National Aeronautics and Space Administration

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Announcement of Opportunity

Draft Earth Venture Mission - 3

Earth System Science Pathfinder Program

Comments on Draft AO Due:	**May 20, 2020**
Notices of Intent Due Date:	**Month DD, YYYY**
Proposal Due Date:	**Month DD, YYYY**

OMB Approval Number 2700-0085

ANNOUNCEMENT OF OPPORTUNITY
EARTH VENTURE MISSION – 3
EARTH SYSTEM SCIENCE PATHFINDER PROGRAM
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FOREWORD

The National Aeronautics and Space Administration (NASA) Science Mission Directorate (SMD) is releasing this draft Announcement of Opportunity (AO) to solicit Principal Investigator (PI)-led science investigations for the Earth Venture Mission - 3 (EVM-3) element of the Earth System Science Pathfinder (ESSP) Program.

The AO Cost Cap for an EVM-3 mission is $190M in NASA Fiscal Year (FY) 2022 dollars, not including contributions. NASA will not retain Unallocated Future Expenses (UFE) for the selected mission to cover any activities or products funded under the PI Managed Mission Cost (PIMMC). NASA plans to select no more than one proposal to proceed into Phase A and subsequent mission phases. The selected mission(s) must be ready for launch no later than November 30, 2026, or five years after the contract is in place, whichever is later.

Proposers should be aware that the following aspects of changes in this AO have been modified from previous Earth Venture Mission AOs to adapt to current program resources and objectives. In particular, this AO is based on SMD's current Standard PI-led Mission AO and there are many EVM-3 specific modifications in this AO from the language in the Standard PI-led Mission AO. Significant changes include:

- AO Cost Cap increased from $170M to $190M
- Contributions are limited to 1/3 of the total investigation;
- Launch services are to be available only through LSP.

All proposers must read this AO carefully, and all proposals must comply with the requirements, constraints, and guidelines contained within this AO.

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1. Description of Opportunity

1.1 Introduction

The National Aeronautics and Space Administration (NASA) issues this Announcement of Opportunity (AO) for the purpose of soliciting proposals for investigations to be implemented through its Earth Venture Mission-3 (EVM-3) program element. All investigations proposed in response to this solicitation must support the goals and objectives of EVM-3 (Section 2), must be implemented by Principal Investigator (PI) led investigation teams (Section 5.4.1), and must be implemented through the provision of complete spaceflight missions (Section 5.3.1).

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 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 contents of the EVM-3 Library. In order to provide a consistent basis for proposals and evaluations, documents in the EVM-3 Library will be the versions used for evaluations even when superseded elsewhere.

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

1.2 NASA's Policies on Harassment and Discrimination

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

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

Discrimination and harassment, including sexual harassment, are not tolerated at NASA. Having a diverse, inclusive, and safe workplace is essential to achieving the excellence for which NASA strives. Proposers are reminded that contracts awarded under this AO will include conditions enforcing the civil rights acts that prohibit employment discrimination in all of its forms, including harassment. NASA enforces Federal equal employment opportunity obligations as directed by Executive Order 11246 and in accordance with Federal Acquisitions Regulations (FAR) Section 22.808.

When NASA receives reports of discrimination or harassment by contractor employees working on NASA-funded projects at non-federal facilities, NASA must refer these reports to the Office of Federal Contracts Compliance Programs in the Department of Labor in accordance with the FAR Section 22.808.

Where discrimination or harassment involves both civil servants and contractors, NASA policy and practice is to investigate and, when appropriate, apply remedies against the party whose conduct is discriminatory.

Accordingly, proposers and contractors are urged to be conscientious in ensuring that their officers, researchers and employees abide by anti-discrimination and anti-harassment laws at all times, both in their own workplaces and at NASA facilities.

Students, faculty or staff in programs receiving NASA financial assistance, such as grant awards, may raise allegations of discrimination, including harassment, by contacting the NASA Office of Diversity and Equal Opportunity. Information on filing a complaint through ODEO may be found at https://missionstem.nasa.gov/filing-a-complaint.html.

1.3 Training Future Mission Leaders

Training the next generation of mission leaders is a priority for NASA, and science missions under the Earth Venture Program present tremendous opportunities for such training. Proposers are encouraged to include career development opportunities in science, engineering, and management areas of their proposed mission. For example, generous use of deputies for Key Management Team members allow individuals to gain experience and expertise, preparing them to assume the lead roles in future missions.

1.4 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 contractor employees working under NASA contracts), and (4) high-value equipment and property.

2. AO Objectives

2.1 NASA Strategic Goals

One of NASA's strategic goals is to "Expand Human Knowledge Through New Scientific Discoveries." Further information on NASA's strategic goals and objectives may be found in NASA Policy Directive (NPD) 1001.0C, *The NASA 2018 Strategic Plan*, available in the EVM-3 Library (Appendix D). 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

One of NASA's strategic objectives is to "Understand the Sun, Earth, Solar System, and Universe". Further information on NASA's Themes, Strategic Goals, and Strategic Objectives may be found in NASA Policy Directive (NPD) 1001.0C, *NASA Strategic Plan 2018*, available through the EVM-3 Library. NASA SMD is addressing this strategic objective by pursuing a better understanding of Earth. 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-3 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 Interio*r)
7. Further the use of Earth system science research to inform decisions and provide benefits to society (*Applied Sciences*)

The foundational document that guides NASA's overall approach to the Earth science program is the National Research Council (NRC) 2017 Earth Science Decadal Survey (DS) (*Thriving on Our Changing Planet: A Decadal Strategy for Earth Observation from Space* [The National Academies Press, 2018]) which follows the initial Earth Science Decadal Survey released in 2007 (both documents are available through the EVM-3 Library).

The 2017 DS recommended a broad portfolio of science questions and objectives that prioritize how NASA should approach the decision process for observations to be pursued over the next decade. These questions and objectives were presented in detail in the five thematic science panel reports that are contained in Chapters 6-10 of the Decadal Survey document. These areas are: Global Hydrological Cycles and Water Resources; Weather and Air Quality: Minutes to Subseasonal; Marine and Terrestrial Ecosystems and Natural Resources Management; Climate Variability and Change: Seasonal to Centennial; and Earth Surface and Interior: Dynamics and Hazards. The Executive Committee took these questions and objectives and crafted recommendations for "Designated Observables" (DOs) that are to be given the highest priority for NASA to pursue over the next decade. The next level of prioritized set of observables that NASA should consider, if possible, are designated at Explorer Class (ES), where NASA would compete for potential observations and approaches to advance the science in these areas. Based on the current expected funding profile, NASA will be prioritizing addressing the DOs over the next decade, as recommended in the 2017 DS. It was expected that NASA would be able to address at most three of these six science objectives recommended for ES within the next decade based on projected funding levels.

Overall, the five panels rated the science questions/objectives in one of three categories for prioritization, Most Important, Very Important, and Important. This prioritization was used as a guide in making the recommendations for which observables NASA should consider for near term mission consideration. These questions, and the corresponding prioritization, can be found in table 3.3 of the Decadal Survey report starting on page 3-13. This table also shows that a number of observables attached to questions rated as Most Important by their various panels were not recommended for either a Designated Observable or to be considered in Explorer Class for various reasons.

2.3 Earth Venture Program Background

The 2007 National Research Council's DS in Earth science recommended that NASA maintains a line of competitively selected investigations in the Earth Venture (EV) mission portfolio. The Earth Venture element has been 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 moderately higher-risk 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-3 solicitation, NASA places a strong emphasis on research and innovation for Earth system science issues, especially those observational objectives given high priority in the 2017 DS, while expecting appropriate attention to applications-oriented aspects to further the overall value of the mission.

The 2017 National Research Council's decadal survey in Earth science and applications reaffirmed the importance of the Venture Class program and suggested an expansion of the program into the future. Through the Earth Venture mission portfolio, NASA has implemented a mix of suborbital, instrument, and complete spaceflight mission investigations. To achieve this mix, four 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 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 EVS-1 element (initially referred to as Earth Venture-1) are now completed. Under the EVS-2 solicitation, the second one of this series, investigations are currently in operations. The latest selections under the EVS-3 solicitation are now in development. Not solicited in this AO.

- *EV Mission* (i.e., EVM-1, 2, 3, …). These solicitations call for complete PI-led spaceflight missions to conduct innovative, integrated, hypothesis or scientific question-driven approaches to pressing Earth system science issues. The EVM-1 (initially referred to as Earth Venture-2) solicitation was the first of this series, with the selected mission (Cyclone Global Navigation Satellite System – CYGNSS) now in post-prime mission operations. The EVM-2 solicitation resulted in the selection of the GeoCARB mission that is now in development. *This AO is the third solicitation in this series, with the selection(s) expected FY2021*.

- EV Instrument (i.e., EVI-1, 2, 3, …). These solicitations call for PI-led instruments or CubeSat investigations for flight 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 prime mission on the International Space Station. EVI-3 resulted in the selection of both the Multi-Angle Imager for Aerosols (MAIA) and the Time-Resolved Observations of Precipitation structure and storm Intensity with a Constellation of Smallsats (TROPICS) investigations that are now in development. EVI-4 resulted in the selection of an additional two investigations (Earth Surface Mineral Dust Source Investigation - EMIT and the Polar Radiant Energy in the Far Infrared Experiment - PREFIRE) that are now in development. For the most recent, EVI-5, the selection of Geostationary Littoral Imaging and Monitoring Radiometer (GLIMR) was announced last August. Solicitations in this series are now anticipated every 36 months. Not solicited in this AO.

- *Earth Venture Continuity* (EVC-1, 2…) These solicitations are new to the Earth Venture series of solicitations and are a direct recommendation of the 2017 Decadal Survey. EVC solicits for new and creative investigations that can allow the continuation of key observations from space that require longer time series to ensure appropriate Climate Data Records. The EVC-1 solicitation was the first of this series with the selection of the Libera instrument investigation, which was announced in February of 2020. 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-3 AO is the third solicitation in the Earth Venture series soliciting for Full Missions. For this solicitation, NASA will prioritize consideration of proposals that address the questions laid out in the 2017 Decadal Survey and will use the classification of the question being addressed as a guide for consideration. Observables that were deemed to be considered for Explorer Class (ES) Investigations and those listed in Table 3.5 as "Other ESAS 2017 Targeted Observables, not Allocated to a Flight Program Element" will be considered here as there are no assurances that all of these particular observables would be addressed in the near future.

3. Proposal Opportunity Period and Schedule

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

AO Release Date.....<<AO R DATE>>
Preproposal Conference.....<<AO R DATE + 3 weeks>>
Mandatory Notice of Intent to Propose Deadline .....<<AO R DATE + 4 weeks>>
Electronic Proposal Submittal Deadline
at 11:59 p.m. Eastern Time.....<<AO R DATE + 3 months>>
Letters of Commitment Due (with Proposal).....<<AO R DATE + 3 months>>
Deadline for Receipt of Proposal on CD-ROMs
at 4:30 p.m. Eastern Time.....<<AO R DATE + 3 months + 4 business days>>
Selections Announced (target).....<<AO R DATE + 12 months>>
Initiate Investigation (target).....<<AO R DATE + 15 months>>
Launch Readiness Date.....November 2026 or 5 years from initiation of Phase A contract

All proposals, U.S. and non-U.S., must be received by the proposal submittal deadline. For those received after the deadline, the Government reserves the right to consider proposals or modifications thereof received after the date indicated for such purpose, if the Selection Official deems it to offer NASA a significant technical advantage or cost reduction (see NFS 1815.208).

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, two identical CD-ROMs containing the proposal and relevant files described in Section 6.2.3 shall be submitted. Proposals on CD-ROMs submitted in response to this solicitation shall be delivered no later than the Deadline for Receipt of Proposal on CD-ROMs. Proposals shall be delivered to the Address for Submittal of Proposals given in Section 6.2.3.

4. Policies Applicable to this AO

4.1 NASA Management Policies

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

4.1.1 NASA Flight Program and Project Requirements

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

Formulation is divided into:

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

Approval is the Confirmation process for transitioning into Implementation.

Implementation is divided into:

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

Evaluation is the ongoing independent review and assessment of the project's status during both Formulation and Implementation as described in NPR 7120.5E, which may be found in the EVM-3 Library.

A Key Decision Point (KDP) occurs before the project is approved to begin the next phase of development; KDPs are defined in NPR 7120.5E. For EVM-3 investigations, KDP-A is the selection of a proposal for Phase A as a result of this solicitation; KDP-B is the gate to allow the mission 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 evaluation that the project and all supporting systems are ready for safe, successful launch and early 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. Since the selected mission will be Class D, KDP-B and KDP-D are held at the Earth Science Division level as opposed to the SMD level, per the current NASA Class D guidelines.

4.1.2 NASA Program Management

Owing to the significant expenditure of Government funds on these space flight investigations, as well as to their expected complexity, NASA intends to maintain an essential degree of insight and oversight into mission development to ensure that the implementation is responsive to NASA requirements and constraints. NASA requirements and constraints are stated in the *ESSP Program Plan*, available in the EVM-3 Library. The Associate Administrator for SMD has established an Earth System Science Pathfinder (ESSP) Program Office at the NASA Langley Research Center (LaRC) to be responsible for project oversight. The ESSP Program Manager at the NASA LaRC reports programmatically to the Associate Director for Flight Programs within the Earth Science Division at NASA Headquarters (HQ). Additional details about the program office staffing, structure, and goals can be found in the *ESSP Program Plan* available in the EVM-3 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 the 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.

The ESSP safety, reliability, and quality assurance requirements are documented in the *ESSP Program Plan*, Section 3.2, and in Appendix C of NPR 8705.4 for the payload class specified in Section 4.1.4 (documents available in the EVM-3 Library). These requirements will apply to selected investigations. 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 these documents. Although these documents may impose requirements on selected investigations, they do not impose requirements, either implicitly or explicitly, on proposals submitted in response to an AO.

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 post-selection project management processes. Other than that, the ESSP Program Office plays no role in the AO process; specifically, it plays no role in defining the scientific scope of the AO, writing the AO, evaluating proposals, or selecting proposals. SMD at NASA HQ 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 proposals. 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 Roles and Responsibilities in Communications and Outreach

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

4.1.3.1 <u>NASA Centers or Jet Propulsion Laboratory (JPL)</u>

Each flight mission manages the communications plan and activities utilizing the communications office of a NASA Center or JPL. Missions managed by a NASA Center or JPL will request support of that Center's communications office. For EVM-3 missions not managed by a NASA Center or JPL, NASA LaRC where the ESSP Program Office resides will fulfill the communications management role.

The communications offices will be responsible for coordinating and executing mission communications activities—along with the mission's PI and Project Office for PI-led missions

and Program Office for strategic missions—and with the approval of SMD and Office of Communications.

4.1.3.2 Principal Investigators

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

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

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

Selected PIs also must work with NASA to ensure their mission follows NPD 2521.1B *Communications and Material Review* and NPR 2200.2D *Requirements for Documentation, Approval and Dissemination of Scientific and Technical Information* (see the EVM-3 Library). NASA, and through NASA the selected investigation, is required under the Information Quality Act (44 U.S.C. 3504(d)(1) and 3516) and associated guidelines to maximize the quality, objectivity, utility, and integrity of information and services provided to the public.

4.1.3.3 NASA Headquarters

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

4.1.4 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 life-cycle cost and mission priority level. The project 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 C of NPR 8705.4 and are applied at the deployed investigation level.

The EVM-3 mission to be selected as a result of this AO have been determined to be Category 3 projects (per NPR 7120.5E) with Class D payloads (per NPR 8705.4). Proposers must incorporate appropriate work effort and support in their proposals accordingly

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

4.2 Participation Policies

4.2.1 Eligibility to Participate in this AO

Prospective investigators from any category of organizations or institutions, U.S. or non-U.S. with some restrictions as specified in this section and in Section 4.2.2, are welcome to respond to this solicitation. Specific categories of organizations and institutions that are welcome to respond include, but are not limited to, educational, industrial, and not-for-profit organizations, Federally

Funded Research and Development Centers (FFRDCs), University Affiliated Research Centers (UARCs), NASA Centers, the Jet Propulsion Laboratory (JPL), and other Government agencies.

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

NASA contracts for the services of outside, non-governmental organizations for support in evaluating proposals and performing programmatic assessments (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 evaluation-support organization. For non-governmental organizations, this requires limiting the extent to which the outside evaluation-support or programmatic-assessment organizations can participate in proposal development and/or execution of the work proposed. NASA has two general classes of limitation for organizations.

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

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

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

(ii) The evaluation-support organization has established firewalls within the organization to prevent conflicts of interest between organizational units and employees supporting NASA's evaluation of proposals and organizational units and employees supporting proposal efforts. Any supporting analysis services, including supporting cost analysis and

supporting engineering analysis, provided to a proposal team must comply with the firewall that has been established by the evaluation-support organization and is described in a NASA approved Organizational Conflict of Interest Avoidance Plan.

(iii) The proposer fully describes in a memorandum submitted to NASA at the same time as the proposal all of the supporting analysis services provided by the evaluation-support organization to the proposing team. The memorandum must be signed by the proposing organization and must be concurred on by the evaluation-support organization. The memorandum is not to be incorporated into the proposal itself, but must be a separate document submitted by mail or email to the NASA Point of Contact (POC) identified in Section 6.1.5. This memorandum must describe all of the work provided by the evaluation-support organization, must identify any work products of the evaluation-support organization that are included in the proposal or its appendices, and must list all employees of the evaluation-support organization who participated in the work.

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

- Cornell Technical Services (CTS) will be subject to the "Full Limitation" described above. The NASA Evaluations, Assessments, Studies, Services, and Support (EASSS) 2 contract with CTS creates an unmitigable 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.
- Arctic Slope Regional Corporation (ASRC) and its subsidiaries and affiliates will be subject to the "Full Limitation" described above. The NASA Research and Education Support Services (NRESS) contract creates an unmitigable organizational conflict of interest for ASRC in the event that any business unit of ASRC has a proposed role as prime contractor, subcontractor, or participating organization. Because of this organizational conflict of interest, ASRC and affiliates are precluded from participating in any capacity in support of a respondent under this AO.
- The Aerospace Corporation is subject to the "Full Limitation" described above. The Aerospace Corporation, as the Federally Funded Research and Development Center (FFRDC) for space systems acquisition, is available to the U.S. Government and other organizations under the terms of its sponsoring agreement with the U.S. Air Force. The Aerospace Corporation under its contract with NASA will provide programmatic assessments of projects selected under this AO. This contract creates an unmitigatable organizational conflict of interest for the Aerospace Corporation in the event that any business unit of the Aerospace Corporation has a proposed role as prime contractor, subcontractor, or participating organization. Because of this organizational conflict of interest, the Aerospace Corporation is precluded from participating in any capacity in support of a respondent under this AO.

