ground, special facilities that may be required for testing, large scale simulation tools that must be developed and how they will be validated, critical path items, etc.) shall be highlighted. The I&T description shall demonstrate the credibility of the overall I&T approach, as reflected by consistency between the described test plans and the schedule, cost, and other resources needed to carry them out.

6. Schedule.

Requirement B-39. A project schedule foldout(s) covering all phases of the investigation shall be provided. This foldout will not be counted against the page limits. The schedule format shall indicate the month and year of each milestone, have a corresponding table of dates, and follow standard NASA WBS elements for task descriptions as prescribed in NPR 7120.5E. The schedule foldout and accompanying narrative, which is included in the page count for this section, shall address proposed major milestones including, at a minimum, the following items:
- Spacecraft development and major review dates;
- Instrument development and major review dates, including instrument-to-spacecraft/host integration and test;
- Ground systems development and major review dates (e.g., mission operations and data analysis development schedule);

- Major deliverables (e.g., Interface Control Documents (ICDs), simulators, engineering modules, flight modules, etc.);
- Launch vehicle integration and launch readiness;
- Compliance with National Environmental Policy Act (NEPA) and Launch Approval processes, if appropriate;
- Long-lead item specifications, development paths, and their impacts to schedule;
- Schedule critical path identification; and
- Funded schedule reserve, with indications of appropriate reserves associated with major milestones and deliverables.

G. MANAGEMENT

The following expands requirements in the AO, in particular Requirement 18 through Requirement 20, Requirement 34 through Requirement 42, Requirement 67, Requirement 67, Requirement 67, Requirement 70 and Requirement 67.

Requirement B-40. This section shall describe the investigator's proposed management approach. The management organization (including an organization chart) and decision-making process shall be described, and the teaming arrangement and team communications shall be discussed. The organization chart should clearly indicate how the mission team is structured. The names of the primary team members, their organization, and their reporting relationship within the project shall be provided.

Requirement B-41. 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-42. This section shall describe the top risks considered significant by the PI and the PM, especially technical risks and risks associated with contributed hardware (if any), and potential mitigation strategies and associated schedule impacts. If cost risks are in this list, they should be described here and then discussed in Section H (see Requirement B-47). The management strategies for control, allocation, and release of technical margins, cost reserves, and schedule reserves shall be described. The approach to any potential descopes, including savings of resources (mass, power, dollars, schedule, etc.) by implementing descopes, the decision milestone(s) for implementing descopes, and the scientific impact of individual as well as combined descopes shall be discussed. Specifically, this description shall identify how these margins and reserves are to be allocated, tracked, and monitored, with what tools and by whom, and who will have the authority to release them. When contracts are required, the acquisition strategy, including any incentive strategy, shall be described.

Requirement B-43. 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-44. In the case where a proposal does not provide the required management and schedule details, for whatever reason, this section shall (i) describe the current management approach and schedule, (ii) justify that the development of that aspect of the project management and schedule is not required at this stage and that it is acceptable to develop details later, and (iii) explain why the lack of information at this stage should not translate into a risk to the proposer's ability to implement the mission as proposed, and (iv) justify the adequacy of the proposed cost reserves, given that the PI-Managed Mission Cost is not allowed to increase beyond the AO Cost Cap at any time. The process for developing the required depth of information, along with a corresponding schedule, shall be explicitly included among the plans for future activity.

H. COST AND COST ESTIMATING METHODOLOGY

The following expands requirements in the AO, in particular Requirement 52 through Requirement 65, Requirement 67, and Requirement 52.

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-45. This section shall include the estimated cost of the proposed investigation. The estimated cost shall encompass all proposed activities, including all applicable mission phases, launch services, flight systems, ground systems, ground network fees, contributions, any other AO-specific activities (e.g., SC), and all cost reserves. These costs shall be consistent with the policies and requirements described in Sections 4 and 5 of this AO.

Requirement B-46. This section shall provide a Basis of Estimate, including a description of the methodologies used to develop the primary cost estimate. The cost estimating methodology discussion in this section shall provide an overview of the cost estimate development process. Any additional cost estimates or other validation efforts shall be described, the results presented, and any significant discrepancies discussed. The rationale for the proposed cost reserve levels shall be presented. Proposers shall provide additional Basis of Estimate data to assist the validation of their costs estimates. Examples of useful Basis of Estimate data include cost comparisons to analogous items/missions, vendor quotes, and parametric model results.

Requirement B-47. This section shall include a discussion of cost risks.

Requirement B-48. 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$) in Table B3a and FY 2018 dollars (FY18$) 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 (if applicable). The rows in Tables B3a and B3b shall be the NASA standard WBS elements as defined in NPR 7120.5E. The costs for most elements shall be provided to WBS level 2, as shown in Tables B3a and B3b. Exceptions are the costs of individual instruments and any unique flight system elements such as coordinating science ground stations, DSN, or nonstandard 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$) and totals in fiscal year 2018 dollars (FY18$). Proposers shall use their own forward pricing rates to translate between real year dollars (RY$) and fiscal year 2018 dollars (FY18$). For organizations that are without approved forward pricing rates, proposers may use the NASA inflation/deflation indices in Table B4 to translate between real year dollars (RY$) and fiscal year 2018 dollars (FY18$).

Requirement B-49. Tables B3a and B3b shall be provided additionally in Microsoft Excel format on each CD-ROM submitted. Microsoft Excel format templates are available for download in the EVM-2 Library.

Requirement B-50. 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$) and fiscal year 2018 dollars (FY18$) in Table B3.

I. COMMUNICATIONS AND OUTREACH PROGRAM AND STUDENT COLLABORATION

1. Communications and Outreach Program

The following expands requirements in the AO, in particular Requirement 51.

Requirement B-51. This section shall describe the Communications and Outreach Program.

2. Student Collaborations (Optional)

The following expands requirements in the AO, in particular Requirement 50 and Requirement 51.

Requirement B-52. If a Student Collaboration (SC), as described in Section 5.5.3 of this AO, is proposed, then this section shall provide details of the development schedule of the SC, including decision points for determining SC readiness for flight. This section shall describe how the SC can be incorporated into the mission on a nonimpact basis. This section shall show that the SC is clearly separable from the rest of the proposed effort.

J. PROPOSAL APPENDICES

Requirement B-53. 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. 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 76 and Requirement 76.

Requirement B-54. A table of Proposal Participants shall be provided. The table shall include all organizations named in the proposal including contributing organizations. The primary purpose of the table is to aid NASA in avoiding conflicts of interest during the evaluation of the proposal. A secondary purpose is to provide material helpful for the evaluation and selection process. The table shall have three columns: (i) name of organization, including city and state/country where it is located, (ii) role of organization, and (iii) total cost or budget for that organization (real year dollars over the life of proposal for baseline mission). The table shall have a row for every organization named in the proposal, and the rows shall be organized into three sections: (i) major partners, (ii) science only, nonhardware partners, and (iii) minor partners, vendors, and suppliers, as known at the time of the proposal. Major partners are defined to be organizations responsible for providing project management, system engineering, major hardware elements, science instruments, spacecraft accommodations, launch services, integration and test, mission operations, and other major elements of the proposed investigation, as defined by the proposer.

J.2. Letters of Commitment.

The following expands requirements in the AO, in particular Requirement 26, Requirement 69, Requirement 75, and Requirement 76.

Requirement B-55. 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 35, Requirement 45, and Requirement 46.

Requirement B-56. This section shall include resumes or curriculum vitae for the PI, PM, PSE, all Co-Is identified in the science section, and for any key project personnel who are named in the proposal. Specifically, each resume shall cite the individual's experience that is pertinent to the role and responsibilities that she/he will assume in the proposed investigation. Project management experience shall be included in the resumes of the PI, PM, 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.

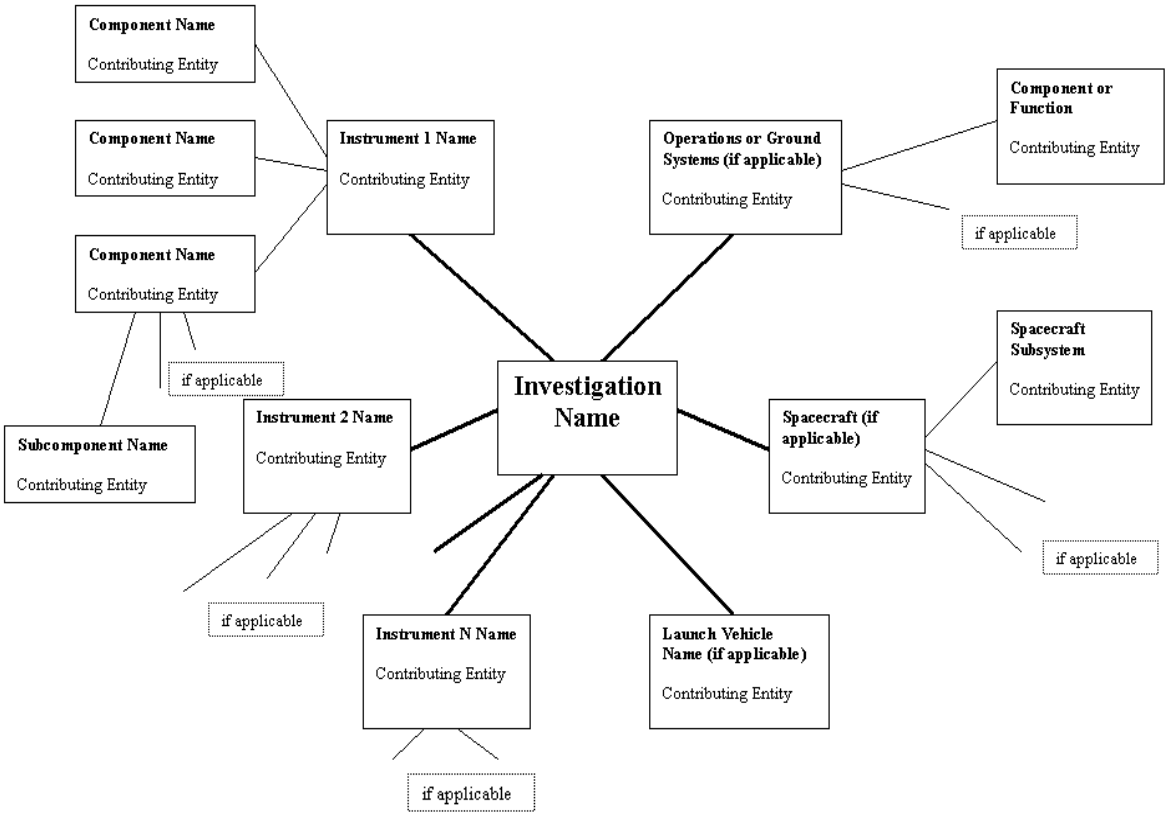
J.4. Summary of Proposed Program Cooperative Contributions.