4.2.2 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.

4.2.3 Responsibility of Principal Investigator for Implementation

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

4.2.4 NASA Concurrence for Change(s) of Named Key Management Team Members or Co-Is

Subsequent to selection, any replacement, addition, or removal of a named Key Management Team member (including, but not limited to, the PI and Project Manager (PM)) or any Co-I require concurrence by NASA. Institutions with a recent history of replacing named Key Management Team members or Co-Is may receive Factor C-4 weaknesses.

4.3 Cost Policies

4.3.1 PI-Managed Mission Cost

PI-Managed Mission Cost (PIMMC) is defined as the cost proposed by the PI's implementation team to be funded by the ESSP Program for the development and execution of the proposed project during Phases A through F. It includes any reserves applied to the development and operation of the mission. It also includes any costs that are required to be counted against the PIMMC, even though the PI is not directly responsible for those costs. The term does not imply that a contractual relationship between the Proposing Organization and other proposal partners is required. The PIMMC is capped at the AO Cost Cap or Adjusted AO Cost Cap, as applicable (see Section 5.7.1).

Examples of costs to be included in the PIMMC, as applicable and unless contributed, are: development activities (e.g., instrument development, spacecraft development, management, software, testing); launch services; Student Collaboration in excess of the associated incentive (see Section 5.6.3); 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, with applicable costs (i.e., NASA's Near-Earth Network, Space Network, Deep Space Network); any program/project-specific costs (e.g., curation of returned samples); and all labor, including contractor and Civil Servant (NASA and non-NASA).

4.3.2 Total Mission Cost

Total Mission Cost is defined as the PIMMC (see Section 4.3.1) plus any Student Collaboration costs up to the associated incentive (see Section 5.6.3) and additional costs that are contributed or provided in any way other than through the ESSP Program (see Section 5.7.6). 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 or Adjusted AO Cost Cap, as applicable, 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 non-selection of a proposal. A final funding profile for each selected mission will be negotiated.

4.3.4 Availability of Appropriated Funds

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

4.4 Intellectual Property Rights

4.4.1 Invention Rights

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

4.4.2 Data Rights

In keeping with NASA Earth Science Data policy (fully described at https://science.nasa.gov/earth-science/earth-science-data/data-information-policy), all science data returned from NASA missions are made available immediately in the public domain. There must be no period of exclusive access. The PI is required to propose and justify any necessary data product latency period for standard products listed in the proposal, based primarily on the time required to produce, quality-check, and validate the products. Barring exceptional circumstances, data product latency may not exceed six months.

4.4.3 Sensitive Government Information

Sensitive Government information is defined as information the Government has generated that qualifies for an exception to the Freedom of Information Act, which is not currently in the public domain, may embody trade secrets or commercial or financial information, and may be sensitive or privileged. If performing any contract resulting from this opportunity entails access to such sensitive Government information then the Contractor must limit utilization of the information to

performing the services specified in said contract; must not utilize the information to improve its own competitive position in another procurement; must safeguard the information from unauthorized use and disclosure, allowing access only to those employees that need it to perform services under the contract; and must preclude access and disclosure of the information to persons and entities outside of the Contractor's organization. A Contractor's Organizational Conflicts of Interest Avoidance Plan is a procedures and obligations compliance document that will be required for contract award.

4.4.4 Trademark

The National Aeronautics and Space Act directs NASA to "provide for the widest practicable dissemination of the information concerning its activities and the results thereof." 51 USC 20 112(a)(3). NASA's mission supports broad public engagement, enhanced educational opportunities, and open scientific inquiry. Accordingly, selected missions may not assert trademark or other ownership rights in the mission name, mission logos, mission graphics, or any other program identifier.

4.5 Project Management Policies

4.5.1 Independent Verification and Validation of Software

The NASA Chief, Safety and Mission Assurance (CSMA) has the authority to select software projects to which Independent Verification and Validation (IV&V) must be applied, as defined in NASA-STD-8739.8, *Standard for Software Assurance*, and NPR 7150.2B, *NASA Software Engineering Requirements*. At a minimum, all Category 1 and those Category 2 missions with a payload risk classification A or B will require IV&V. If the software assurance classification assessment is expected to determine that IV&V is necessary, 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 CSMA.

4.5.2 Earned Value Management Plan

For Government entities, the earned value management (EVM) requirements are listed in NPR 7120.5E. For entities receiving contracts, the EVM requirements are listed in NFS 1852.234-2.

4.5.3 Cost Analysis Data Requirement (CADRe)

NASA has established a Cost Analysis Data Requirement (CADRe) in NPR 7120.5E, Table I-4, which will apply to investigations selected through this AO. Support contractors funded directly by NASA HQ will perform the actual development of the CADRe; the costs for these services need not be included in the proposed PIMMC. Selected investigations will have to spend project funds only to collect existing documentation and transmit it to the CADRe support contractor at selected major milestones and then to review the completed CADRe for completeness and accuracy.

4.5.4 Conjunction Assessment Risk Analysis

NASA has established conjunction assessment risk analysis requirements in NPR 8715.6B, Chapter 3 that will apply to investigations selected through this AO. Two organizations—the Conjunction Assessment Risk Analysis (CARA) team at NASA Goddard Space Flight Center for Earth-orbiting missions—are funded directly by NASA HQ and the Multi-Mission Ground Systems and Services (MGSS) program, respectively, to perform the actual analysis and risk assessment; the costs for these services need not be included in the mission PIMMC. However, an investigation to which NPR 8715.6B, Chapter 3 is applicable will have to budget costs under the PIMMC to establish a working interface between the Flight Operations Team and the CARA or the Multimission Automated Deepspace Conjunction Assessment Process (MADCAP) team in the proposal. This interface will be used to routinely share orbital ephemerides data and covariance data, any maneuvering plans, and to perform any maneuver planning activities required for collision avoidance once on orbit. Additionally, estimates of how many maneuver planning events may be required in a particular Earth orbit regime are available from the CARA team. The interface between the mission and CARA or MADCAP team should be agreed-to and documented one year prior to launch.

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

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 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 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;* and information on the NASA Earth Science Division Senior Review can be found in the *Call for Proposals - Senior Review 2020 for Extension of Earth Science Operating Missions.* These documents are accessible from the EVM-3 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 3. Proposals shall describe a science investigation with goals and objectives that address the program science objectives described in Section 2.

Requirement 4. Proposals shall demonstrate how the proposed investigation will fully achieve the proposed objectives.

5.1.2 Traceability of Proposed Investigation

EVM-3 missions are 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 5.2).

Requirement 5. 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 6. Proposals shall include a plan to calibrate (both preflight and in-flight), analyze, validate, publish, and archive the data returned, and shall demonstrate, analytically or otherwise, that sufficient resources have been allocated to carry out the Data Plans within the proposed mission cost. The Data Management and Archiving Plan shall include a discussion and justification of any data latency period (see Appendix B, Section E.4, for additional detail). The Data Management and Archive Plan shall be in compliance with the requirements and guidelines in the *NASA Plan for Increasing Access to the Results of Scientific Research* or a justification shall be provided that this is not necessary given the nature of the work proposed (see Section 5.2).

Requirement 7. Proposals shall clearly present a plan for analysis of the mission data that will lead to the completion of the proposed science investigation and will achieve the identified investigation objectives. Proposals shall show that adequate resources, including funding, schedule, and personnel, are identified to complete the proposed science investigation.

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.

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 are necessary and sufficient to the achievement of these objectives (see Appendix B, Sections D and E, for additional detail).

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

5.1.4 Baseline and Threshold Science Missions

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

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

The differences between the Baseline Science Mission and the Threshold Science Mission provide resiliency to potential cost and schedule growth in the proposed formulation and implementation plan. A Threshold Science Mission that does not provide meaningful resource reduction compared to the Baseline Science Mission does not provide this intended resiliency while degrading the science return of the proposed mission. NASA recognizes that, in some circumstances, the Threshold Science Mission may be identical to the Baseline Science Mission.

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

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

5.1.5 Level 1 and 2 Requirements

The Level 1 science requirements identify the mission, science, and programmatic requirements as well as constraints imposed on the project. The Level 1 requirements (defined by the Baseline Science Mission objectives and are referred to as program level requirements in NPR 7120.5E) and Level 2 project requirements specify requirements and constraints on science and engineering data collection, mission and spacecraft performance, prime mission lifetime, budget, schedule, launch vehicle, and any other requirements or constraints that need to be controlled. The requirements provide the criteria to be used to evaluate whether a project should be called for a termination review if it appears it might fail to meet its requirements.

Requirement 12. Proposals shall provide a set of proposed Level 1 requirements that will achieve the objectives of the Baseline Investigation. Both Baseline Mission requirements and Threshold Mission requirements shall be identified. The Level 1 requirements shall be unambiguous, quantifiable, objective, verifiable, and traceable to the mission objectives.

Requirement 13. Proposals shall provide Level 2 requirements that will guide the design and development of the mission. Lower level requirements shall be provided to the extent that they

are known and necessary to explain and justify the design concept, including instrument capability, instrument performance, and other aspects of the system architecture that enable the accomplishment of the mission science objectives. The Level 2 requirements shall be unambiguous, quantifiable, objective, verifiable, and traceable to the Level 1 requirements.

5.1.6 Applied Science Opportunities

One of 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 can help achieve this goal and increase the overall value and benefits of a mission by considering innovative and practical applications for the collected data as part of the overall mission concept.

To enable the realization of societal and economic benefits from Earth observations, proposals are required to articulate, to the extent possible, potential innovative and practical applications of the mission data and a plan to engage those users that would use mission data to inform their decisions and actions. Proposers are referred to the *2016 Directive on Project Applications Program* in the EVM-3 Library for further information.

NASA recognizes that, in some science investigations, applications are not possible. In such cases, the proposer is required to explain and justify why there is no viable application dimension to the investigation.

Requirement 14. The proposal shall describe:

- Innovative and practical applications of the data that will be collected and disseminated.
- How users will be engaged.
- How the project will adapt to new application opportunities that may emerge.
- How the project will coordinate applications activities with NASA.
- A budget for implementation of the activities listed in the above bullets.
- Or, a justification as to why there is no viable application dimension to the investigation.

5.1.7 NOAA Operational Enhancement Opportunity

NOAA is interested in seeking ideas that enhance NOAA's operational capability. Observations from the Earth Venture Program have the potential to provide novel possibilities for extending and enriching NOAA's mission. To capitalize on these possibilities, NOAA is interested in sponsoring an Operational Enhancement (OE) to the selected investigation from this Earth Venture Mission announcement to provide proposers the opportunity to put forward activities that directly support the NOAA mission.

These activities would allow NOAA to explore or facilitate the use of the EV science investigation to support NOAA's current or future operations. These activities could include but are not limited to: improving mission availability and reliability towards NOAA operational needs; developing operationally-focused data products/algorithms; enhancing calibration, validation, and testing; reducing data latency to NOAA to meet its mission needs; and delivering

mission data to a location (such as the Commercial Cloud) where it can be accessed by operational users in support of NOAA's weather, climate, and ocean observations.

Shortly after award of the EVM-3 contract, NOAA intends to review the OE concept, if proposed, and decide, with NASA support, whether to support and request a sole source Request for Proposal (RFP) for the OE as a modification to the NASA EVM-3 contract, subject to any legal requirements applicable to such a transaction. The evaluation criteria for the OE sole source proposal will be established at the time of the request for proposal, as the criteria may vary depending on the nature of the OE. NOAA and NASA reserve the right to accept or decline proposed OE activities at any time during the mission. As these activities are optional and are not included within the baseline investigation, the science enabled by OE activities is not considered part of the scientific merit of the proposed investigation nor can the OE science be necessary to achieve the proposed EV investigation objectives. These OE concepts and activities will not be part of the body of the proposal and will not be part of NASA's selection criteria for EVM-3. NOAA will not be directly involved in the selection of the EVM-3 investigation.

OE concepts or activities, supplied as supplementary information to the proposal through the NSPIRES proposal information, may describe the OE activities envisioned, and the potential operational value of these activities to NOAA. Offerors choosing to submit supplementary information concerning potential OE activities must indicate that they consent to the release of the supplementary information to NOAA. Flight hardware will not be considered for the OE concept. Including the OE informational data does not imply a commitment to fund the OE if the baseline investigation is selected.

NOAA presently contemplates supporting potential OE activity procurement costs up to $20M over the lifecycle of the mission. NOAA will be fully responsible for the costs of the OE. NOAA expects that OE activities prior to Phase E will be minimal. However it is understood that some funding might be needed in phases B through D to plan, design, and prepare for Phase E. NOAA reserves the right to negotiate the OE with the proposers to ensure value and scope support it mission.

NOAA's product needs and areas of interest are the following:

- real-time multi-spectral imagery (rapid refresh, low latency)
- non-real-time global multi-spectral imagery,
- real time and non-real time infrared and/or microwave atmospheric vertical soundings,
- 3D atmospheric winds,
- GNSS radio occultation,
- GNSS reflectometry,
- global precipitation measurements,
- lightning mapping,
- ozone mapping and sounding,
- chemical composition mapping,
- sea surface height, temperature, and vector winds,
- ocean color and data relevant to coastal health,

- soil moisture,
- solar wind measurements,
- solar imagery,
- *in situ* space weather observations, and
- other observations that meet NOAA's operational mission requirements.

5.2 Data Policies and Requirements

5.2.1 Data Analysis

The PI will be responsible for production and analysis of the mission data necessary to achieve the proposed science objectives, delivery of products to one or more NASA-selected Distributed Active Archive Centers (DAAC), and for timely publication of initial scientific results in peer-reviewed scientific journals, as part of their mission operations (Phase E). The assigned NASA DAAC(s) will be responsible for archival and public distribution of all data collected by the instrument(s) and produced by the investigation's prime measurement. The PI shall work with the DAAC to ensure that the mission data are delivered in a format that meets NASA requirements. A full description of these requirements can be found at https://earthdata.nasa.gov/collaborate/new-missions/adding-orbital-airborne.

Requirement 15. A Data Analysis Plan including approaches for data retrieval, validation, and preliminary analysis 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.

Requirement 16. Proposals shall describe the complete data processing flow leading to the archived data products, including the time required to complete the initial and final on-orbit calibration and validation of the measurements. Proposal shall show adequate resources for delivering data products to the assigned NASA DAAC(s).

Requirement 17. Proposals shall clearly present a plan for analysis of the mission data leading to completion of the proposed PI-led science investigation and achieving the identified investigation goals and objectives. Proposals shall show that adequate resources, including funding, schedule, and personnel, are identified to complete the proposed science investigation. Proposals shall demonstrate a clear commitment to providing data at the earliest possible time to the broader scientific and applications communities. Proposals shall include a clear commitment to minimizing the latency for data products. Proposals shall specify the minimum necessary data latency period and shall provide a justification for that data latency period.

5.2.2 Delivery of Data to Archive

Mission data will be made fully available to the public as quickly as possible, and no longer than six months following its collection, barring exceptional circumstances. The PI will be responsible for collecting the scientific, engineering, and ancillary information necessary to

validate and calibrate the data. During Phase A, NASA will either assign a data center, e.g., one or more of the Earth Observing System Data and Information System (EOSDIS) DAACs, to be the data archive(s) or detail which science processing facility the data shall be delivered to. The DAAC will be outside the PIMMC. Throughout the investigation, the project will deliver all data products; the scientific algorithm software, coefficients, and ancillary data used to generate these products; and the algorithm and calibration documentation to the NASA designated repository as the data products are generated or updated. Information on EOSDIS and the DAACs is available at https://earthdata.nasa.gov/about/esdis-project and https://earthdata.nasa.gov/about/daacs.

NASA data archives have resources allocated 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 NASA Earth Science data archives. For information on NASA Earth Science data policy, nomenclature, standards, and EOSDIS, see http://science.nasa.gov/earth-science/earth-data/.

Requirement 18. A schedule-based end-to-end Data Management and Archive Plan which includes approaches for the release of peer-reviewed publications, the release of the research data that underlie the results and findings in peer-reviewed publications, and delivery to the assigned NASA DAAC for public distribution, 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 Data Management and Archive Plan shall identify the formats and standards to be used, selected from the published list of approved NASA Earth Science Data System Standards (https://earthdata.nasa.gov/user-resources/standards-and-references). It shall include an estimate of the raw data volume and a schedule for the submission to the data archive of raw and reduced data in physical units accessible to the science community. The Data Management and Archive Plan shall conform to the NASA Earth Science Data and Information Policy (see http://science.nasa.gov/earth-science/earth-science-data/data-information-policy/). It shall be in compliance with the requirements and the guidelines stated in the *NASA Plan for Increasing Access to the Results of Scientific Research* or a justification shall be included that this is not necessary given the nature of the work proposed. The data management plan (DMP) (see https://science.nasa.gov/earth-science/earth-science-data/data-management-plan-guidance) shall be addressed as part of the Data Management and Archive Plan. This supersedes Requirement B-23 in Appendix B of the EVM-3 AO.

5.3 Technical Requirements

5.3.1 Complete Spaceflight Missions

The term “complete” encompasses all appropriate mission phases (see Section 4.1.1) from project initiation (Phase A) through mission operations (Phase E), which must include analysis and publication of data in the peer reviewed scientific literature, delivery of the data to an appropriate NASA data archive, and, if applicable, extended mission operations or other science enhancements (see Section 5.1.7), and closeout (Phase F). The term “spaceflight missions” is defined as Earth orbital to deep-space missions; it specifically excludes suborbital missions (e.g., via sounding rockets, balloons, and aircraft).

Requirement 19. Proposals submitted in response to this AO shall demonstrate that the proposed investigation is a complete science investigation requiring a spaceflight mission.

Requirement 20. Proposals shall describe the proposed mission architecture and the rationale for each mission element.

Requirement 21. Proposals shall describe the proposed mission design and mission operations concept.

Requirement 22. Proposals shall describe the proposed flight system concept, including the spacecraft bus and its major subsystems.

Requirement 23. 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-3 AO. Proposals of instruments to be hosted on the International Space Station are not solicited by this EVM-3 AO.

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

Requirement 24. Each proposal shall fully describe the requirements for calibration and validation. If the collection of some validation data are not to be funded directly by the selected PI-led investigation, the proposal shall provide information about the expectations for available calibration and validation instruments and/or commitment to fund the collection of those data in the time frame of five to ten years after selection of the investigation and describe the implications to meeting the requirements if such activities do not become available.

See Appendix B, Section F, for additional detail.

5.3.2 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. Each implementing organization is free to propose its own processes, procedures, and methods for managing its mission; however, they must be consistent with the principles of NPR 7120.5E. Any deviations from the prescribed requirements in NPR 7120.5E will require a waiver during formulation.

Requirement 25. 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. Each implementing organization is free to propose its own processes, procedures, and methods for systems engineering; however, they must be consistent with NPR 7123.1B.

Requirement 26. Proposals shall describe the investigation's proposed systems engineering approach, including interface management, mission assurance approach, trade studies, identification of the key Technical Performance Measures (TPMs), and the acquisition approach. (See Appendix B, Section F, for additional detail).

Requirement 27. Proposals shall describe any deviations from the prescribed requirements in NPR 7120.5E, NPR 7123.1B, or other NASA procedural requirements that will require a waiver during formulation.

5.3.3 New Technologies/Advanced Engineering Developments

This AO solicits flight missions, not technology or advanced engineering development projects. However, proposals may contain less mature technologies and/or advanced engineering developments necessary to achieve the Baseline and Threshold Science Missions. These are permitted as long as proposals contain plans for maturing associated systems to TRL 6 (see NASA/SP-2016-6105 Rev 2, *NASA Systems Engineering Handbook*) by no later than PDR, as well as backup plans that will provide adequate mitigation in the event that the systems cannot be matured as planned. The realism of maturation plans will be evaluated during the peer review, and the technological maturity of these systems will be independently validated at PDR.

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 3-9 of the *NASA WBS Handbook*, NASA/SP-2016-3404/REV1, which can be found in the EVM-3 Library. TRLs are defined in NPR 7123.1B *NASA Systems Engineering Processes and Requirements*, Appendix E, which can be found in the EVM-3 Library.

Requirement 28. 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).

5.3.4 Environmental Compliance

The *National Environmental Policy Act* (NEPA) *of 1969*, as amended (42 USC 4321 *et seq.*), is the Nation's policy for the protection, maintenance and enhancement of the environment. It

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

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

Depending on the complexity of a proposal, the NEPA process will require preparation of one of three levels of NEPA documentation: (i) Record of Environmental Consideration (REC) Routine Payloads; (ii) Environmental Assessment (EA); or (iii) Environmental Impact Statement (EIS).

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

Depending upon the complexity of analysis required, NEPA documentation requiring an EA or EIS can be resource intensive. Costs for an EA are often in the $100K+ range and can require one year to complete. Typical cost estimates to prepare an EIS involving a RPS or RHUs can be $1M+ and require more than one year to complete. NEPA compliance costs specifically identified in this AO or documents posted to the EVM-3 Library must be reflected against the PIMMC; major NEPA milestones must be included in the proposed schedule.

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

5.3.4.1 Use of Radioactive Material

The proposed use of radioactive materials of any quantity and any isotope, including radioisotope power sources, radioisotope heater units, or radiological sources for science instruments is prohibited for this AO.

5.3.4.2 Environmental Review and Launch Approval Requirements

Because the use of limitations on this AO for the types of launches, the costs associated with satisfying the requirements of the NEPA and NLSA against the PIMMC are expected to be at the minimal level of $100K. The final NEPA document will be produced at PDR.

Requirement 29. The costs of environmental review and launch approval shall be reflected against the PIMCC. The key milestone for the final NEPA document is PDR.

5.3.5 Telecommunications, Tracking, and Navigation

Use of NASA's Near-Earth Network, Space Network, or Deep Space Network (DSN) may be proposed, as appropriate. Points of contact and cost information for these services may be found in the *Space Communications and Navigation (SCaN) Mission Operations and Communications Services (MOCS)* and *Near Earth Network (NEN) Users' Guide Revision 4* documents in the EVM-3 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 *Space Communications and Navigation (SCaN) Mission Operations and Communications Services (MOCS)* in the document or at the Interplanetary Network Directorate's Commitment Office website at https://deepspace.jpl.nasa.gov/about/commitments-office/. For assistance with the cost calculation, contact the persons named on the website. Proposers to this AO who propose the use of the DSN should compute the estimated DSN Aperture Fees and report this in their proposal as a means of assessing the reasonableness of the proposed DSN use. DSN Aperture Fees should not be included in the PIMMC nor should they appear in any cost table.

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

Requirement 30. Proposals shall include mission requirements for telecommunications, tracking, and navigation; proposals shall also include a plan for meeting those requirements. If non-NASA networks are used, a cost plan for the use of services shall also be included in the PIMMC.

Where the use of NASA's network services is clearly within the capabilities and capacities described in the *Space Communications and Navigation (SCaN) Mission Operations and Communications Services (MOCS)* 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 *Space Communications and Navigation (SCaN) Mission Operations and Communications Services (MOCS)* document, discussions should be initiated with the 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.

NASA intends to transition all space missions to the use of Ka-band for science data return (telemetry, tracking, and commanding (TT&C) data may still be transmitted using X-band or S-Band). In order to better manage the Agency's transition to Ka-band service, proposed investigations are required to baseline the use of Ka-band for science data return, unless it is inappropriate.

Radio frequency spectrum for telecommunications is allocated by service (e.g., Earth Exploration-Satellite, Space Research, and Space Research (Deep Space)) and may be further constrained by maximum channel bandwidth limits (see the *Available Spectrum and Channel Limits By Allocated Service* document in the EVM-3 Library). Proposals are required to address conformance to the applicable maximum channel bandwidth limit(s).

Requirement 31. If use of NASA's network services is proposed, costs for services, as described in the *Space Communications and Navigation (SCaN) Mission Operations and Communications Services (MOCS)* document, including the cost of any development but excluding DSN Aperture Fees, shall be included in the PIMMC and the proposal's cost plan. Cost estimates for DSN Aperture Fees shall be included in the proposal but not in any cost table.

Requirement 32. If use of NASA's network services beyond the capabilities and capacities described in the *Space Communications and Navigation (SCaN) Mission Operations and Communications Services (MOCS)* document is proposed, the proposal shall include a Letter of Commitment from the NASA network provider; the Letter shall confirm the ability of the network to provide the required capabilities and capacities and shall include an estimate of the additional costs for these capabilities and capacities.

Requirement 33. Proposals shall baseline the use of Ka-band for science data return, unless it is inappropriate for the proposed investigation; proposal of an alternative communications approach shall be justified.

Requirement 34. Proposals shall address conformance to the applicable maximum channel bandwidth limit(s).

Requirement 35. Proposals that propose the use of the DSN shall baseline the use of only one DSN 34 meter at any time for normal operations (not including periods of station hand-off, emergencies, Delta-Differential One-Way Ranging measurements, etc.).

5.3.6 Critical Event Coverage

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

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

Requirement 36. 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.

5.3.7 Joining Existing Orbital Constellations

If a mission has a need to fly in an existing orbital constellation, such as the Afternoon Constellation (A-train), the proposer should be aware that the constellation members may levy additional requirements on the mission.

Requirement 37. Proposals for missions that need to fly in an existing orbital constellation shall acknowledge any requirements imposed by the constellation and demonstrate that the requirements will be accommodated if the mission is selected.

5.3.8 Orbital Debris Assessment and End-of-Mission Spacecraft Disposal Requirement

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

Requirement 38. As applicable for Earth and Moon orbiters, proposals shall demonstrate satisfaction of requirements to limit the generation of orbital debris during mission operations and the disposal per NPR 8715.6B and NASA-STD-8719.14A (see Appendix B, Section J.6, for additional detail).

5.3.9 Deviations from Recommended Payload Requirements

EVM-3 investigations are required to meet the requirements for safety, reliability, and mission assurance in the *ESSP Program Plan*, Section 3.2, and in Appendix C of NPR 8705.4 for the payload class specified in Section 4.1.4. (see EVM-3 Library).

Requirement 39. Proposals shall indicate any expected deviations from the recommended requirements in the *ESSP Program Plan*, Section 3.2, and in Appendix C of NPR 8705.4 for the payload class specified in Section 4.1.4.

5.3.10 Mission Operations Tools and Services

NASA's Advanced Multi-Mission Operating System (AMMOS) comprises a set of tools and services that support the operations of robotic flight missions (see the AMMOS catalog at

http://ammos.nasa.gov/). AMMOS may be proposed, as appropriate. AMMOS tools and services and their long-term sustaining engineering are fully funded by NASA and are provided by NASA free of charge to all missions. Only mission-unique adaptations to the AMMOS must be funded by missions. Use of applicable AMMOS tools is expected, although not required. Points of contact and cost information for these services may be found on the AMMOS website specified above.

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

Requirement 40. If a ground/operations system solution other than the AMMOS or mission-unique adaptations to the AMMOS is proposed, it shall be described and budgeted for in the proposal.

5.3.11 Space Systems Protection

Threats and vulnerabilities to space systems have indicated the command uplink to robotic spacecraft must be better protected. These threats can also interfere with spacecraft position, navigation, and timing subsystems which must be able to survive such interference. Because of the sensitivity of command uplink information, all such information, including command dictionaries, are now required to be protected at the Sensitive But Unclassified (SBU) level. All of these issues, plus additional requirements, are documented in NASA Standard 1006 with which all missions shall comply.

Requirement 41. Proposals shall demonstrate that adequate resources (including, but not limited to, cost, schedule, technical accommodation, etc.) have been allocated to protect uplink commands using approaches compliant with FIPS 140-2 Level 1.

Requirement 42. Proposals shall demonstrate that adequate resources (including, but not limited to, cost, schedule, technical accommodation, etc.) have been allocated to ensure that the command uplink, position, navigation, and timing subsystems can recognize and survive interference.

Requirement 43. Proposals shall demonstrate that adequate resources (including, but not limited to, cost, schedule, technical accommodation, etc.) have been allocated to protect command uplink information at no less than the Sensitive But Unclassified level.

Detailed plans for command uplink encryption, recognizing and surviving interference, and protecting command uplink information will be required after selection.

5.4 Management Requirements

See Appendix B, Section G, for additional detail.

5.4.1 Principal Investigator

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

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

Requirement 44. A proposal shall identify and designate one, and only one, PI as the individual in charge of the proposed investigation.

5.4.2 Project Manager

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

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

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

Requirement 45. 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.

5.4.3 Project Systems Engineer

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

Requirement 46. 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.

5.4.4 PI and PM, and PSE Roles

Requirement 47. Proposals shall clearly define the respective roles of the PI and PM, and PSE.

5.4.5 Management and Organization Experience and Expertise

The qualifications and experience of the PI, PM, Project Systems Engineer (PSE), Deputy PI (if specified), Project Manager Alternate (if specified), Project Scientist (PS, where appropriate), partner leads for substantial efforts, and other named Key Management Team members of the PI-

led investigation team must be—taken together—commensurate with the technical and managerial needs of the proposed investigation.

The PI may delegate some responsibility to ensure that the mission meets schedule and cost constraints. Regardless of such delegation, NASA will hold the PI ultimately responsible for mission success. It is responsibility of the PM, the implementing organization, and all partners to provide the quality personnel and resources necessary to meet the technical and managerial needs of the mission.

The commitment, spaceflight experience, and prior working relationships of the implementing organization and all partners will be assessed against the needs of the investigation.

Requirement 48. Proposals shall identify named Key Management Team members. At a minimum, the individuals proposed to fill the roles of PI, PM, and PSE per Requirement 44, Requirement 45, and Requirement 46 shall be named. Proposals shall describe the qualifications and experience of the individuals who will occupy the positions. Proposals shall also demonstrate that the qualifications and experience of the Key Management Team are commensurate with the technical and managerial needs of the proposed investigation. The time commitment of each named Key Management Team member shall be provided by mission phase.

Requirement 49. Proposals shall identify other positions that will be filled by Key Management Team members. These requirements are, at a minimum, the Deputy PI (if specified), Project Manager Alternate (if specified), and, where appropriate, the PS and partner leads for substantial efforts. For Key Management Team positions to which members are not named, proposals shall describe the qualifications and experience required of any candidate who will occupy those positions. Proposals shall also demonstrate that the qualifications and experience of the Key Management Team as a whole are commensurate with the technical and managerial needs of the proposed investigation.

Requirement 50. Proposals shall describe the qualifications and experience of the implementing organization and all partners and demonstrate that they are commensurate with the technical and managerial needs of the proposed investigation.

5.4.6 Risk Management

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

Requirement 51. Proposals shall define and discuss the major risks to the formulation and implementation of the proposed investigation.

Requirement 52. Proposals shall discuss management approaches to mitigate risks to ensure successful achievement of the investigation objectives within the committed cost and schedule.

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

Requirement 53. 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, the decision milestone(s) for implementing descopes, and the scientific impact of individual, as well as combined, descopes.

Requirement 54. Proposals that include international participation shall address the risk resulting from any international contributions to the proposed mission (see Section 5.7.6 and Section 5.8).

5.4.7 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) 1872.306).

Requirement 55. Proposals submitted by NASA Centers shall contain any descriptions, justifications, representations, indications, statements, and/or explanations that are required by the regulations in NFS 1872.306 (see Appendix B, Section J.7, for additional detail).

5.5 Science Team, Co-Investigators, and Collaborators

5.5.1 Science Team

Requirement 56. Proposals shall clearly define the science team necessary to successfully conduct the science investigation.

5.5.2 Co-Investigators

A Co-Investigator (Co-I) is defined as an investigator who plays a necessary role in the proposed investigation. A Co-I's services are either funded by the EVM-3 investigation (within the PIMMC) or are contributed.

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 57. 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 58. Proposals shall identify the funding source for each Co-I. If funded by the EVM-3 investigation, costs shall be included in the PIMMC. If contributed, the costs shall be included in the Total Mission Cost.

5.5.3 Collaborators

A collaborator is an individual who is less critical to the successful development of the mission than a Co-I. A collaborator must not be funded by the EVM-3 investigation. A collaborator may be committed to provide a focused contribution to the project for a specific task, such as data analysis. If EVM-3 investigation 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-I or another category of team member.

Requirement 59. Proposals shall identify and designate all collaborators and describe the role of each collaborator in the development of the mission.

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Requirement 60. Proposals shall identify the funding source for each collaborator; the costs shall be included in the Total Mission Cost.

5.6 Small Business Participation, Education Program Plan, and Communications and Outreach Program

5.6.1 Small Business Participation

It is the policy of the Government when contracts are issued to emphasize subcontracting opportunities for small businesses. Proposers 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. Proposers 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.

Proposers are advised that, by law, for NASA prime contracts resulting from this solicitation that offer subcontracting possibilities, exceed $700,000, and are with organizations other than small business concerns, the clause at FAR 52.219-9 will apply. Proposers 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), HBCUs, and OMIs entities to the maximum practicable extent.

Proposals are *not* required to include small business subcontracting plans; however, selected investigations *will be required* to provide them prior to negotiation and award, as applicable (see Section 7.4.3). Failure to submit a subcontracting plan after selection will make the proposer

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.

5.6.2 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) will be required after selection. Mission-related communications will be negotiated and funded directly through a NASA Center. The communications plan must be developed during Phase B of the mission. The plan must include topline messaging, target audiences, and media processes linked to reaching target audiences and associated detailed budgets, milestones, metrics and timelines, and reporting requirements.

5.6.3 Student Collaboration (SC) (optional)

PI-led missions potentially provide active research opportunities for current or aspiring graduate or undergraduate students, including advanced high schoolers. SCs are defined and described in the SPD-31, *SMD Policy Document on Student Collaboration* that is found in the EVM-3 Library. SCs may involve students in multiple aspects of a mission spanning scientific formulation; mission planning; systems engineering; design and development of flight hardware; qualification, test and integration; and mission operations.

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

The objective of an SC is enhancement of student research experience through collaborative work associated with a specific NASA spaceflight mission. This is not to be confused with a Scholarship or Fellowship, where the sole objective is the training/development of a particular student. This flight mission SC is not one of the specific opportunities for NASA Scholarships and Fellowships. OMB Uniform Guidance, 2 CFR Part 200.466, "Scholarships and student aid costs", clarifies the difference between a Scholarship or Fellowship and the allowable compensation of a student research assistant employed under an SC.

SC funds may also be requested to purchase special equipment, modify equipment, or provide services required specifically for the work to be undertaken by special needs students. Examples of such efforts include, but are not limited to, the provision of prosthetic devices to manipulate a

particular apparatus; the acquisition of equipment to convert sound to visual signals, or vice versa, for a particular experiment; accessing a special site or usage of a mode of transportation (rental services only—no vehicle purchases permitted); or, support of a reader or interpreter with special technical competence related to the project.

If a proposed investigation is selected, NASA retains the option to fund or not to fund the proposed SC in full or in part. There is no minimum and no maximum allowable cost for a SC. NASA is providing a SC option that is defined to be 1% of the PI-Managed Mission Cost. Contributions to the SC are permitted. The proposed NASA cost of the SC, up to the SC incentive, will be outside of the PIMMC. If the SC costs NASA more than the SC incentive, then the balance of the NASA cost of the SC must be within the PIMMC. SC resources, as an addition to a mission's implementation, are not available to solve mission cost overrun issues. SC provides no cost-savings to a NASA mission.