The following expands requirements in the AO, in particular Requirement 64 through Requirement 66 , Requirement 76 , Requirement 76, and Requirement 72.

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

a. An "exploded diagram" of the investigation.

SAMPLE EXPLODED DIAGRAM



Requirement B-57. If a proposal includes cooperative contributions, this section shall include an "exploded diagram" of the investigation (see example figure) that provides a clear visual representation of cooperative contributions incorporated in the proposed implementation approach. All cooperative contributions, including those that will require an international agreement or interagency memorandum of agreement, shall be shown in this diagram. Each contribution shown shall display a unique name for the contribution, as well as the identity of the contributing entity. However, the following should not be shown:

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

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

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

b. A supporting table of collaborative contributions

Requirement B-58. 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 5.6.6 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 5.6.6 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 74.

Requirement B-59. 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-60. 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. Not applicable to this AO.

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

The following expands requirements in the AO, in particular Requirement 31.

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-61. This section shall discuss briefly how the mission meets the orbit disposal requirement applicable to its proposed orbit. For LEO missions, this section shall briefly discuss the lifetime of the mission and whether it meets the 25-year postmission (or 30-year from launch – whichever comes first) requirement for LEO missions.

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

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

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

The following references are available in the EVM-2 Library:

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

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

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

This appendix is required only for proposals submitted by NASA PIs or NASA Centers (excluding JPL). Proposals submitted by NASA Centers must comply with regulations governing proposals submitted by NASA PIs (NFS 1872.308). Additional instructions may be found in Procurement Information Circular (PIC) 05-15 which is available in the EVM-2 Library.

Requirement B-62. For NASA Center proposals, this section shall include any descriptions, justifications, representations, indications, statements, and/or explanations that are required by the regulations.

J.9. Master Equipment List.

The following expands requirements in the AO, in particular Requirement 60.

Requirement B-63. 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-64. 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-65. The MEL shall be additionally provided in Microsoft Excel format on each CD submitted with the proposal. A Microsoft Excel template of the MEL is available for download in the EVM-2 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 of the board. If proposing Field-Programmable Gate Arrays (FPGAs) or Application-Specific Integrated Circuits (ASICs), list the design size (in the appropriate sizing parameter such as logic cells, logic elements), the board the chip(s) will be integrated onto, and how much heritage will be used in the design.

J.10. Heritage.

The following expands requirements in the AO, in particular Requirement 55 and *Requirement 76.*

Requirement B-66. This section shall discuss each element of any heritage from which the proposed investigation derives substantial benefit, including heritage from spacecraft subsystems, instruments, ground systems, flight and ground software, test set ups, simulations, analyses, etc. This discussion shall be at an appropriate level of granularity (e.g., component, assembly, subsystem) to clearly separate the heritage element from other elements of the design. The discussion of each element shall include:

- a concise description of the design heritage claimed;

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

Proposals must substantiate all heritage claims, including descriptions of changes required to accommodate project-unique applications and needs. Where enhancements to heritage elements are proposed or heritage is from a different application, sufficient descriptions must be provided to independently assess the current level of maturity.

Requirement B-67. 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 at least three levels (full, partial, or none) as illustrated in the table below.

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

J.11. List of Abbreviations and Acronyms.

The following expands requirements in the AO, in particular Requirement 94.

Requirement B-68. This appendix shall provide a list of abbreviations and acronyms.

J.12. List of References (optional).

In addition to the above items, this appendix may provide a reference list of documents and other materials that were fundamentally important in generating the proposal. This may include a Uniform Resource Locator (URL) for documents that are available through the Internet. As noted at the outset of Appendix B of this AO, however, proposals must be self-contained: any data or other information intended as part of a proposal must be included within the proposal itself. If any documents or other materials are submitted as a part of a proposal, they must fit within the prescribed page limits. If internal documents such as Flight Project Practices are referenced, an externally accessible URL shall be provided to download them.