For proposals submitted as a result of this AO, a proposed SC will be evaluated only for its impact on mission feasibility. For the selected investigation, the merit of the proposed SC will be evaluated as part of the reviews leading to KDP-B; see SPD-31, *SMD Policy Document on Student Collaboration* found in the EVM-3 Library. The three SC review criteria are:

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

To address the merit evaluation, SC proposals will be required to include appropriate plans and budgets for evaluation, participant recruitment and retention, mentoring and oversight of students to maximize their learning and describe R&D conduct, particularly design and development of flight systems; assembly, integration and test; and mission operations and data analysis that enhances without interference the mission's success.

Requirement 61. If a proposal contains a SC, the proposal shall demonstrate that the proposed SC is clearly separable from the proposed Baseline and Threshold Science Missions; will not increase the mission development risk; and will not impact the science investigation in the event that the SC is not funded, fails during flight operations, or encounters technical, schedule, or cost problems during development (see Appendix B, Section I, for additional detail).

Requirement 62. If a proposal contains a SC, the proposal shall identify the funding set aside for the SC. This funding may be outside the PIMMC up to the Student Collaboration incentive, and any SC costs beyond the Student Collaboration incentive shall be within the PIMMC.

5.7 Cost Requirements

5.7.1 PI-Managed Mission Cost and Total Mission Cost

The PI-Managed Mission Cost (PIMMC), including all mission phases is capped at the AO Cost Cap of $190M FY 2022 dollars.

Requirement 63. Proposals shall include the proposed PIMMC and the proposed Total Mission Cost in all required AO cost tables (see Appendix B, Section H).

Requirement 64. The proposed costs shall comply with and specify the PIMCC.

Requirement 65. No more than 25% of the PIMMC shall be incurred prior to KDP-C (Confirmation).

5.7.2 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). However, the credibility of proposed costs is likely to be enhanced by the application of methodologies that are typically employed for mature projects.

Requirement 66. Proposals shall identify the methodologies (cost models, cost estimating relationships of analogous missions, etc.) and rationale used to develop the proposed cost.

Requirement 67. Proposals shall include a discussion of sources of estimate error and uncertainty in the proposed cost and management approaches for controlling cost growth.

Proposals that are unable to show adequate unencumbered cost reserves are likely to be judged a high risk and not selected. For the purpose of this AO, the unencumbered cost reserves on the PIMMC 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 PIMMC to complete Phases A/B/C/D, including the cost of technical design margin, including funded schedule reserve, and encumbered cost reserve, but not including unencumbered cost reserve. The calculation for Phases E/F is separate but uses the same methodology.

Adequate unencumbered cost reserves must be demonstrated at each of the following milestones: KDP-A (demonstrated in the proposal), KDP-B (at the end of Phase A), KDP-C (the independent cost estimate for Confirmation), and KDP-D (at the end of Phase C). KDP-D (at the end of Phase C), KDP-E (generally 30 days before launch), and KDP-F (at the end of Phase E). KDP-B and KDP-D reviews are delegated to the ESD level and not an SMD review.

Requirement 68. Proposals shall identify and justify the adequacy of the proposed cost reserves. Proposals shall include a minimum of 25% of unencumbered cost reserves against the cost to complete Phases A/B/C/D and shall demonstrate an approach to maintaining at least the required unencumbered cost reserves through subsequent development phases.

Requirement 69. Although minimum unencumbered cost reserves are not specified in this AO for Phases E or F, proposals shall establish, identify and justify adequate reserves for these phases of the mission.

5.7.3 Work Breakdown Structure

Requirement 70. Proposals shall provide a Work Breakdown Structure (WBS) that conforms to the standard prescribed in Appendix G of NPR 7120.5E. Costs for most elements shall be specified to WBS Level 2. Exceptions are the costs of elements that explicitly appear only at a level below WBS Level 2; these exceptions include individual instruments, unique flight system elements, the use of NASA or NASA-procured tracking and communications, and data analysis/archiving (see Appendix B, Section H, for additional detail).

5.7.4 Master Equipment List

Requirement 71. 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.8, for additional detail).

5.7.5 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 PIMMC 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 PIMMC, to enable a level playing field for all proposers. Per NASA HQ policy guidance signed in June 2010 by the Associate Administrator for the Mission Support Directorate and by the Agency Chief Financial Officer, all NASA Centers are to use an identical CM&O burden rate of $48K (Fiscal Year 2020) per "equivalent head." As per Agency policy, this rate must be applied as a "cost per equivalent head" to all Civil Servant Full-Time Equivalents (FTEs) plus on or near-site contractor Work-Year Equivalents (WYEs) associated with the proposal. The estimated FTEs and WYEs per Fiscal Year, and the resulting CM&O burden, must be identified in a separate table within the budget justification section of the proposal. The CM&O rate will not change from year to year in Fiscal Year (FY) 2020 dollars, but in Real Year (RY) terms, it will inflate.

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

Do not include within the cost proposal, or within the PIMMC, any estimate for Agency Management and Operations (AM&O, a.k.a. NASA HQ overhead).

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

Element	Identify in proposal?	Include in PIMMC?	Funding source	Comments
Civil Service Labor	Yes	Yes	SMD Program	Includes salaries and benefits
Civil Service Travel	Yes	Yes	SMD Program	
Other Direct/Procurements	Yes	Yes	SMD Program	Includes procurements as typically identified by flight projects in the NASA N2 budget database
CM&O	Yes	Yes	SSMS	Applied to NASA-provided labor, including Center civil servants and on-site contractors
AM&O	No	No	SSMS	
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

*Safety, Security, and Mission Services (SSMS)

Requirement 72. 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 73. 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-3 Library.

Requirement 74. Proposals including costs for non-NASA Federal Government agencies shall follow the applicable accounting standards.

5.7.6 Contributions

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

A contribution does not alleviate the responsibility of the PI and management team to exert sound and timely oversight on the development, delivery, and performance of the contribution. The PI remains accountable to NASA for the success of the entire investigation, including contributions, with full responsibility for its scientific integrity and for its execution within committed cost and schedule (Section 5.4.1).

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

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

Requirement 76. If a proposal includes one or more contributions, the total value of the contributions shall be established in accordance with the applicable and stated cost principles and shall comply with the stated cap on the sum of all contributions.

Letters of Commitment are required from each organization responsible for a contribution (for U.S. organizations, see Section 5.9.1.1 and Requirement 86; for non-U.S. contributing organizations, see Section 5.8.2, Section 5.9.1, and Requirement 80).

The requirement for institutional Letters of Commitment for contributions does not apply to contributed support for collaborators. The requirement for personal statements of commitment from collaborators is given in Section 5.9.2 and Requirement 86.

A contributed item that is essential for the success of the proposed investigation and/or is in the critical path of mission development is a risk factor. Risks include the failure of funding or contributions to materialize when they are outside the control of the PI. Mitigation may include, but is not limited to, descoping the contributed items and/or holding reserves to develop the contribution directly. When no mitigation is possible, this should be explicitly acknowledged and the rationale for accepting the unmitigated or residual risk should be explicitly stated.

Requirement 77. 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.

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

In accordance with existing laws and regulations, NASA is restricted from funding any NASA contract, grant, or cooperative agreement action that involves bilateral participation, collaboration, or coordination with China or any Chinese-owned company or entity, whether funded or performed under a no-exchange-of-funds arrangement.

Requirement 78. Proposals shall not include bilateral participation, collaboration, or coordination with China or any Chinese-owned company or entity, whether funded or performed under a no-exchange-of-funds arrangement.

5.8 Non-U.S. Participation Requirements

5.8.1 Overview of Non-U.S. Participation

NASA solicits research proposals from both U.S. and non-U.S. sources (see NFS 1835.016-70) with some restrictions (see Section 4.2.1). NASA welcomes international participation in its missions.

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* (available in the EVM-3 Library). 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.

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

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

Requirement 79. Unless otherwise noted, proposals from non-U.S. entities shall not include a cost plan unless the proposal involves collaboration with a U.S. institution, in which case a cost plan that covers only the participation of the U.S. entity shall be included. Proposals from U.S. institutions with non-U.S. participation shall include a cost plan that only covers U.S. entities.

Requirement 80. Proposals from non-U.S. entities and proposals from U.S. entities that include non-U.S. participation shall be formally endorsed, through Letters of Commitment, by the responsible funding agency in the country of origin. The required elements of a Letter of Commitment for a contribution are given in Section 5.9.1.1. 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 shall sign these Letters of Commitment.

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

Requirement 81. Proposals from U.S. proposers shall include a discussion of mitigation plans, where possible, for the failure of non-U.S. funding or contributions to materialize when they are outside the control of the PI. When no mitigation is possible, this shall be explicitly acknowledged and the rationale for accepting the unmitigated or residual risk shall be explicitly stated.

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

Any proposed non-U.S. participation must be described at the same level of technical, schedule, and management detail as that of U.S. partners. However, a cost plan for the non-U.S. participation should not be included (see Requirement 81). Failure to document technical and schedule data, management approaches, or failure to document the commitment of team members or funding agencies may cause a proposal to be found unacceptable.

Requirement 82. To the maximum extent practical, and allowing for any AO-specified exemptions (e.g., Requirement 79) any proposed non-U.S. contribution shall be described at the same level of detail as those of U.S. partners.

Requirement 83. Proposals with non-U.S. participation shall include a table listing: (i) non-U.S. participants (individuals, institutions), (ii) roles and responsibilities, (iii) funding organization, (iv) approximate value of any non-U.S. participation and method for estimating value (detailed budget not required), and (v) cross-reference to any Letters of Commitment in the proposal appendix. Proposals with non-U.S. participation shall clearly describe the flow of design requirements (potentially export-controlled information) and hardware between U.S. and non-U.S. participants. This description may take the form of an exploded diagram. See Section J.4 of Appendix B.

5.8.3 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 (NPD 1360.2B) 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 84. If applicable, proposals shall show how formulation can be completed in the absence of an international agreement.

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

Requirement 85. 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 parts

120–130 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).

5.9 Additional Proposal Requirements

5.9.1 Institutional Letters of Commitment

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

5.9.1.1 Institutional Letters of Commitment for Contributions

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

Requirement 86. For all U.S. organizations offering contributions, proposals shall include appropriate Letters of Commitment from both the organization(s) providing any contributed property or service and from the organization(s) providing any required funding.

Additional requirements for Institutional Letters of Commitment from non-U.S. organizations offering contributions are given in Section 5.8.2 and Requirement Requirement 80.

5.9.1.2 Institutional Letters of Commitment for Major Partners

Major partners are the organizations, other than the proposing organization, responsible for providing science leadership, project management, system engineering, spacecraft (as applicable), science instruments, technology or advanced engineering developments, integration and test, mission operations, and other critical or essential products or services as defined by the proposer. Regardless of role, all organizations, other than the proposing organization, receiving or contributing more than 10% of the PIMMC are included as major partners. All other participants are regarded as not major. Major partners are listed in Section (i) of the Table of Proposal Partners (see Appendix B, Section J.1, for additional detail).

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

Requirement 87. Unless otherwise explicitly exempted elsewhere in this AO (e.g., Section 5.3.5), proposals shall include an Institutional Letter of Commitment from each major partner in the proposal, regardless of source of funding. For major partners providing one or more contributions, only a single Letter of Commitment is required.

5.9.2 Personal Letters of Commitment

No Personal Letters of Commitment are required in the proposal; however every Proposal Team member must indicate his/her commitment to the proposed investigation and specifically to the role, responsibilities, and participating organization proposed for him/her, through the NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES). The Proposal Team is defined to include, but not be limited to, all named Key Management Team members, all Co-Is, and all collaborators. Proposal Team members are identified on the NSPIRES proposal cover page (see Appendix B, Section A.3, for more information).

Requirement 88. Every Proposal Team member shall indicate his/her commitment to the proposed investigation and specifically to the role, responsibilities, and participating organization proposed for him/her, through NSPIRES. By committing, Proposal Team members are certifying that their linked organization in NSPIRES is correct, for the purposes of the proposal.

5.9.3 Export-Controlled Material in Proposals

Under U.S. law and regulations, spacecraft and their specifically designed, modified, or configured systems, components, and parts are generally considered "Defense Articles" on the United States Munitions List and are, therefore, subject to the provisions of the International Traffic in Arms Regulations (ITAR), 22 CFR parts 120–130. Consideration must also be given to the Export Administration Regulations (EAR), 15 CFR parts 730–774, issued by the United States Department of Commerce, Bureau of Industry and Security (BIS) under laws relating to the control of certain exports, reexports, and activities.

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

Requirement 89. If the proposal contains ITAR or EAR material, the material shall be presented in a red font or enclosed in a red-bordered box, and the following statement shall be prominently displayed in Section A of the proposal (following the Proposal Summary Information):

> "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. The identified information (data) is (are) printed in a red font and figure(s) and table(s) containing the identified information (data) is (are) placed in a red-bordered box."

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

5.9.4 Classified Materials

Requirement 90. 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.9, for further details).

In order to increase the capabilities of investigations proposed in response to this AO while minimizing the development and operations risks within the PIMMC, proposers may choose to leverage technology with classified heritage that was developed by other institutions and agencies, as well as by NASA and NASA-funded partners.

If a proposer chooses to submit a classified appendix regarding heritage, the requirements on content, format, and length are the same as, but independent from, those for the unclassified appendix regarding heritage included in the proposal (see Appendix B, Section J.12, for further details) with the exceptions that Letters of Validation and cost bases of estimate may be included in 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, however. Proposers are strongly encouraged to provide as much information and detail as possible on their technology heritage in the unclassified appendix regarding heritage.

NASA allows three options for proposers to support heritage claims from classified programs: 1) delivery to NASA of a classified appendix regarding heritage, 2) "delivery in place" of a classified appendix regarding heritage, and subject to possible restriction 3) sponsor verification of the heritage claims derived from classified programs. Each option is explained in a subsection below.

5.9.4.1 Delivery to NASA

Proposers may provide NASA access to a classified proposal appendix for validation of classified heritage claims. The classified appendix regarding heritage may include Letters of Validation for classified heritage claims from technology development sponsors and a classified cost bases of estimate. The proposer is responsible for determining which information is classified and which information is unclassified; any classified information provided to NASA must be handled appropriately, including appropriate marking must comply with the applicable Security Classification Guide (SCG) or similar document. 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.

The delivery to NASA option of a classified appendix regarding heritage requires delivery to NASA HQ separately from the proposal. A single copy of the classified appendix regarding heritage must be submitted along with a cover letter referencing the submitted proposal by name, PI, and proposing organization. The "need to know" permission for the reviewer should be discussed in a cover letter. The proposer assumes all responsibility for determining the appropriate security clearance and method of delivery to NASA HQ of the classified appendix regarding heritage. The classified appendix regarding heritage must be handled and delivered to NASA HQ in compliance with NPR 1600.1A, *NASA Security Program Procedural Requirements*.

Requirement 91. Proposers that choose to deliver to NASA a classified appendix regarding heritage shall submit the appendix and a cover letter to NASA HQ no later than the deadline for receipt for the CD-ROM in Section 3. The proposer shall determine the appropriate security classification for the classified appendix, the proposer shall obtain any permission required for a reviewer to read the classified appendix, and the proposer shall ensure that all appropriate security requirements are followed in delivering the classified appendix to NASA HQ.

Requirement 92. The point-of-contact (POC) for the AO (see Section 6.1.5) shall be notified of the intent to submit a classified appendix regarding heritage and its level of classification to ensure sufficient evaluator clearance. The POC notification shall include whether the sender is considering delivery to NASA via a classified email system in lieu of physical delivery. The unclassified appendix regarding heritage shall also indicate that a classified appendix is being submitted.

The address for delivery of the package containing the classified appendix regarding heritage is: Mr. Paul Raudenbush, Chief, NASA Headquarters Security Office, Suite 1M40, 300 E Street SW, Washington, DC 20546. The package containing the classified appendix regarding heritage should be sent to NASA HQ by an appropriate means (e.g., courier, U.S. Registered Mail, etc.) with coordination in advance with the receiving facility.

Should a proposer choose to deliver a classified appendix regarding heritage to NASA in addition to a complete proposal, the evaluation process (see Section 7.1.1) will be supplemented. At least one NASA-selected evaluator with appropriate clearance and relevant expertise will review the classified appendix regarding heritage; this evaluator may be a member of the evaluation panel or this evaluator may be a specialist reviewer. All findings generated during the review of the classified appendix regarding heritage will be unclassified, and these findings will be provided as input for assessing the Technical, Management, and Cost (TMC) Feasibility of the Proposed Mission Implementation. Clarifications may be requested concerning findings from evaluation of the classified appendix regarding heritage.

5.9.4.2 "Delivery in Place"

Proposers may choose to utilize the option for "delivery in place" of the classified appendix regarding heritage, where the classified material is not delivered to NASA but is kept at the point of origin. The complete, unclassified proposal must state that a classified appendix regarding heritage has been delivered in place and provide the classification level of the material, the location of the material, and the POC to be contacted to access the material.

Should a proposer choose to submit a classified appendix regarding heritage to NASA in addition to a complete proposal using the "delivery in place" mechanism, the evaluation process (see Section 7.1.1) will be supplemented. At least one NASA-selected evaluator with appropriate clearance and relevant expertise will travel (as part of the evaluation cost to NASA ESD) to the delivery location to review the classified appendix regarding heritage; this evaluator may be a member of the evaluation panel or this evaluator may be a specialist reviewer. All findings generated during the review of the classified appendix regarding heritage will be unclassified, and these findings will be provided as input for assessing the TMC Feasibility of the Proposed Mission Implementation. Clarifications may be requested concerning findings from evaluation of the classified appendix regarding heritage.

Requirement 93. Proposers that choose the option of "delivery in place" of a classified appendix regarding heritage shall develop—and deliver to a designated POC/custodian—the appendix by the deadline for electronic proposal submission in Section 3, with a cover page record of the last date that the document was edited. The POC/custodian of the classified appendix shall certify the date of receipt of the document and its unchanged status, each time the classified appendix is viewed by a reviewer. 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 at the proposer's designated facilities, and the proposer shall ensure that all appropriate security requirements are followed in the handling of the classified appendix.

Requirement 94. The POC for the AO (see Section 6.1.5) shall be notified of the intent to utilize the "delivery in place" option for a classified appendix regarding heritage, the level of classification to ensure sufficient evaluator clearance, and the POC/custodian contact information.

5.9.4.3 Sponsor Verification

Proposals that include technologies with classified heritage may utilize sponsor verification. This option is only available if the sponsor organization is not a proposed partner. Such proposals would only *reference* classified materials, including associated cost bases of estimate; the materials would not be provided to NASA in any format. In lieu of a direct review of the classified materials, the evaluation panel will compile a list of questions regarding claims made in the proposal that need substantiation by the classified material. The list would be sent to the sponsor of the classified programs who must verify that the claims are supported.

Requirement 95. Proposers that choose the option of sponsor verification of classified materials shall provide an enumeration of claims related to the classified materials in the body of the proposal.

Requirement 96. The POC for the AO (see Section 6.1.5) shall be notified of the intent to utilize the sponsor verification option and the POC to whom associated questions would be sent.

5.10 Program Specific Requirements and Constraints

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

5.10.2 Schedule Requirements

Requirement 98. Proposals shall plan for a launch readiness date no later than 30 November 2026.

5.10.3 AO-Provided Access to Space

5.10.3.1 AO-Provided Expendable Launch Vehicle and Venture Class Launch Services

An EVM-3 investigation (including CubeSat investigations) may be launched as the primary payload on a single expendable launch vehicle (ELV) that NASA will provide as Government Furnished Equipment (GFE) at a cost of $61M, which is to be reflected against the PIMMC. Standard launch services utilizing a domestic launch vehicle certified as Category 1, 2, or 3 per NPD 8610.7D, *NASA Launch Services Risk Mitigation Policy for NASA-Owned and/or NASA-Sponsored Payloads/Missions* (see EVM-3 Library) will be provided. Proposers are required to include under the PIMMC any cost of launch services beyond the standard launch services offered. Detailed information on launch vehicle performance options and the potential for additional performance as a mission-unique launch service, including a description of standard launch services and nonstandard services with their associated cost, is provided in the *ELV Launch Services Program Information Summary* document found in the EVM-3 Library.

An EVM-3 Small Satellite or CubeSat investigation may be launched as the primary payload utilizing Venture Class Launch Services (VCLS) that NASA will provide as Government Furnished Equipment (GFE) at a cost of $25M per launch, which is to be reflected against the PIMMC. For this option, utilizing a domestic launch vehicle on its first flight would be permitted; however, prior to launch the vehicle must be certified as Category 1 per NPD 8610.7D, *NASA Launch Services Risk Mitigation Policy for NASA-Owned or NASA-Sponsored Payloads/Missions* (see EVM-3 Library). The $25M charge is only applicable to launch services for no more than a 150kg to a reference orbit of 500km Sun-Sync (inclusive of any project deployment hardware) per launch. NASA will provide no more than two launches. Proposers are required to include under the PIMMC for any cost of launch services beyond the standard launch services offered. Detailed information on launch vehicle performance options and the potential for additional performance as a mission-unique launch service, including a description of standard launch services and nonstandard services with their associated cost, is provided in the *Venture Class Launch Services Program Information Summary* document found in the EVM-3 Library.

Requirement 99. Proposals shall discuss compatibility with the launch vehicle characteristics and capabilities in the *ELV Launch Services Information Summary or Venture Class Launch Services Program Information Summary* in the EVM-3 Library.

Requirement 100. If launch services not specified as standard launch services in the *ELV Launch Services Program Information Summary* or *Venture Class Launch Services Information Summary* document are required, the proposal shall include the cost of such services under the PIMMC.

Missions will not be responsible for any costs for standard launch services that exceed those listed in this AO and the *ELV Launch Services Program Information Summary* or *Venture Class Launch Services Information Summary* (EVM-3 Library), or the impact to the mission of any launch delay caused by AO-provided access to space.

The launch service and the launch event are critical elements affecting mission success. Risk management of the launch service is performed through technical oversight of the commercial service. Technical oversight is a combination of focused approvals and technical insight of the launch provider; reference NPD 8610.23C *Launch Vehicle Technical Oversight Policy* available in the EVM-3 Library. However, in order to take advantage of the full range of launch capabilities available, NASA varies its insight and oversight while ensuring that the risks associated with access to space are consistent with the risk classification approved for individual payloads and missions; reference NPD 8610.7D *NASA Launch Services Risk Mitigation Policy for NASA-Owned and/or NASA-Sponsored Payloads/Missions* available in the EVM-3 Library. Therefore, policy allows for a modified technical oversight approach for payloads and missions able to tolerate more risk, such as for Class D payloads.

Requirement 101. Due to the volatility of the launch services market, NASA cannot ensure which launch vehicles will be available at the time of the launch vehicle procurement. Accordingly, proposers are advised to plan for compatibility with vehicle families that provide the necessary performance and are expected to be available through spacecraft Preliminary Design Review (PDR; see the *ELV Launch Services Information Summary or Venture Class Launch Services Program Information Summary* in the EVM-3 Library). It is recommended that payload designs accommodate launch environments for these vehicle families.

Questions concerning ELVs and VCLS may be addressed to:
Garrett L. Skrobot,
Launch and Flight Operations, NASA Kennedy Space Center, KSC, Florida 32899,
Telephone: 321.867.5365, Email: garrett.l.skrobot@nasa.gov

5.10.3.2 AO-Provided Rideshare Access to Space

An EVM-3 investigation (including CubeSat investigations) may be proposed as a Rideshare Payload (RPL) for up to two platforms on an Evolved Expendable Launch Vehicle Secondary Payload Adapter (ESPA) or ESPA Grande offered as AO-provided launch service. The RPL will be arranged by NASA at a cost of $25M per each potential ride share, which is to be reflected

against the PIMMC. RPL accommodations are described in the *Evolved Expendable Launch Vehicle Rideshare User's Guide* and information regarding the ESPA Grande can be found in the *NASA's Mission Specific Evolved Expendable Launch Vehicle Secondary Payload Adapter (ESPA) System Interface Specification (SIS);* both documents are located in the EVM-3 Library. Rideshare Mission Assurance (RMA) is a process to control and mitigate the risks to the primary mission and other RPLs. Guidelines for this process are discussed in the *ESPA SIS* document (EVM-3 Library). The following orbit categories will be available:

1. Low Earth Orbit (LEO) at 400km-600km,
2. Geostationary Transfer Orbit (GTO) and beyond.

Investigations may propose to utilize one or two ESPA ports. Investigations requiring two ports must comply with the requirements for each port.

The *ESPA System Interface Specifications, Rideshare Users Guide, and Do- no-harm Requirements Document* (hereafter *ESPA RUG*) provides ground rules and assumptions for RPLs utilizing AO-provided ESPA access to space. Information on Rideshare opportunities may evolve during the AO process, so both the *EVM-3 ESPA RUG* and the Rideshare Accommodation worksheet may be updated periodically, but no later than 30 days before proposals are due. It is each proposer's responsibility to check for updates.

Proposals for such investigations are required to clearly demonstrate compliance to the requirements and enveloping characteristics in the *ESPA RUG*, and give details of any deviations from the guidelines of that document in the Rideshare Accommodation worksheet (refer to Requirement 102). The requirements outlined in the *ESPA RUG* cannot be exhaustive because the primary payload and the launch vehicle may not be known at the time of proposal development. Specific interface requirements and generic environment definitions will not be formalized until the launch vehicle contractor and primary observatory have been selected and the mission integration cycle has begun. Guidelines for Maximum Flight Opportunity are given to assist proposers looking to maximize their opportunity for rideshare. Violating these guidelines does not make a payload ineligible for inclusion as a rideshare, however it may limit the number of missions that are compatible with the payload's launch requirements and may increase integration and launch costs. Examples of specific rideshare requirements are given in the *Evolved Expendable Launch Vehicle Rideshare User's Guide (RUG),* and the *2018-09-18-IMAP-ESPA- SIS,* both of which can be found in the EVM-3 Library.

The SMD-specific RPL policy is described in the *SMD Evolved Expendable Launch Vehicle (EELV) Secondary Payload Adapter (ESPA) Secondary Payloads Rideshare* policy document (SPD-32), found in the EVM-3 Library.

The NASA Small Spacecraft Systems Virtual Institute (https://www.nasa.gov/smallsat-institute) operates a website that consolidates and shares known public information on ESPA-Class launch accommodation opportunities and capabilities. Proposers may describe specific LEO or GTO launch opportunities available, however NASA may not be able to procure space on those particular launches.

After the evaluation, but prior to the selection decision, NASA will perform an accommodation study of selectable investigation proposals to assess the extent to which the proposed investigation is compatible with the expected rideshare opportunities. A proposed investigation with a high probability of being compatible with several primary missions is more likely to be selected than one with less flexible accommodation and orbit requirements.

Requirement 102. Proposals utilizing rideshare access to space shall clearly state the proposed instrument mass, volume dimensions, power and other requirements, using the Rideshare Accommodation worksheet template provided in the EVM-3 Library. This worksheet shall summarize information from other sections of the proposal, shall not provide new information, and shall be provided in the experiment implementation section (Section E) of the proposal. This Rideshare Accommodation worksheet is not to be considered during the evaluation and does not count towards the proposal page limit.

Requirement 103. For investigations proposing to launch on the ESPA, proposals shall clearly demonstrate compliance to the ESPA requirements and enveloping characteristics, as given in the ESPA RUG document found in the EVM-3 Library.

Requirement 104. For investigations proposing to launch on an ESPA, proposals shall utilize one or two ESPA Grande ports. Investigations requiring two ports shall comply with the ESPA RUG for each port.

Requirement 105. Proposals shall define applicable Rideshare Mission assurance processes and describe the implementation.

Questions concerning potential ESPA investigations may be addressed to:
Garrett L Skrobot
Launch and Flight Operations NASA Kennedy Space Center KSC, Florida 32899
Telephone: 321-867-5365 E-mail: garrett.l.skrobot@nasa.gov

5.10.4 Alternative Access to Space

NASA will not be accepting proposals that include alternative access to space, whether purchased or contributed.

6. Proposal Submission Information

6.1 Preproposal Activities

6.1.1 Preproposal Conference

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

All interested parties may participate. All expenses and arrangements for participating in this meeting are the responsibility of the attendees.

The purpose of this Conference will be to address questions about the proposal process for this AO. Questions should be sent to the EVM-3 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-3 Acquisition Homepage at the address given in Section 6.1.4 two weeks after this event. Additional questions and answers subsequent to the conference will also appear in this location, if necessary. Questions may be submitted until 14 days before the proposal due date given in Section 3. Answers will be provided no later than 10 days before the proposal due date.

6.1.2 Notice of Intent to Propose

To facilitate planning of the proposal evaluation and peer review process, and to inform prospective proposers of any changes to this AO, NASA requires 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. Proposals will not be accepted without prior submission of a NOI. Material in a 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 email 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, email address, and institutional affiliation of the PI.
(b) Full names and institutional associations(s) 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) Use of the NSPIRES NOI "Summary" section to provide a brief statement (4000 characters or less) covering the following:
  (i) Science objectives of the proposed mission;
  (ii) General design or architecture of the mission;
  (iii) Instrument(s) that may be included in the payload; and
  (iv) Identification of new technologies that may be employed as part of the mission.
(d) Addressing program specific questions.
(e) The name of the organizational lead from each organization (industrial, academic, nonprofit, and/or Federal) included in the proposing team, and the organization's role in the proposed investigation, as may be known at the time of the NOI.

SMD requests that proposers communicate any changes to the investigation team or intent to submit, between NOI and proposal submission, to the EVM-3 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 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-3 Teaming Interest page of the EVM-3 Acquisition Homepage (see address given in Section 6.1.4) have expressed interest in teaming with other organizations on EVM-3 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-3 Acquisition Home Page and Library

An EVM-3 Acquisition Homepage, available at https://essp.larc.nasa.gov/EVM-3/, will provide updates and any AO addenda during the EVM-3 AO solicitation process. It will provide links to the EVM-3 Library, information about the Preproposal Conference, a list of potential teaming partners, and questions and answers regarding the AO.

The EVM-3 Library provides additional regulations, policies, and background information associated with the EVM-3 solicitation. Information on the EVM-3 Library is contained in Appendix D. The EVM-3 Library is described in Appendix D and is accessible at https://essp.larc.nasa.gov/EVM-3/evm-3_library.html.
Any amendments to the AO will be posted on the NSPIRES website and will be announced by email to all subscribers to the SMD general information list in NSPIRES. Proposing teams should also check the NSPIRES website periodically for any AO correction, clarifications, or additional information. A link will be provided on the EVM-3 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-3 Program Scientist:

Dr. Kenneth Jucks
Earth Science Division
Science Mission Directorate
National Aeronautics and Space Administration
Washington, DC 20546-0001
Telephone: 202-358-0476
Email: kenneth.w.jucks@nasa.gov

6.2 Proposal Preparation and Submission

6.2.1 Structure of the Proposal

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 106. 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 referenced 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 107. 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.

Requirement 108. In addition to electronic submission, two identical, clearly labeled CD-ROMs that contain electronic proposal file(s) and additional files (see Requirement B-6) shall be delivered to the following address by the proposal submittal deadline specified in Section 3.

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

Telephone for commercial delivery: 202-479-9030

NSPIRES will notify proposers virtually immediately upon successful submission of the electronic proposal. NASA will notify proposers that their CD-ROMs have been received within two weeks of submission. Proposers who have not received this confirmation within two weeks after submittal of their proposals should contact the EVM-3 Program Scientist at the address given in Section 6.1.5.

The Government reserves the right to consider proposals or modifications thereof received after the date indicated for such purpose, if the Selection Official deems it to offer NASA a significant technical advantage or cost reduction.

6.2.4 Electronic Submission of Proposal Summary Information

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

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

Requirement 109. 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 must indicate their commitment to the proposed investigation through NSPIRES (see Requirement 88).

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

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

7. Proposal Evaluation, Selection, and Implementation

7.1 Overview of the Proposal Evaluation and Selection Process

7.1.1 Evaluation Process

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

Compliant proposals will be evaluated against the criteria specified in Section 7.2 by panels of individuals who are peers of the proposers. Proposals will be evaluated by more than one panel (e.g., a science panel and a technical/management/cost panel). 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. The Proposal Evaluation Plan will be posted on the Acquisition Homepage upon the release of the final version of the AO.

Proposers should be aware that, during the evaluation and selection process, NASA may request clarification of specific points in a proposal; if so, such a request from NASA and the proposer's response must be in writing. In particular, before finalizing the evaluation, NASA will request

clarification on specific, potential major weaknesses in the *Scientific Implementation Merit and Feasibility of the Proposed Investigation* (see Section 7.2.3) and the *TMC Feasibility of the Proposed Mission Implementation* (see Section 7.2.4) that have been identified in the proposal. NASA will request clarification in a uniform manner from all proposers. The ability of proposers to provide clarification to NASA is limited, as NASA does not intend to enter into discussions with proposers. A typical limited response is to direct NASA's attention to pertinent parts of the proposal without providing further elaboration.

7.1.2 Categorization and Steering Process

Subsequent to the evaluation process, NASA will convene a Categorization Committee, composed wholly of Civil Servants and Intergovernmental Personnel Act appointees (some of whom may be from Government agencies other than NASA) and appointed by the Associate Administrator for the Science Mission Directorate. The Categorization Committee will consider the *Scientific Merit*, *Scientific Implementation Merit and Feasibility*, and *TMC Feasibility of the Proposed Mission Implementation* and, based on the evaluations, categorize the proposals in accordance with procedures required by NFS 1872.404. The categories are defined in NFS 1872.404(k) as follows:

> Category I. Well-conceived, meritorious, and feasible 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 that data 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, meritorious, and feasible investigations that are recommended for acceptance, but at a lower priority than Category I, whatever the reason.
>
> Category III. Meritorious investigations that require further development. Category III investigations may be funded for further development and may be reconsidered at a later time for the same or other opportunities.
>
> Category IV. Proposed investigations which are recommended for rejection for the particular opportunity under consideration, whatever the reason.

NASA will convene a Steering Committee, composed wholly of Civil Servants (some of whom may be from Government agencies other than NASA), appointed by the Associate Administrator for the Science Mission Directorate. The Steering Committee will then review the results of the evaluations and categorizations. The Steering Committee will conduct an independent assessment of the evaluation and categorization processes regarding their compliance to established policies and practices, as well as the completeness, self-consistency, and adequacy of all supporting materials.

7.1.3 Selection Process

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

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

7.2 Evaluation Criteria

7.2.1 Overview of Evaluation Criteria

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

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

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

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

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 of the proposed mission implementation, 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; Operational Enhancement Opportunity beyond the Baseline Science Mission will not contribute to the assessment of the scientific merit of the proposed investigation. The factors for scientific merit include the following:

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

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

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

7.2.3 Scientific Implementation Merit and Feasibility of the Proposed Investigation

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

- Factor B-1. Merit of the instruments and mission design for addressing the science goals and objectives. This factor includes the degree to which the proposed mission will address the goals and objectives; the appropriateness of the selected instruments and mission design for addressing the goals and objectives; the degree to which the proposed instruments and mission can provide the necessary data; and the sufficiency of the data gathered to complete the scientific investigation.
- Factor B-2. Probability of technical success. This factor includes the maturity and technical readiness of the instruments or demonstration of a clear path to achieve necessary maturity; the adequacy of the plan to develop the instruments within the proposed cost and schedule; the robustness of those plans, including recognition of risks and mitigation plans for retiring those risks; the likelihood of success in developing any

new technology that represents an untested advance in the state of the art; the ability of the development team—both institutions and individuals—to successfully implement those plans; and the likelihood of success for both the development and the operation of the instruments within the mission design.

- Factor B-3. Merit of the data analysis, data availability, and data archiving plan. This factor includes the merit of plans for data analysis, curation, and data archiving to meet the goals and objectives of the investigation; to result in the publication of science discoveries in the professional literature; and to preserve data and analysis of value to the science community. Considerations in this factor include assessment of planning and budget adequacy and evidence of plans for well-documented, high-level data products and software usable to the entire science community; assessment of adequate resources for physical interpretation of data; 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. The inclusion of career development opportunities to train the next generation science leaders will also be evaluated.
- Factor B-6. Maturity of proposed Level 1 science requirements and Level 2 project requirements. This factor includes assessment of whether the Level 1 science requirements are mature enough to guide the achievement of the objectives of the Baseline Mission and the Threshold Mission, and whether the Level 2 requirements are consistent with the Level 1 requirements. The Levels 1 and 2 requirements will be evaluated for whether they are stated in unambiguous, objective, quantifiable, and verifiable terms that do not conflict and for whether they are traceable to the science objectives. They will be evaluated for the adequacy, sufficiency, and completeness, including their utility for evaluating the capability of the instruments and other systems to achieve the mission objectives.