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
		Density and Temperature of Emitter	Emission Line				Launch window: to meet nadir and limb overlap requirement. Window applies day-to-day.
		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
Mission Requirements or Instrument Accommodation (from Table B1)	Mission	Spacecraft	Ground System	Operations
Four different observing strategies: Solar, limb, nadir, zenith; requires yaw and elevation maneuvers		Agility requirements Slew rate = y deg/sec Settle = stability < .001 deg/sec after 30 secs		Target planning on 3 day centers Ephemeris accuracy of x with updates every 2 days
Instrument X precision of 5K		Thermal stability of 1 deg/hr S/C bus stability of .01 deg over 10 secs	Bit error rate < 1e-5 Time correlation to 2 msec over 1 week	Weekly time correlation

TABLE B3a

TOTAL MISSION COST RY$ PROFILE TEMPLATE

Total Mission Cost Profile Template

FY Costs and Totals in Real Year Dollars (RY$)

WBS#	WBS Element	Phase A			Phase B			Phase C/D				RY$	Phase E				Phase F			RY$
		FY2017	FY2018	Total	FY2018	FY2019	Total	FY2019	FY2020	FY2021	Total	A-D Total	FY2021	FY2022	FY2023	Total	FY2023	FY2024	Total	A-F Total
01	Project Management																			
02	Systems Engineering																			
03	Safety & Mission Assurance																			
04	Science / Technology																			
	Breakout pre-launch science from technology development activities																			
05	Payload(s)																			
	List each instrument separately																			
06	Spacecraft																			
	List each major flight system element separately																			
07	Mission Operations																			
	Breakout separable services, e.g., DSN, etc.																			
08	Launch Vehicle / Services																			
09	Ground System(s)																			
	Breakout non-standard cost, e.g., coordinating ground stations																			
10	Systems Integration & Testing																			
11	Student Collaboration in Excess of Incentive																			
	Reserves																			
	PI-Managed Mission Cost																			
	Student Collaboration Incentive (if applicable)																			
	Contributions																			
	List by organization and WBS element																			
	Total Mission Cost																			

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

A Microsoft Excel version of this template is available in the EVM-2 Library.

TABLE B3b
TOTAL MISSION COST FY$ PROFILE TEMPLATE

Total Mission Cost Profile Template

FY Costs and Totals in Fiscal Year <<CAP YEAR>> Dollars (FY<<CAP YEAR>>$)

WBS#	WBS Element	Phase A			Phase B			Phase C/D			FY<<CAP YEAR>>$	Phase E			Phase F			FY<<CAP YEAR>>$
		FY2017	FY2018	Total	FY2018	FY2019	Total	FY2019	FY2020	FY2021	Total	A-D Total	FY2021	FY2022	FY2023	Total	FY2023	FY2024	Total	A-F Total
01	Project Management																			
02	Systems Engineering																			
03	Safety & Mission Assurance																			
04	Science / Technology																			
	Breakout pre-launch science from technology development activities																			
05	Payload(s)																			
	List each instrument separately																			
06	Spacecraft																			
	List each major flight system element separately																			
07	Mission Operations																			
	Breakout separable services, e.g., DSN, etc.																			
08	Launch Vehicle / Services																			
09	Ground System(s)																			
	Breakout non-standard cost, e.g., coordinating ground stations																			
10	Systems Integration & Testing																			
11	Student Collaboration in Excess of Incentive																			
	Reserves																			
	PI-Managed Mission Cost																			
	Student Collaboration Incentive (if applicable)																			
	Contributions																			
	List by organization and WBS element																			
	Total Mission Cost																			

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

A Microsoft Excel version of this template is available in the EVM-2 Library.

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

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

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

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

TABLE B5

MASTER EQUIPMENT LIST

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 EVM-2 Library.

APPENDIX C

GLOSSARY OF TERMS AND ABBREVIATIONS

Part C.1: GLOSSARY OF TERMS

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

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

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

Applications — Uses of data and information products to support and inform decision-making duties of organizations for nonresearch purposes, such as policy, business, and management activities.

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

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

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

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

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

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

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

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

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

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

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

Descope — Any alteration of a mission that facilitates 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.

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

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

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

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

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

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

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

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

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

Mission — Used interchangeably with investigation.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Project Office — An office established to manage a project.

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

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

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

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

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

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

Team — A group of investigators responsible for carrying out and reporting the results of an investigation or group of investigations.

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

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

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

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

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

Part C.2: COST ELEMENT DEFINITIONS

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

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

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

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

Launch Services — Launch vehicles and services are either procured and provided by NASA to launch spacecraft under fixed price contracts or provided by the proposer. The launch service price includes procurement of the ELV, spacecraft-to-launch vehicle integration, placement of spacecraft into designated orbit, analysis, 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 Phase E (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 EVM-2 Library.) Includes development of science data processing and analysis capability. Also includes prelaunch training of the command team, development and execution of operations simulations, sequence development, and flight control software. This element includes any mission-unique tracking network development costs.

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

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

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

SEO Activities — Options for enlarging the science/technology impact beyond the baseline investigation, such as extended missions, guest investigator programs, 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 EVM-2 Library.)