Student Collaboration proposals, if any, will be evaluated only for the impact they have on science implementation feasibility to the extent that they are not separable; Student Collaboration proposals will not be penalized in 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.

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 proposed investigation.

7.2.4 TMC Feasibility of the Proposed Mission Implementation

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. 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, 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 prior working relationships of the implementing organization and known partners; 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 potential science impact to the proposed Baseline Science Mission. The plans for managing the risk of contributed critical goods and services will be assessed, including the plans for any international participation, the commitment of partners and contributors, as documented in Letters of Commitment, and the technical adequacy of contingency plans, where they exist, for coping with the failure of a proposed cooperative arrangement or contribution. This factor also includes assessment of elements such as the relationship of the work to the project schedule, the project element interdependencies, the associated schedule margins, and an assessment of the likelihood of meeting the proposed launch readiness date. Also evaluated under this factor are the proposed project and schedule management tools to be used on the project.
- Factor C-5. Adequacy and robustness of the cost plan, including cost feasibility and cost risk. This factor includes elements such as cost, cost risk, cost realism, and cost completeness including assessment of the basis of estimate, the adequacy of the approach, the methods and rationale used to develop the estimated cost, the discussion of cost risks, the allocation of cost reserves by phase, and the team's understanding of the scope of work (covering all elements of the mission including contributions). The adequacy of the cost reserves and understanding of the cost risks will be assessed. This factor also includes an assessment of the proposed cost relative to estimates generated by the evaluation team using parametric models and analogies. Also evaluated under this factor are the proposed cost management tools to be used on the project.

Student Collaboration proposals, if any, will be evaluated only for the impact they have on overall TMC mission feasibility to the extent that they are not separable; Student Collaboration proposals will not be penalized 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 panel evaluating the "TMC Feasibility of the Proposed Mission Implementation" will provide comments to NASA regarding the extent to which the proposed investigation provides

career development opportunities to train the next generation of engineering and management leaders. While these comments will not be considered in the evaluation, they may be considered during selection.

Programmatic risks may be assessed but are not included in the TMC risk rating. Examples include but are not limited to: stability and reliability of proposed partners and their contributions, and environmental assessment approvals.

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

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

7.4 Implementation of Selected Proposals

7.4.1 Notification of Selection

Following selection, the PI of the selected investigation 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., 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.) and any special instructions for implementation. The formal notification will also include instructions for scheduling a debriefing at which written debriefing materials will be provided, and any issues noted during the evaluation that may require attention during implementation will be discussed, as well as instructions for attending the Project Initiation Conference. Travel and associated costs of attendance at the debriefing and

Project Initiation Conference are not allowable as direct costs under another Federal Government award (i.e., contract, grant, or cooperative agreement) and may not be allowable under the Phase A contract. Government employees may attend and be authorized travel and associated costs as a matter of official business.

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

7.4.2 ESSP Program 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. ESSP has established a two-day ESSP Program Forum for all the selected PI-led mission management teams. These forums are planned to be held every two years. The purpose of the ESSP Program Forum is to facilitate knowledge sharing in areas that are deemed necessary to successfully execute PI-led Earth science missions. Attendance by the leaders of the selected EVM-3 mission management team (e.g., PI, Project Manager, Project Scientist, Project Systems Engineer, and/or Project Resource Control Manager) is required. Travel and associated costs of attendance are allowable as direct costs and proposing teams are required to budget it within the PIMMC.

Requirement 110. Proposals shall include within the PIMMC the cost of the investigation management team attendance to the ESSP Program Forum.

7.4.3 Award Administration and Funding

Program management responsibilities for EVM-3 missions have been assigned to the ESSP Program Office at NASA LaRC. The responsibilities of the Program Office will include oversight and insight of mission implementation; coordination of Government-furnished services, equipment, and facilities; and contract management for selected investigations.

The ESSP Program Office will administer the funding of the selected investigation. The appropriate contractual vehicle will be initiated as soon as possible after notification of selection. Generally, there is a three to six-month period between notification of selection and contract award. NASA Centers will receive funding via intra-agency funding mechanisms.

An existing EVM contract has been provided in the EVM-3 Library for reference. This contract is representative of the type of contract likely to be awarded to the selected investigation, including contract clauses, requirements, and deliverables. Proposers are encouraged to consider the existing contract in preparation to accommodate these contractual requirements in the case of selection.

Proposals are *not* required to include Statements of Work (SOWs), certified cost and pricing data, or small business subcontracting plans. These items will be required *only* for investigation that are selected at the outcome of the competition. If more than one contractual arrangement

between NASA and the proposing team is required, a separate SOW will be required for each organization.

For the investigation that is selected, the PI-led investigation management teams will be required to provide draft SOW and deliverables documents within 60 calendar days of selection. The process for awarding a contract (and providing funds to any implementing organization) cannot begin until the draft SOW and deliverables document is received. Reference the existing EVM contract in the EVM-3 Library for a sample SOW and deliverables document; these sample documents cover the minimum acceptable content as edited for the immediate effort.

SOWs will be required for selected investigation regardless of whether a proposing organization is NASA or non-NASA. For NASA Centers, the initial SOW is the Formulation Agreement for Phases A and B. A template for the Formulation Agreement can be found in the Appendix E of NPR 7120.5. For non-NASA, the SOW will cover all phases of development (Phases A through F).

For contracts that exceed $2,000,000, the contractor will be required to provide certified cost and pricing data to support the cost estimate and award of the contract in accordance with FAR 15.403-4 and NASA Procurement Class Deviation 18-04 (https://www.hq.nasa.gov/office/procurement/regs/pcd/pcd18-04.pdf). NOTE: The Adequate Price Competition exception to obtaining certified cost or pricing data [FAR 15.403-1(b)(1)] is not applicable to these investigations as each proposer is proposing a unique investigation to support NASA's strategic goals and is not proposing to complete a specific NASA requirement where all proposers are competing against an identical and specific requirement.

Proposers are advised that, by law, the clause at FAR 52.219-9, Small Business Subcontracting Plan, will apply to NASA prime contracts resulting from this solicitation which offer subcontracting possibilities, exceed $700,000, and are with organizations other than small business concerns. Accordingly, proposers awarded contracts that exceed $700,000 will be required to submit small business subcontracting plans consistent with the FAR unless they adequately demonstrate that subcontracting opportunities are not reasonably available in the performance of the investigation. Failure to do so will make the proposer ineligible for award. These plans will be required to be submitted for negotiation after selection in conjunction with contract execution.

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. sponsoring agency for the proposed participation on a no-exchange-of-funds basis, in which NASA and the non-U.S. sponsoring agency will each bear the cost of discharging their respective responsibilities. Depending on the nature and extent of the proposed cooperation, these arrangements may entail a letter of notification by NASA with a subsequent exchange of letters between NASA and the sponsoring governmental agency or a formal agency-to-agency memorandum of understanding.

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 PIMMC. The results of the independent review and the project status will be presented to the appropriate decision authority (e.g., Agency Program Management Council [APMC], SMD Program Management Council [DPMC], or SMD Division) at the Confirmation Review (KDP-C) for Confirmation to enter Phase C. Following Confirmation, no rephasing of costs from Phases E/F to Phases 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 HQ or by telephone if the proposal PI prefers. In the former case, please note that all expenses and arrangements for attending a debriefing are the responsibility of the attendee. Travel and associated costs of attendance are not allowable as a direct cost under another Federal Government award, i.e., contract, grant, or cooperative agreement. Government employees may attend and be authorized travel and associated costs as a matter of official business.

7.6 Process for Appeals

7.6.1 Agency Procurement Ombudsman

The Agency Procurement Ombudsman, designated in NPD 5101.32E, *Procurement, Financial Assistance,* will take action to resolve concerns, disagreements, and recommendations submitted by interested parties that cannot be resolved at the Center level, or those having NASA-wide implications, refer Center-specific issues to the appropriate Center Procurement Ombudsman for action, and periodically communicate with Center Procurement Ombudsmen on common NASA-wide issues and refer those issues to the appropriate office for action. Under NPD 5101.32E, the designated Agency Procurement Ombudsman is:

Director of the Contract and Grant Policy Division
Office of Procurement
NASA Headquarters
Washington, DC 20546
USA

7.6.2 Protests

Only prospective proposers 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-3 investigations in response to this AO.

Sandra Cauffman
Acting Director
Earth Science Division

Thomas Zurbuchen
Associate Administrator
for Science Mission Directorate

APPENDIX A

RESERVED FOR FUTURE USE

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APPENDIX B

REQUIREMENTS FOR PROPOSAL PREPARATION

INTRODUCTION

The following requirements apply to preparation of proposals in response to this 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 provides further definition of the proposal requirements in the AO and contains the specific requirements for the format and content of proposals. Some AO requirements do not require further definition by an Appendix B requirement; however, they must be addressed in the proposal. Failure to follow Appendix B may result in reduced ratings during the evaluation process or, in some cases, could lead to rejection of the proposal without review. In the event of apparent conflicts between this Appendix and the policies and requirements specified within the body of the AO, the latter takes precedence.

GENERAL REQUIREMENTS

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

Requirement B-1. A proposal shall consist of one file comprising readily identifiable sections that correspond and conform to Sections A through J of this appendix. It shall be written 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 5.5 lines per vertical inch 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 horizontal inch; six characters per horizontal 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	As per NSPIRES
	Graphic Cover Page	1
	Export-controlled material statement (Section 5.9.3)	0.5
	Optional Restriction on Use statement*	0.5
	PI Time Commitment	1
B	Fact Sheet	2
C	Table of Contents	None
D	Science Investigation	25 + 2 pages / additional non-identical instrument
E	Science Implementation	
F	Mission Implementation	25 + 2 pages / additional non-identical flight element (3 Schedule Foldouts do not count against limit)
	Schedule Foldout(s)	
G	Management	
H	Cost and Cost Estimating Methodology	8
	Cost Table B3a and Cost Table B3b	(Cost Table Foldouts do not count against limit)
I	Optional Student Collaboration Plan	2
J	Proposal Appendices (no others permitted):	
J.1	Table of Proposal Participants	None
J.2	Letters of Commitment	None
J.3	Resumes	None
J.4	Summary of Proposed Program Cooperative Contributions	None
J.5	Draft International Participation Plan Discussion of Compliance with U.S. Export Laws and Regulations	None
J.6	Discussion of End-of-Mission Spacecraft Disposal Requirements	None
J.7	Compliance with Procurement Regulations by NASA PI Proposals	None
J.8	Master Equipment List (MEL)	None
J.9	Heritage	30
J.9a	Classified Materials	30
J.10	Certifications Amendments (optional)	None
J.11	List of Abbreviations and Acronyms	None
J.12	List of References (optional)	None

	Optional NOAA Operational Enhancement Option uploaded as separate PDF as document type “Total Budget”	2

* 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

Requirement B-4. Proposals shall conform to the page limits specified in the *Proposal Structure and Page Limits* table. Two extra pages are allotted for each additional separate, non-identical science instrument in the Science Section (Sections D and E); and two extra pages are allotted for each additional separate, non-identical flight element (e.g., additional non-identical spacecraft) in the Mission Implementation and Management Sections (Sections F and G). Different instruments on identical spacecraft will only be allotted extra pages for additional non-identical science instruments; no extra pages will be allotted for the resulting additional non-identical flight elements. The total number of such extra pages in Sections D-G shall not exceed a maximum of nine extra pages regardless of the number of science instruments and flight elements. Every page upon which printing appears will count against the page limits and, unless specifically exempted (e.g., Requirement B-40 and Requirement B-54.), each foldout page will count as two pages against the page limits as appropriate for its area (e.g., a fold-out with the total area of two standard pages counts as two pages, etc.).

Requirement B-5. Electronic proposals shall be a single unlocked (e.g., without digital signatures) searchable Adobe Portable Document Format (PDF) file, composed of the main proposal, all tables (see Requirement B-51 and Requirement B-69), and all applicable proposal appendices (see Section J of this appendix). Images (e.g., figures and scans) shall be converted into machine-encoded text using optical character recognition. Animations shall not be included.

Electronic proposals shall be limited to 25 MB in size. Links to other parts of the proposal are permitted, but links to materials outside of the proposal are not. Once submitted, the document uploaded to NSPIRES will be considered the official submission.

Requirement B-6. Two identical 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-51 and Requirement B-69), and Microsoft Project file of project schedule (see Requirement B-41. CD-ROMs of proposals may additionally include up to 100 MB, higher resolution but otherwise identical, versions of electronic proposals. In the event of a conflict between versions of electronic proposals, the version specified in Requirement B-5 shall take precedence.

A. NSPIRES COVER PAGES AND GRAPHIC COVER PAGE

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

Requirement B-7. The NSPIRES Cover Pages and the Graphic Cover Page, prepared as directed below, shall preface every proposal. The NSPIRES Cover Pages will not be counted against the page limits. The Proposal Summary (abstract) shall not contain proprietary or confidential information that the submitters wish to protect from public disclosure. The Graphic Cover Page shall be the first page of the electronic proposal document specified in Requirement B-5; when combined by NSPIRES with the NSPIRES Cover Pages, the Graphic Cover page will follow that information.

A.1. NSPIRES Cover Pages.

The following expands requirements in the AO, in particular Requirement 109.

Electronic submission must be through the NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES) at http://nspires.nasaprs.com/. The appropriate NSPIRES Cover Page is available only to those who log into NSPIRES and who execute the "create proposal" process.

Requirement B-8. This AO requires that summary information, referred to as the Electronic Cover Pages, shall be submitted electronically. The forms for the Electronic Cover Page are found in NSPIRES at http://nspires.nasaprs.com/.

The Program Specific Data part of 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 were not added to the Proposal Team section of the proposal's cover page as a Co-Investigator, collaborator, or any other category of participant. Include name, institution, city, state or country, and a description of the role in five words or less (e.g., data analyst, facility provider, support technician)." It is recognized that individuals may be affiliated with the proposed investigation without being listed as team members on the proposal cover page. The information provided is used to ensure that the evaluation panels do not include

individuals as reviewers who have participated in one or more proposals, as they have the appearance of being biased.

Requirement B-9. 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 Conflicts of Interest. In order to assist in planning of the proposal evaluation process, NASA requires a comprehensive list of proposed investigation participants.

Requirement B-10. With the proposal submission via NSPIRES, the proposers shall identify any institution that is specified in the proposal but that does not appear in either the "Team Member" section of the cover page or in answer to the question about "participants […] who do not appear on the proposal's cover page." The proposer shall list the institution and division name, role (e.g., instrument component provider), and estimated funds to be received. This information will be used to avoid financial and organizational conflicts of interest during the evaluation process by checking evaluators against institutions that are proposed to supply materials, parts, or services.

The following expands requirements in the AO, in particular Requirement 88 and Requirement 109.

Every Proposal Team member must be identified on the Proposal Team section of 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 109. 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. Note that the proposal cannot be submitted until all identified team members have confirmed their participating organization.

Requirement B-11. 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.

A.2. Graphic Cover Page.

Requirement B-12. 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 physical or images of signatures 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).

B. FACT SHEET

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

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 PIMMC in real year dollars (RY$) and in FY 2022 dollars (FY2022$) 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$) and in FY 2022 dollars (FY2022$) from Tables B3a and B3b respectively.

C. TABLE OF CONTENTS

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

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 3 through Requirement 19.

D.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.

D.2. Science Requirements.

Requirement B-16. This section shall describe the investigation to be performed, the types of measurements to be taken; the characteristics, precision, and accuracy required to attain the scientific objectives; and the projected instrument performance. This section shall describe the data to be returned in the course of the investigation. The quality (e.g., resolution, coverage, pointing accuracy, measurement precision, etc.) and quantity (bits, images, etc.) of data required to 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. These descriptions constitute the Baseline Science Mission.

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

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

D.3. Threshold Science Mission.

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

E. SCIENCE IMPLEMENTATION

The following expands requirements in the AO, in particular Requirement 5 through Requirement 19 and Requirement 54 through Requirement 59.

E.1. Instrumentation.

Requirement B-19. This section shall describe the instrumentation and the rationale for its selection. It shall identify the instrument systems (i.e., individual instruments), instrument subsystems, instrument components, and sample collection and preservation systems as applicable, including their characteristics and requirements, and indicate items that are proposed for development, as well as any existing instrumentation or design/flight heritage. It shall provide a clear understanding of how the concept will provide the required data, show how it can be accommodated by the spacecraft, demonstrate that instruments have the necessary unobstructed fields-of-view over the measurement period required, describe the technology readiness levels and the approach to bring each instrument to technology readiness level (TRL) 6 by preliminary design review (PDR). If no development plan is needed, the reasons for this shall be explicitly stated and the rationale shall be described. A preliminary description of each instrument design, with a block diagram showing the instrument subsystems and components, and their interfaces, along with a description of the estimated performance of the instrument, shall be included. These performance characteristics shall be considered as requirements on the flight system. 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 environmental effects, such as radiation, temperature, and contamination, on each instrument's measurement capabilities as a function of mission time.

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

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

E.2. Data Sufficiency.

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

E.3. Science Mission Profile.

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

E.4. Data Plans.

Requirement B-23. A Data Analysis Plan including approaches for data retrieval, validation, and preliminary analysis 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.

Requirement B-24. A schedule-based end-to-end Data Management and Archive Plan, including approaches for the release of peer-reviewed publications, the release of the science data that underlie the results and findings in peer-reviewed publications, and the archiving of all science products 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 Data Management and Archive Plan shall be in compliance with requirements and the guidelines in the *NASA Earth Science Data Policy* (see Section 5.2.). The Data Management and Archive 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—including the data latency by product—for submission of raw and reduced data, to the data archive, in physical units accessible to the science community.