Part C.3: ABBREVIATIONS AND ACRONYMS

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

GFE	Government Furnished Equipment
GFS	Government Furnished Service
HBCU	Historically Black Colleges and Universities
HBZ	HUB Business Zone
HUBZone	Historically Underutilized Business Zone
IAT	Integration, Assembly, and Test
ICD	Interface Control Document
IRD	Interface Requirements Document
ITAR	International Traffic in Arms Regulations
IV&V	Independent Verification and Validation
JPL	Jet Propulsion Laboratory
JSC	Johnson Space Center
KDP	Key Decision Point
MEL	Master Equipment List
MEP	Mars Exploration Program
MMRTG	Multiple Mission Radioisotope Thermoelectric Generator
MO&DA	Mission Operations and Data Analysis
MOS	Mission Operations Services
MOU	Memorandum of Understanding
NAICS	North American Industry Classification System
NASA	National Aeronautics and Space Administration
NASA-STD	NASA-Standard
NEN	Near-Earth Network
NEPA	National Environmental Policy Act
NFS	NASA FAR Supplement
NISN	NASA Integrated Services Network
NLS	NASA Launch Services
NLSA	Nuclear Launch Safety Approval
NODIS	NASA Online Directives Information System
NOI	Notice of Intent
NPD	NASA Policy Directive
NPR	NASA Procedural Requirements
NRA	NASA Research Announcement
NRC	National Research Council
NRP	NASA Routine Payload
NSPIRES	NASA Solicitation and Proposal Integrated Review and Evaluation System
NSS	NASA Safety Standard
OCFO	Office of the Chief Financial Officer
OMI	Other Minority Institution
OSTP	Office of Science and Technology Policy
PDF	Portable Data Format
PDR	Preliminary Design Review
PI	Principal Investigator
PIC	Procurement Information Circular
P.L.	Public Law
PM	Project Manager

POC	Point of Contact
PS	Project Scientist
PSE	Project Systems Engineer
RHU	Radioisotope Heater Unit
ROD	Record of Decision
ROM	Rough Order-of-Magnitude
ROSES	Research Opportunities in Space and Earth Sciences
RPS	Radioisotope Power System
RTG	Radioisotope Thermoelectric Generator
RY	Real Year
SALMON	Stand Alone Missions of Opportunity Notice
SB	Small Business
SC	Student Collaboration
SCaN	Space Communication and Navigation
SDB	Small Disadvantaged Business
SDVOSB	Service Disabled Veteran Owned Small Business
SE	System Engineer(ing)
SEO	Science Enhancement Option
SMD	Science Mission Directorate
SN	Space Network
SOW	Statement of Work
SPD	SMD Policy Document
SPG	Strategic Planning Guidance
TA	Technical Authority
TMC	Technical, Management, and Cost
TRL	Technical Readiness Level
UARC	University Affiliated Research Center
UFE	Unallocated Future Expense
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

EVM-2 LIBRARY

EVM-2 Acquisition Homepage: http://essp.larc.nasa.gov/EVM-2
EVM-2 Program Library: http://essp.larc.nasa.gov/EVM-2/evm-2_library.html.

Strategic Documents

1. The 2014 NASA Strategic Plan
2. 2014 Science Mission Directorate Science Plan (hereafter referred to as the 2014 Science Plan)
3. National Research Council's decadal survey in Earth science, Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond (The National Academies Press, 2007)
4. Responding to the Challenge of Climate and Environmental Change: NASA's Plan for a Climate-Centric Architecture for Earth Observations and Applications from Space (June 2010)
5. ESSP Program Plan
6. National Space Transportation Policy

Program Specific Documents

1. EVM-2 Announcement of Opportunity (AO)
2. ~~ESSP Mission Assurance Requirements (MAR) Payload Classification: D~~
2. **Class D Cat 3 and OSMC SMA Compliance Matrixes [Changed October 15, 2015]**
3. TRL 6 Examples
4. TMC on Class C and Class D Payloads
5. EVI Common Causes of Major Weaknesses
6. Cal Poly CubeSat Developer's specifications
7. Statement of Work (SOW) Template
8. Microsoft Excel Versions of the Template Tables in the EVM-2 AO
    - Table B1: Example Science Traceability Matrix
    - Table B2: Example Mission Traceability Matrix
    - Table B3a: Total Mission Cost Funding RY$ Profile Template
    - Table B3b: Total Mission Cost Funding FY$ Profile Template
    - Table B5: Master Equipment List
9. 2015 Call Letter for ESD Senior Review
10. 2015 ESD Senior Review Final Report
11. EVM-2 AO ELV Launch Services Program Information Summary
12. Launch Services Program (LSP) Advisory Services Plan
13. NASA's Mission Operations and Communications Services
14. EVM-2 FAQs on Applications
15. Operations Coordination Plan for the Morning and Afternoon Constellations
16. The Explanatory Guide to the NASA Science Mission Directorate Educational Merit Evaluation Factors for Student Collaboration Elements