E.5. Science Team.

Requirement B-25. This section shall identify each member of the science team and his/her role and responsibilities. Resumes or curriculum vitae of science team members shall be included as appendices to the proposal (see Section J.3 of this appendix). The role of the PI and each Co-investigator (Co-I) shall be explicitly defined, the necessity of that role shall be justified, and the funding source (NASA or contributor) shall be noted. The role of each collaborator shall be described and the funding source shall be noted.

F. MISSION IMPLEMENTATION

The following expands requirements in the AO, in particular AO Requirement 19 through Requirement 28.

F.1. General Requirements and Mission Traceability.

Requirement B-26. 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-27. 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-28. NASA recognizes that the full depth of information requested in Requirement B-29 through Requirement B-40 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 or its Adjusted 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 or its Adjusted 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.

F.2. Mission Concept Descriptions.

Requirement B-29. 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-30. Mission Design: This section shall address the following elements of mission design to the extent that they are applicable to the proposed mission and that they are known at the time of proposal submission. Any additional elements that are applicable to explaining the mission and demonstrating its feasibility shall also be addressed.

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

Requirement B-31. Launch Services and Launch Vehicle Compatibility: For AO- 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). Any known nonstandard requirements such as additional fairing doors, cleanliness and purge requirements, planetary protection, etc. shall be described.

Requirement B-32. 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 for solar-powered missions including, (i) expected power requirement for each mission phase, (ii);type of array structure (rigid, flexible, body mounted); (iii) solar array axes of rotation (vector projected in spacecraft coordinates); (iv) array size; (v) solar cell type and efficiency; (vi) expected power generation at Beginning of Life and End of Life; (vii) worst case Sun incidence angle to solar panels during science mission; (viii) battery type and storage capacity; (ix) phased and worst case battery Depth of Discharge (DOD); (x) spacecraft bus voltage.

(d) Attitude Determination and Control, including system pointing requirements and capabilities. Describe or define the following: (i) each spacecraft operational mode, including the sensors and actuators used, control method, and safing and/or contingency modes; (ii) attitude determination methodology and estimate of accuracy, including identifying whether ground post-processing is required to meet science needs; (iii) agility requirements for slews or scanning; (iv) appendage pointing requirements, including articulation control methods and deployment accommodations; (v) sensor selection and performance, including identifying mounting location and field-of-view (FOV); (vi) actuator selection and sizing, including identifying mounting location(s); (vii) translational maneuver (Delta-V) control and accuracy; (viii) momentum management approach and mitigation of impacts on navigation accuracy, if applicable; (ix) on-orbit calibrations, if required, including expected accuracy; and (x) attitude control requirements for the spacecraft pointing control, pointing knowledge (at the instrument interface), pointing stability, or jitter.

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

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

Requirement B-33. Additional Mission Elements: This section shall address any other major mission elements (e.g., 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-34. Flight System Contingencies and Margins: This section shall summarize contingencies and margins of all key flight systems resources. For the driving mission element requirements derived from the Mission Functional Requirements, it should provide estimates of implementation performance and design margins with respect to the required performance. At a minimum, it shall include the following:

- Dry Mass;
- Launch Mass not useable by the proposed mission;
- Propellants;
- Power;
- Data Storage; and
- Attitude Control System.

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

If internal documents such as Flight Project Practices are referenced, an externally accessible URL shall be provided to download them.

Definitions:
Contingency, when added to the current estimate for a resource, results in the maximum expected value for that resource. Percent contingency is the value of the contingency divided by the value of the resource less the contingency.
Margin is the difference between the maximum possible capability of a resource (the physical limit or the agreed-to limit) and the maximum expected value for a resource. Percent margin for a resource is the available margin divided by its maximum expected value.
Example: A payload in the design phase has a maximum expected mass of 115 kg, including a mass contingency of 15 kg. There is no other payload on the ELV and the ELV provider plans to allot the payload the full capability of the vehicle, if needed. The ELV capability is 200 kg. The mass contingency is 15/100 = 15% and the mass margin is 85 kg or 85/115 = 74%.
Example: The end-of-life (EOL) capability of a spacecraft power system is 200 Watts, of which 75 Watts has been allocated to the instrument and 100 Watts has been allocated to the spacecraft bus. The power margin is the unallocated 25 Watts or 25/175 = 14.3%. The current best estimate for the instrument power is 60 Watts, leaving 15 Watts or 15/60 = 25% contingency to the 75 Watt maximum expected value.

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

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

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

Margin = Max Possible Resource Value – Max Expected Resource Value

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

Requirement B-35. Mission Operations: This section shall address, at a minimum, the following elements of mission operations to the extent that they are applicable to the proposed mission and that they are known at the time of proposal submission. Any additional elements that are applicable to explaining the mission operations and demonstrating their feasibility shall also be addressed. This section shall provide, at a minimum, the following items:

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

F.3. Development Approach.

Requirement B-36. This section shall describe the systems engineering development approach. This description shall include the following items:

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

- Mission assurance approach, including (i) fault tolerance and fault management, (ii) product assurance, and (iii) reliability;
- Essential trade studies to be conducted in Phase A including the considered options and driving requirements;
- Identification of the key Technical Performance Measures (TPMs)—as specified in NPR 7123.1B—and descriptions of how these margins and reserves are to be allocated, tracked, and monitored, with what tools and by whom, and who will have the authority to release the associated reserves and margins;
- Descriptions of when contracts are required, the acquisition strategy, including any incentive strategy.

F.4. New Technologies/Advanced Engineering Developments.

Requirement B-37. 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-3 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-2016-6105 Rev 2, *NASA Systems Engineering Handbook*);
- Rationale for the stated TRL value of an element that is an adaptation of an existing element of known TRL;
- The approach for maturing each of the proposed systems to a minimum of TRL 6 by PDR:
  - Demonstration (testing) in a relevant environment can be accomplished at the system level or at lower level(s);
  - If applicable, justify what demonstration(s) in a relevant environment at lower level(s) (subsystem and/or subsystem-to-subsystem) would be sufficient to meet system level TRL 6, considering (i) where any new technology is to be inserted, (ii) the magnitude of engineering development to integrate elements, (iii) any inherent interdependencies between elements (e.g., critical alignments), and/or (iv) the complexity of interfaces—see the EVM-3 Library for examples; and
  - Include discussion of simulations, prototyping, demonstration in a relevant environment, life testing, etc., as appropriate;
- An estimate of the resources (staffing, cost, and schedule) required to complete the technology and/or advanced engineering development; and
- Approaches to fallbacks/alternatives that exist and are planned, a description of the cost, decision date(s) for fallbacks/alternatives, relevant development schedules, and performance liens they impose on the baseline design, and the decision milestones for their implementation.

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

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

Requirement B-38. 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-39. 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 are required to be developed and how they will be validated, critical path items, etc.) shall be included. The I&T description shall demonstrate the credibility of the overall I&T approach, as reflected by consistency between the described test plans and the schedule, cost, and other resources needed to carry them out.

F.6. Schedule.

Requirement B-40. A project schedule foldout(s) covering all phases of the investigation shall be provided to at least WBS level 3, except where greater detail is necessary to identify critical paths, as well as significant TRL or engineering development activities and events. The first 3 foldouts will not be counted against the page limits. The schedule format shall indicate the month and year of each milestone, have a corresponding table of dates, and follow standard NASA WBS elements for task descriptions as prescribed in NPR 7120.5E. The schedule foldout(s) and accompanying narrative (included in the page count for this section) shall address proposed major milestones including, at a minimum, the following items:

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

Requirement B-41. The project schedule shall be additionally provided in Microsoft Project format on each CD-ROM submitted. Although the project schedule foldout(s) in Requirement B-40 does not need to have been generated in Microsoft Project, the project schedule provided on each CD-ROM shall address the items specified in Requirement B-40 at a level of detail commensurate with that of the graphical foldout. The Microsoft Project schedule is not intended to be a fully Integrated Master Schedule for the project, but rather, it is to be a representation of

the summarized schedule foldout that provides a quantified data set that will facilitate understanding of the proposed flow of development activities, timelines, milestones, schedule reserves, and risk. Although tasks in this high-level summary schedule are not expected to be fully linked to their predecessor and successor tasks, the level of linkage detail should support the assignment of the critical path in the graphical foldout. Task links are also needed to identify points of assembly, integration, and testing in the schedule and links to major milestones.

G. MANAGEMENT

The following expands requirements in the AO, in particular Requirement 25, Requirement 44 through Requirement 53, Requirement 77., and Requirement 81.

Requirement B-42. This section shall describe the investigator's proposed management approach. The management organization (including an organization chart), decision-making authority, and the teaming arrangement and responsibilities shall be discussed. The organization chart should clearly indicate how the mission team is structured. The names of the primary team members, their organization, and their reporting relationship within the project shall be provided.

Requirement B-43. 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 the Key Management Team, and demonstrate that they are commensurate with the technical and managerial needs of the proposed investigation. The time commitment of each named Key Management Team member shall be provided by mission phase. This section shall also describe the qualifications and experience of the implementing organization and major partners and demonstrate that they are commensurate with the technical and managerial needs of the proposed investigation.

Requirement B-44. This section shall describe the project risks and project resiliency considering these risks.

- Provide, at a minimum, the top five 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. Proposal shall provide an indication of where resources to address these risks are held. If cost risks are in this list, they shall be described here and then discussed in Section H (see Requirement B-49).
- The approach to any potential descopes, including savings of resources (mass, power, dollars, schedule, etc.) by implementing descopes, the decision milestone(s) for implementing descopes, and the scientific impact of individual as well as combined descopes shall be discussed.

Requirement B-45. 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-46. In the case where a proposal does not provide the required management and schedule details, for whatever reason, this section shall (i) describe the current management approach and schedule, (ii) justify that the development of that aspect of the project management and schedule is not required at this stage and that it is acceptable to develop details later, (iii) explain why the lack of information at this stage should not translate into a risk to the proposer's ability to implement the mission as proposed, and (iv) justify the adequacy of the proposed cost reserves, given that any increase in the PIMMC may subsequently subject the investigation to termination or cancellation (see Section 4.1.5). The process for developing the required depth of information, along with a corresponding schedule, shall be explicitly included among the plans for future activity.

H. COST AND COST ESTIMATING METHODOLOGY

The following expands requirements in the AO, in particular Requirement 63 through Requirement 73.

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-47. This section shall include the estimated cost of the proposed investigation. The estimated cost shall encompass all proposed activities, including all applicable mission phases, mission unique or special launch services (e.g., loads isolation systems, unique mechanical/electrical interfaces, payload processing facilities, commodities, post-encapsulation access requirements, supplemental propulsion systems, deployable telemetry tracking assets, and GN2 Purge), 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-48. 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. 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-49. This section shall include a discussion of cost risks.

Requirement B-50. 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$) in Table B3a and FY 2022 dollars (FY2022$) in Table B3b. The top portion of Tables

B3a and B3b shall contain cost data relevant to the PIMMC. The lower portion shall contain cost data for contributions and enhanced mission costs. The rows in Tables B3a and B3b shall be the NASA standard WBS elements as defined in NPR 7120.5E. The costs for most elements shall be provided to WBS level 2, as shown in Tables B3a and B3b. Exceptions are the costs of individual instruments and any unique flight system elements such as coordinating science ground stations, 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$) and totals in Fiscal Year 2022 dollars (FY2022$). Proposers shall use their own forward pricing rates to translate between real year dollars (RY$) and Fiscal Year 2022 dollars (FY2022$). For organizations that are without approved forward pricing rates, proposers shall use the NASA inflation/deflation indices in Table B4 to translate between real year dollars (RY$) and Fiscal Year 2022 dollars (FY2022$).

Requirement B-51. Tables B3a and B3b shall be provided additionally in Microsoft Excel format on each CD-ROM submitted. Microsoft Excel format templates of tables B1, B2, B3a, B3b, and B5 are available for download in a consolidated workbook from the EVM-3 Library.

Requirement B-52. 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$) and Fiscal Year 2022 dollars (FY2022$) in Table B3.

I. OPTIONAL STUDENT COLLABORATION PLAN

The following expands requirements in the AO, in particular Requirement 61 and Requirement 62.

Requirement B-53. If a Student Collaboration (SC), as described in Section 5.6.3 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-54. The following additional information is required to be supplied with the proposal as Appendices and, as such, will not be counted within the specified page limit, except as noted in the Proposal Structure and Page Limits table. The proposer shall *not* include in these Appendices material required in the page-limited sections in the body of the proposal. Any additional information *not* specifically required in a given appendix will not be considered by the evaluation panel and may result in reduced ratings during the evaluation process or, in some cases, could lead to rejection of the proposal without review. No other appendices are permitted.

J.1. Table of Proposal Participants

The following expands requirements in the AO, in particular Requirement 87.

Requirement B-55. A table of Proposal Participants shall be provided. The table shall include all organizations named in the proposal including contributing organizations. The primary purpose of the table is to aid NASA in avoiding conflicts of interest during the evaluation of the proposal. A secondary purpose is to provide material helpful for the evaluation and selection process. The table shall have three columns: (i) name of organization, including city and state/country where it is located, (ii) role of organization, and (iii) total cost or budget for that organization (over the life of proposal for baseline mission). The table shall have a row for every organization named in the proposal, and the rows shall be organized into three sections: (i) major partners, (ii) science only, nonhardware partners, and (iii) minor partners, vendors, and suppliers, as known at the time of the proposal. Major partners are defined to be organizations, other than the proposing organization, responsible for providing science leadership, project management, system engineering, spacecraft (as applicable), science instruments, integration and test, mission operations, and other critical or essential products or services as defined by the proposer; all organizations, other than the proposing organization, receiving or contributing more than 10% of the PIMMC are included, regardless of role.

J.2. Letters of Commitment.

The following expands requirements in the AO, in particular Requirement 32, Requirement 80, Requirement 86, and Requirement 87.

Requirement B-56. 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 5.9.1 of this AO.

J.3. Resumes.

The following expands requirements in the AO, in particular Requirement 44, Requirement 45, Requirement 56, and Requirement 57.

Requirement B-57. This section shall include resumes or curricula vitae for the PI, PM, PSE, any other named Key Management Team member, and all Co-Is. 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 curricula vitae shall be no longer than three pages for the PI and one page for each additional participant. Resumes shall be organized alphabetically after that of the PI, by surname.

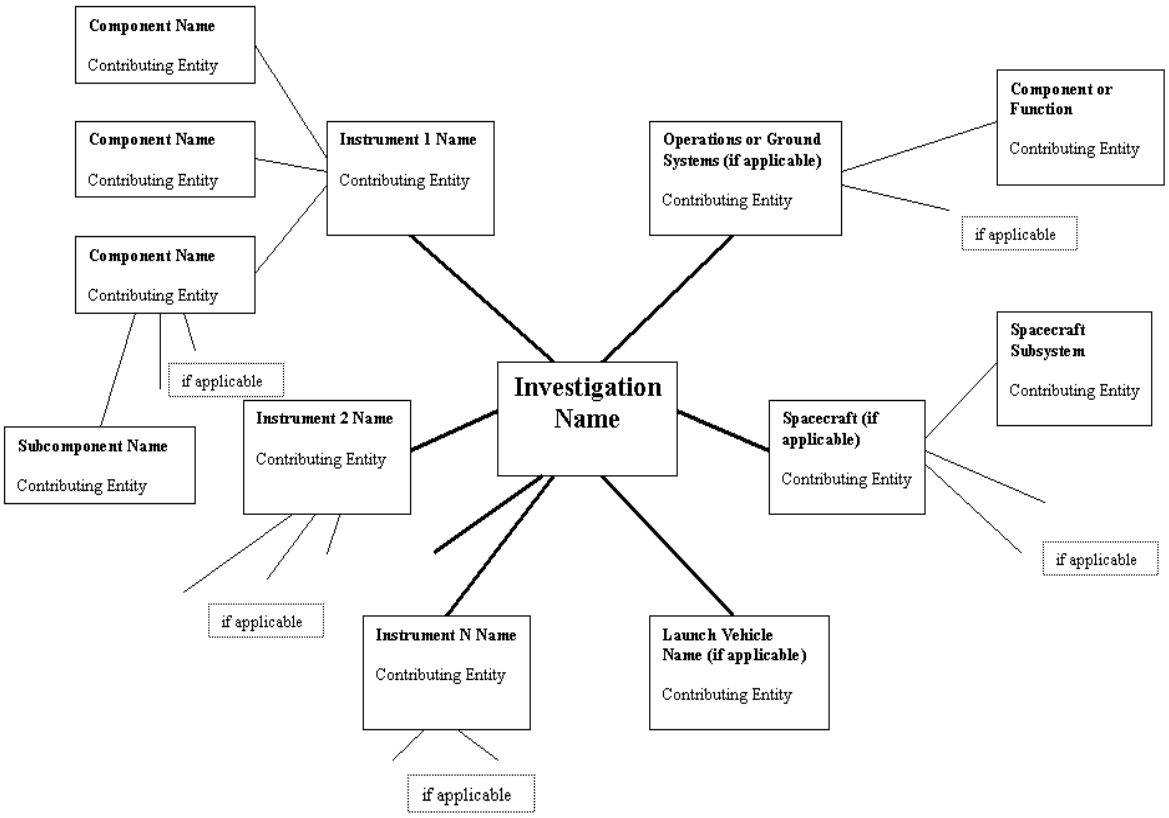
J.4. Summary of Proposed Program Cooperative Contributions.

The following expands requirements in the AO, in particular Requirement 75 through Requirement 77..

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

a. An "exploded diagram" of the investigation.

SAMPLE EXPLODED DIAGRAM



Requirement B-58. If a proposal includes cooperative contributions, this section shall include an "exploded diagram" of the investigation (see example figure) that provides a clear visual representation of cooperative contributions incorporated in the proposed implementation approach. All cooperative contributions, including those that will require an international agreement or interagency memorandum of agreement, shall be shown in this diagram. Each

contribution shown shall display a unique name for the contribution, as well as the identity of the contributing entity. However, the following shall not be shown:

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

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

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

b. A supporting table of collaborative contributions

Requirement B-59. 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 5.7.6 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 5.7.6 of this AO; and

(vi.) Cross reference to letters of commitment, as required in Section 5.9.1 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 85.