NASA and Federal Documents

1. NASA Space Flight Program and Project Management Requirements, NPR 7120.5E
2. NASA Systems Engineering Processes and Requirements, NPR 7123.1B
3. NASA WBS Handbook, NASA/SP-2010-3404
4. NASA Systems Engineering Handbook, NASA/SP-2007-6105 Rev 1
5. Risk Classification for NASA Payloads, NPR 8705.4
6. Launch Services Risk Mitigation Policy for NASA-Owned and/or NASA-Sponsored Payloads/Missions, NPD 8610.7D
7. NASA Procedural Requirements for Limiting Orbital Debris, NPR 8715.6A
8. Process for Limiting Orbital Debris, NASA-STD-8719.14
9. NASA General Safety Program Requirements, NPR 8715.3
10. Managerial Cost Accounting Concepts and Standards for the Federal Government
11. Procurement Information Circular (PIC) 05-15

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 EVM-2 Library (Appendix D).

NPR 7120.5E, NASA Space Flight Program and Project Management Requirements
NPR 7123.1B, NASA Systems Engineering Processes and Requirements
NPR 8705.4, Risk Classification for NASA Payloads
NPR 8715.3, NASA General Safety Program Requirements

APPENDIX F

COMPLIANCE CHECKLIST

This appendix contains a checklist with the list of items that NASA will check for compliance before releasing a proposal for evaluation. All other requirements will be checked during evaluation.

Administrative	
1. Electronic proposal received on time	Requirement 1
2. Proposal on CD-ROM received on time	Requirement 2
3. Original signatures of PI and of authorizing official included	Requirement B-8
4. PI Commitment Statement/Letter included	Requirement B-81
5. Meets page limits	Requirement B-4
6. Meets general requirements for format and completeness (one volume, maximum 55 lines text/page, maximum 15 characters/inch -- approximately 12 point font)	Requirement 94 Requirement B-1 Requirement B-2 Requirement B-3
7. Required appendices included; no additional appendices	Requirement B-53
8. Budgets are submitted in required formats	Requirement B-48
9. All individual team members who are named on the cover page indicate their commitment through NSPIRES	Requirement 77
10. All export-controlled information has been identified	Requirement 78
11. Restrictions Involving China acknowledged on Electronic Cover Page	Requirement 3
Scientific	
12. Addresses solicited science research programs	Requirement 4
13. Requirements traceable from science to instruments to mission	Requirement 6
14. Appropriate data archiving plan	Requirement 7
15. Baseline science mission and threshold science mission defined	Requirement 11
Technical	
16. Complete spaceflight mission (Phases A-F) proposed; appropriate type of spaceflight mission proposed (e.g. no data buys, no International Space Station hosted instruments)	Requirement 13
17. Team led by a single PI	Requirement 34
18. PI-Managed Mission Cost within AO Cost Cap	Requirement 53
19. Co-investigator costs in budget	Requirement 47
20. Required Investigation Start Date	Requirement 82
21. Launch Readiness Date (LRD) prior to LRD deadline	Requirement 82
22. Includes table describing non-U.S. participation	Requirement 72
23. Includes letters of commitment from funding agencies for non-U.S. participating institutions	Requirement 69
24. Includes letters of commitment from all U.S. organizations offering contributions	Requirement 75
25. Includes letters of commitment from all major partners	Requirement 76

APPENDIX G

REQUIREMENTS CROSSWALK

This appendix contains an approximate crosswalk between proposal requirements in the AO and proposal requirements in Appendix B. Proposal requirements in Appendix B expand upon the proposal requirements in the AO and provide further definition on the structure and content of the proposal. Some AO requirements do not require further definition by an Appendix B requirement. Not all possible crosswalk relations are shown.

AO Requirement	AO Section	AO Requirement Topic	Appendix B Requirement
1	3	Electronic Proposal Submission	B-5
2	3	CD_ROMs Submission	B-6
3	4.2.2	Restrictions Involving China	
4	5.1.1	Science scope	B-15
5	5.1.1	Science scope achievement	B-16
6	5.1.2	Science traceability	B-17
7	5.1.2	Data plan	B-21, B-22, B-23
8	5.1.3	Measurement traceability	B-17, B-21
9	5.1.3	Instrumentation rational	B-19, B-20, B-26
10	5.1.4	Applications Requirements	B-16
11	5.1.5	Baseline and threshold mission	B-18, B-26
12	5.1.5	Threshold mission	B-18
13	5.2.1	Complete Spaceflight Missions	B-25, B-26, B-27, B-28, B-45
14	5.2.1	Mission architecture	B-26, B-27, B-28, B-29
15	5.2.1	Mission design and operations	B-26, B-27, B-28, B-29 B-30, B-31, B-32, B-33, B-34, B-35
16	5.2.1	Flight systems design	B-26, B-27, B-28, B-31, B-32, B-33, B-34
17	5.2.1	Development approach	B-19, B-26, B-27, B-28, B-33, B-35, B-36, B-37, B-38, B-39, B-40
18	5.2.2	Management approach	B-26, B-27, B-28, B-35, B-40, B-41, B-42, B-43, B-44
19	5.2.2	Systems Engineering	B-35, B-40, B-41, B-42, B-43, B-44

20	5.2.2	NPR waivers	B-35, B-40, B-41, B-42, B-43, B-44
21	5.2.3	Mission Category and Payload Risk Classification	B-35, B-42, B-37, B-38
22	5.2.4	New technologies	B-28, B-35, B-36
23	5.2.5	Environmental review	B-28, B-45, B-39
24	5.2.6	Space communications and tracking	B-28, B-29, B-34, B-45
25	5.2.6	NASA standard space communications	B-28, B-29, B-34, B-45
26	5.2.6	NASA non-standard space communications	B-28, B-29, B-34, B-45, B-55
27	5.2.6	Use of Ka-band	B-28, B-29, B-34, B-45
28	5.2.6	DSN use	B-28, B-29, B-34, B-45
29	5.2.7	Critical events	B-28, B-29, B-34, B-45
30	5.2.8	Orbital Constellations	B-22, B-28, B-29, B-34
31	5.2.9	End-of-mission spacecraft disposal	B-28, B-61
32	5.2.10	Deviations from payload risk classification requirements	B-28, B-35, B-42, B-37, B-38
33	5.2.11	Ground/operations system solution	B-28, B-34, B-35, B-45
34	5.3.1	Principal Investigator	B-28, B-41, B-56
35	5.3.2	Project Manager	B-28, B-41, B-56
36	5.3.3	Project Systems Engineer	B-28, B-41, B-56
37	5.3.4	PI, PM and PSE roles	B-28, B-40, B-41, B-42
38	5.3.5	Qualifications of individuals	B-28, B-41, B-56
39	5.3.5	Qualifications of institutions	B-28, B-40, B-41
40	5.3.6	Risk identification	B-28, B-42
41	5.3.6	Risk mitigation	B-28, B-42
42	5.3.6	Descopes	B-28, B-42
43	5.3.6	Risk from international contributions	B-28, B-42, B-43
44	5.3.7	NASA PI proposals	B-28, B-62
45	5.4.1	Science team	B-24, B-56
46	5.4.2	Co-investigator roles	B-24, B-56
47	5.4.2	Co-investigator funding	B-45, B-48
48	5.4.3	Collaborators	B-24, B-56

49	5.5.2.1	Communications and Outreach	B-45, B-51
50	5.5.3	Student collaboration separable	B-52
51	5.5.3	Student collaboration funding	B-45, B-48
52	5.6.1	Cost tables	B-48, B-49, B-50
53	5.6.1	PI-Managed Mission Cost Cap	B-45, B-48
54	5.6.1	Limit on pre-Confirmation spending	B-45, B-48
55	5.6.2	Cost methodologies	B-45, B-46, B-47, B-48, B-50, B-66
56	5.6.2	Cost control	B-45, B-46, B-47, B-48, B-50
57	5.6.2	Cost reserves, Phases A-D	B-45, B-46, B-47, B-48, B-50
58	5.6.2	Cost reserves, Phases E and F	B-45, B-46, B-47, B-48, B-50
59	5.6.3	Work Breakdown Structure	B-48
60	5.6.4	Master Equipment List	B-63, B-64, B-65
61	5.6.5	Full cost accounting	B-45
62	5.6.5	NASA contributions	B-45, B-48
63	5.6.5	Applicable accounting standards	B-45
64	5.6.6	Contribution identification	B-48, B-57, B-58
65	5.6.6	Contribution value	B-48, B-58
66	5.6.6	Contribution risk management	B-42, B-43, B-45, B-47, B-57
67	5.6.6	Contributed access to space	B-28, B-29, B-30, B-31, B-32, B-33
68	5.7.2	Non-US cost plan	
69	5.7.2	Non-US letters of commitment	B-55
70	5.7.2	Non-US contribution risk management	B-42, B-43, B-43, B-47, B-58
71	5.7.2	Non-US contribution detail	B-19, B-20, B-28, B-30, B-31, B-32, B-33, B-34
72	5.7.2	Non-US participation table	B-58
73	5.7.3	International agreements	B-40
74	5.7.4	Export Control laws compliance	B-59, B-60
75	5.8.1.1	US contribution letters of commitment	B-55
76	5.8.1.2	Major partner letters of commitment	B-54, B-55

77	5.8.1.3	NSPIRES commitment for team members	B-12
78	5.8.2	Export controlled proposal material	B-4
79	5.8.3	Unclassified Proposal and unclassified heritage appendix	B-19, B-20, B-28, B-30, B-31, B-32, B-33, B-34, B-35, B36 B-66, B-67
80	5.8.3	Classified Heritage Appendix	B-66, B-67
81	5.9.1	PI Commitment Statement/Letter	B-4
82	5.9.2	Investigation Start Date	B-39
83	5.9.2	Launch Readiness Date	B-39
84	5.9.3	NASA-provided Launch vehicle compatibility	B-30
85	5.9.3	Costs for NASA-provided non-standard launch services	B-45, B-48
86	5.9.3	Compatibility with multiple launch vehicles	B-30
87	5.9.4	PI in charge of investigation on alternative access to space arrangement	B-16, B-25, B-40
88	5.9.4	Requirements met by host partner	B-35, B-39, B-40, B-42, B-43, B-45
89	5.9.4	PI assumes risk for delays on alternative access to space arrangements	B-39, B-40, B-45, B-47
90	5.9.4.1	Non-NASA Launch Services	B-30, B-40, B-45, B-54, B-55
91	5.9.4.1	Non-NASA Launch Services on foreign manufactured launch vehicle	B-16, B-25, B-40, B-43, B-45, B-54, B-55, B-57, B-58
92	5.9.4.2	Hosted Payload accommodations	B-16, B-25, B-30, B-31, B-35, B-40, B-45, B-54, B-55
93	5.9.4.2	Hosted Payload accommodations on foreign manufactured launch vehicle	B-16, B-25, B-40, B-43, B-45, B-54, B-55, B-57, B-58
94	6.2.1	Proposal format	Appendix B
95	6.2.3	Electronic Proposal Submission	B-5,
96	6.2.3	CD-ROMs Submission	B-6,

97	6.2.4	NSPIRES registration	

APPENDIX H

CERTIFICATIONS

Included for reference only. Submission of the signed proposal including Section V of the Proposal Summary Information certifies compliance with these certifications.

Assurance of Compliance with the National Aeronautics and Space Administration Regulations Pursuant to Nondiscrimination in Federally Assisted Programs

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The *(Institution or organization on whose behalf this assurance is signed, hereinafter called "Applicant.")*

HEREBY AGREES THAT it will comply with Title VI of the Civil Rights Act of 1964 (P.L. 88-352), Title IX of the Education Amendments of 1972 (20 U.S.C. 1680 et seq.), Section 504 of the Rehabilitation Act of 1973, as amended (29 U.S.C. 794), and the Age Discrimination Act of 1975 (42 U.S.C. 16101 et seq.), and all requirements imposed by or pursuant to the Regulation of the National Aeronautics and Space Administration (14 CFR Part 1250) (hereinafter called "NASA") issued pursuant to these laws, to the end that in accordance with these laws and regulations, no person in the United States shall, on the basis of race, color, national origin, sex, handicapped condition, or age be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity for which the Applicant receives Federal financial assistance from NASA; and HEREBY GIVES ASSURANCE THAT it will immediately take any measure necessary to effectuate this agreement.

If any real property or structure thereon is provided or improved with the aid of Federal financial assistance extended to the Applicant by NASA, this assurance shall obligate the Applicant, or in the case of any transfer of which the Federal financial assistance is extended or for another purpose involving the provision of similar services or benefits. If any personal property is so provided, this assurance shall obligate the Applicant for the period during which it retains ownership or possession of the property. In all other cases, this assurance shall obligate the Applicant for the period during which the Federal financial assistance is extended to it by NASA.

THIS ASSURANCE is given in consideration of and for the purpose of obtaining any and all Federal grants, loans, contract, property, discounts or other Federal financial assistance extended after the date hereof to the Applicant by NASA, including installment payments after such date on account of applications for Federal financial assistance which were approved before such date. The Applicant recognizes and agrees that such Federal financial assistance will be extended in reliance on the representations and agreements made in this assurance, and that the United States shall have the right to seek judicial enforcement of this assurance. This assurance is binding on the Applicant, its successors, transferees, and assignees, and the person or persons whose signatures appear below are authorized to sign on behalf of the Applicant.

Certification Regarding Debarment, Suspension, and Other Responsibility Matters Primary Covered Transactions

This certification is required by the regulations implementing Executive Order 12549, Debarment and Suspension, 14 CFR Part 1265.

A. The applicant certifies that it and its principals:

1. Are not presently debarred, suspended, proposed for debarment, declare ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;

2. Have not within a three-year period preceding this application been convicted or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State, or Local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

3. Are not presently indicted for or otherwise criminally or civilly charged by a government entity (Federal, State, or Local) with commission of any of the offenses enumerated in paragraph A.(b) of this certification;

4. Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State, or Local) terminated for cause or default; and

B. Where the applicant is unable to certify to any of the statements in this certification, he or she shall attach an explanation to this application.

C. Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion -- Lowered Tier Covered Transactions (Subgrants or Subcontracts)

1. The prospective lower tier participant certifies, by submission of this proposal, that neither it nor its principles is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any Federal department of agency.

2. Where the prospective lower tier participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

Certification Regarding Lobbying

As required by S 1352 Title 31 of the U.S. Code for persons entering into a grant over $100,000, the applicant certifies that:

1. No Federal appropriated funds have been paid or will be paid by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, in connection with making of any Federal grant, the entering into of any cooperative, and the extension, continuation, renewal, amendment, or modification of any Federal grant;

2. If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting an officer or employee of any agency, Member of Congress, or an employee of a Member of Congress in connection with this Federal grant, the undersigned shall complete Standard Form -- LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

3. The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subgrants, contracts under grants, and subcontracts), and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by S1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

National Aeronautics and Space Administration