Requirement B-60. 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 parts 120–130, *et seq.* and 15 CFR parts 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.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 parts 120–130, *et seq*.

Requirement B-61. 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. Discussion of Limiting the Generation of Orbital Debris and End of Mission Spacecraft Disposal Requirements.

The following expands requirements in the AO, in particular Requirement 38.

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-62. This section shall discuss briefly how the mission meets the NPR 8715.6B and NASA-STD-8719.14A orbit debris requirements applicable to its proposed orbit.

Requirement B-63. 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. An orbital lifetime analysis addressing all assumptions and inputs contributing to the analysis shall be provided and describe, at a minimum:

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

Requirement B-64. If the plan is to dispose of the satellite at the end of mission, this section shall provide the parameters of the disposal orbit, the delta-v allocation for disposal, and any other relevant assumptions.

Requirement B-65. For Lunar missions, this section shall include a discussion of how end-of-mission requirements will be met.

The following references are available in the EVM-3 Library:

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

J.7. Compliance with Procurement Regulations by NASA PI Proposals.

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

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 1872.306).

Requirement B-66. For NASA Center proposals, this section shall include any descriptions, justifications, representations, indications, statements, and/or explanations that are required by the regulations.

J.8. Master Equipment List.

The following expands requirements in the AO, in particular Requirement 71.

Requirement B-67. 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-68. 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. However, do not include the spacecraft and/or any instrument when entirely contributed.

Requirement B-69. The MEL shall be additionally provided in Microsoft Excel format on each CD-ROM submitted. A Microsoft Excel template of the MEL is available for download in the EVM-3 Library.

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

List each electronic board separately, identify the functionality of each board (either in the MEL or in the Mission Implementation section), and provide the speed the board will be running at. If proposing Field-Programmable Gate Arrays (FPGAs), Application-Specific Integrated Circuits (ASICs), or Radio Frequency Integrated Circuits (RFICs), list the design size (in the appropriate

sizing parameter such as logic cells, logic elements), the board the chip(s) will be integrated onto, and how much heritage will be used in the design.

J.9. Heritage.

The following expands requirements in the AO, in particular Requirement 66.

Requirement B-70. This section shall discuss each element of any heritage from which the proposed investigation derives substantial benefit, including heritage from spacecraft subsystems, instruments, ground systems, flight and ground software, test set ups, simulations, analyses, etc. This discussion shall be at an appropriate level of granularity (e.g., component, assembly, subsystem) to clearly separate the heritage element from other elements of the design. The discussion of each element shall include:

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

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

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

Requirement B-71. If a proposal claims any heritage from which the proposed investigation derives substantial benefit, this appendix shall discuss each element to an appropriate level of granularity (e.g., component, assembly, subsystem) to clearly separate the heritage element from other elements of the design.

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

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

J.10. Certifications Amendments (optional).

This appendix *may* provide amendments to certifications, as provided for in Section 6.2.2.

J.11. List of Abbreviations and Acronyms.

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

Requirement B-72. This appendix shall provide a list of abbreviations and acronyms.

J.12. List of References (optional).

This appendix *may* provide a reference list of documents and other materials that were fundamentally important in generating the proposal. This *may* include a Uniform Resource Locator (URL) for documents that are available through the Internet. As noted at the outset of Appendix B of this AO, however, *proposals must be self-contained*: any data or other information intended as part of a proposal must be included within the proposal itself. If any documents or other materials are submitted as a part of a proposal, they must fit within the prescribed page limits.

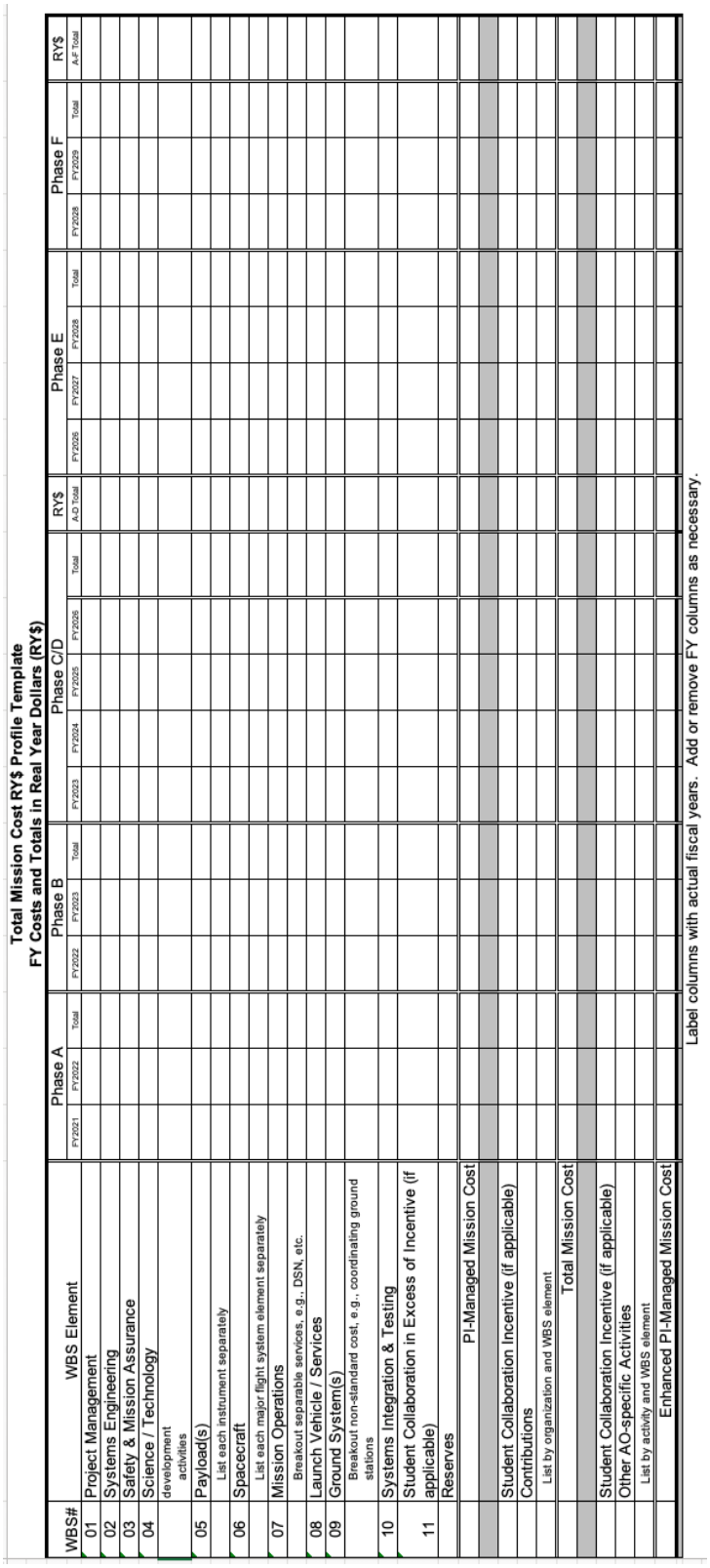
TABLE B1
EXAMPLE SCIENCE TRACEABILITY MATRIX

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

TABLE B2
EXAMPLE MISSION TRACEABILITY MATRIX

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

TABLE B3a
TOTAL MISSION COST RY$ PROFILE TEMPLATE



Total Mission Cost RY$ 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$
		FY2021	FY2022	Total	FY2022	FY2023	Total	FY2023	FY2024	FY2025	FY2026	Total	A-D Total	FY2026	FY2027	FY2028	FY2028	FY2029	Total	A-F Total
01	Project Management																			
02	Systems Engineering																			
03	Safety & Mission Assurance																			
04	Science / 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 (if applicable)																			
	Reserves																			
	PI-Managed Mission Cost																			
	Student Collaboration Incentive (if applicable)																			
	Contributions																			
	List by organization and WBS element																			
	Total Mission Cost																			
	Student Collaboration Incentive (if applicable)																			
	Other AO-specific Activities																			
	List by activity and WBS element																			
	Enhanced PI-Managed Mission Cost																			

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-3 Library.

TABLE B3b
TOTAL MISSION COST FY$ PROFILE TEMPLATE

Total Mission Cost FY$ Profile Template
FY Costs and Totals in Fiscal Year 2022 Dollars (FY2022$)

WBS#	WBS Element	Phase A			Phase B			Phase C/D					Phase E				Phase F			FY2022$
		FY2021	FY2022	Total	FY2022	FY2023	Total	FY2023	FY2024	FY2025	FY2026	Total	FY2026	FY2027	FY2028	Total	FY2028	FY2029	Total	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 (if applicable)																			
	Reserves																			
	PI-Managed Mission Cost																			
	Student Collaboration Incentive (if applicable)																			
	Contributions																			
	List by organization and WBS element																			
	Total Mission Cost																			
	Student Collaboration Incentive (if applicable)																			
	Other AO-specific Activities																			
	List by activity and WBS element																			
	Enhanced PI-Managed Mission Cost																			

A Microsoft Excel version of this template is available in the EVM-3 Library.

TABLE B4
2018 NASA NEW START INFLATION INDEX
FOR FY19 USE

Fiscal Year	2019	2020	2021	2022	2023	2024	2025	2026
Inflation Rate		3.0%	2.9%	2.8%	2.7%	2.7%	2.7%	2.7%
Cumulative Inflation Index	1.000	1.030	1.060	1.090	1.119	1.150	1.180	1.212

Use an inflation rate of 2.7% for all other years beyond 2026.

Note: Proposers must use their own forward pricing rates. For organizations that are without forward pricing rates, proposers must use the NASA New Start Inflation Index above and available in the EVM-3 Library.

TABLE B5
MASTER EQUIPMENT LIST

MASTER EQUIPMENT LIST Template - MISSION X

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

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

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

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

A Microsoft Excel version of this template is available in the EVM-3 Library.

APPENDIX C

GLOSSARY OF TERMS AND ABBREVIATIONS

Part C.1: GLOSSARY OF TERMS

Adjusted AO Cost Cap — The value to which a proposal's PIMMC is limited to, after adjustment from the AO Cost Cap for proposal-specific incentives and/or charges associated with NASA-provided items that have firm fixed values. Expressed in applicable Fiscal Year Dollars.

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

AO Cost Cap — The typical value to which the PIMMC is limited to. Represents the publicly announced Program funding available to all proposers to an opportunity. May be adjusted for individual proposals by incentives and/or charges (see Adjusted AO Cost Cap). Expressed in applicable Fiscal Year Dollars.

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

AO Steering Committee — A NASA committee composed wholly of 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, which provides procedural review over the investigation evaluation, categorization, and selection process.

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

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

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

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

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

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

Co-Investigator (Co-I) — An investigator who plays a necessary, defined role in the proposed investigation and whose services are either funded by the ESSP Program or are contributed. 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 by the ESSP Program. A collaborator may be committed to provide a focused contribution to the project for a specific task, such as data analysis. If ESSP Program 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 funded 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 closeout (Phase F), including the analysis and publication of data in the peer reviewed scientific literature, delivery of the data to an appropriate NASA data archive, and, if applicable, extended mission operations or other science enhancements.

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

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

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

Cost plan — The plan for meeting the funding resource requirements of a mission's development and operations, to include support for proposed cost estimates (e.g., basis of estimate, heritage, and letters of commitment), justification and adequacy of proposed encumbered and unencumbered cost reserves, feasibility of the costs to perform the mission, and cost risks to the mission.

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

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

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

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

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

Enhanced PI-Managed Mission Cost — the PI-Managed Mission Cost plus costs of optional components such as any Student Collaboration up to any associated incentive.

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

Flight worthiness — The competency and adequacy of the technical work performed by a provider of a non-AO-provided launch service.

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

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

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

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

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

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

Key Management Team members **—** The project leaders whose qualifications and experience are relevant and necessary to the success of the project. These positions must include, as a minimum, the PI, PM, PSE, Deputy PI (if specified), Project Manager Alternate (if specified), and, where appropriate, the PS and partner leads for substantial efforts. Individuals to be identified as named Key Management Team members minimally include the PI, PM, and PSE.

Launch Readiness Date — The date by which the proposed mission must be ready to launch.

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

Major partners — The organizations, other than the proposing organization, responsible for providing science leadership, project management, system engineering, spacecraft (as applicable), science instruments, PI-Team-Developed TDOs, integration and test, alternative access to space, mission operations, and other critical or essential products or services as defined by the proposer; all organizations, other than the proposing organization, receiving or contributing more than 10% of the PI-Managed Mission Cost are included, regardless of role.

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 AO.

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 (PIMMC) — The cost proposed by the PI's implementation team to be funded by the Program sponsoring the AO or Safety, Security, and Mission Services (SSMS) for the development and execution of the proposed project, Phases A through F. It includes any reserves applied to the development and operation of the mission as well. It also includes any costs that are required to be accounted for against the PI-Managed Mission Cost even though the PI is not responsible for those costs (e.g., NASA-provided telecom and network). The term does not imply that a contractual relationship between the Proposing Organization and other proposal partners is required. The PIMMC is capped at the AO Cost Cap or Adjusted AO Cost Cap, as applicable.

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

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

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

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

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

Project Office — An office established to manage a project.

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

Project Systems Engineer (PSE) — The individual responsible to the PI for all system engineering aspects of the mission per NPR 7123.1B**.**

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

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

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

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

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

Science data — the recorded factual material commonly accepted in the scientific community as necessary to validate research findings, but not any of the following: preliminary analyses, drafts of scientific papers, plans for future research, peer reviews, or communications with colleagues. This "recorded" material excludes physical objects (e.g., laboratory samples).

Science data also do not include:

> (A) Trade secrets, commercial information, materials necessary to be held confidential by a researcher until they are published, or similar information which is protected under law; and
>
> (B) Personal and medical information and similar information[,] the disclosure of which would constitute a clearly unwarranted invasion of personal privacy, such as information that could be used to identify a particular person in a research study.

Data are understood to include not only the recorded technical information, but also metadata (describing the data), descriptions of the software required to read and use the data, associated software documentation, and associated data (e.g., calibrations).

Exclusion: NASA creates and provides a large suite of scientific and engineering "data products" whose dissemination to the research community and the general public advance the Agency's core mission objectives. These "data products" come from NASA missions, instruments, and projects and typically have well-established scientific or technological goals and requirements. Subject to Federal laws regarding sensitive data and privacy, these data products are captured and archived by NASA for public access and use and are thus already compliant with the OSTP February 22, 2013, memorandum on access to research results. This plan therefore excludes these types of data.

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

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 or other specified costs up to any associated incentive(s), and any additional costs that are contributed or provided in any way other than through the Program sponsoring the AO. The Total Mission Cost will define the total value of the baseline investigation, not including any excluded costs or other costs only included in the Enhanced PI-Managed Mission Cost.

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 (LVs) 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 LV, spacecraft-to-launch vehicle integration, placement of spacecraft into designated orbit, analysis, flight mission data evaluation, oversight of the launch service and coordination of mission-specific integration activities.

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

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

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

Prelaunch Ground Data System (GDS)/Mission Operations Services (MOS) Development — Includes costs associated with development and acquisition of the ground infrastructure used to transport and deliver the telemetry and other data to/from the Mission Operations Center and the Science Operations Center. (For more information, refer to *Space Communications and Navigation (SCaN) Mission Operations and Communications Services (MOCS)* document in the EVM-3 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.

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-3 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
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
DPI	Deputy Principal Investigator
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
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
LV	Launch Vehicle
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
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
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
SSMS	Safety, Security, and Mission Services
TA	Technical Authority
TDO	Technology Demonstration Opportunity
TMC	Technical, Management, and Cost
TRL	Technical Readiness Level
UARC	University Affiliated Research Center
URL	Uniform Resource Locator
U.S.	United States
U.S.C.	United States Code
VOSB	Veteran Owned Small Business
WBS	Work Breakdown Structure
WOSB	Women Owned Small Business

APPENDIX D

EVM-3 LIBRARY

Earth Venture Mission - 3 Acquisition Homepage: https://essp.larc.nasa.gov/EVM-3/
EVM-3 Library: https://essp.larc.nasa.gov/EVM-3/evm-3_library.html

Strategic Documents

1. NPD 1001.0C, NASA 2018 Strategic Plan
2. 2014 Science Plan
3. Thriving on Our Changing Planet: A Decadal Strategy for Earth Observation from Space. The National Academies Press (2018).
4. Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond. The National Academies Press (2007).

Program Specific Documents

1. ESSP Program Plan
2. ELV Launch Services Program Information Summary
3. Venture Class Launch Services Program Information Summary
4. SMD Evolved Expendable Launch Vehicle (EELV) Secondary Payload Adapter (ESPA) Secondary Payloads Rideshare, SPD-32
5. Evolved Expendable Launch Vehicle Rideshare User's Guide (RUG)
6. 2019 ESPA Rideshare Users Guide (RUG)
7. 2018-09-18-IMAP-ESPA- SIS
8. Rideshare Accommodation Worksheet Template
9. Space Communications and Navigation (SCaN) Mission Operations and Communications Services (MOCS)
10. Available Spectrum and Channel Limits By Allocated Service
11. System-Level TRL 6 Examples
12. Call for Proposals - Senior Review 2020 for Extension of Earth Science Operating Missions
13. 2016 Directive on Project Applications Program
14. Microsoft Excel version of the template tables in the AO:
    Table B1: Example Science Traceability Matrix
    Table B2: Example Mission Traceability Matrix
    Table B3a: Total Mission Cost RY$ Profile Template
    Table B3b: Total Mission Cost FY$ Profile Template
    Table B5: Master Equipment List
15. 2019 NASA New Start Inflation Index for FY20 Use
16. Meeting the 70% JCL Requirement in PI-led Missions, SPD-19
17. EVM Contract Sample
18. SMD Policy Document on Student Collaboration, SPD-31

NASA and Federal Documents

1. NPR 7120.5E, NASA Space Flight Program and Project Management Requirements
2. NPR 7123.1B, NASA Systems Engineering Processes and Requirements
3. NASA/SP-2016-3404/REV1, NASA WBS Handbook

4. NPR 8715.6B, NASA Procedural Requirements for Limiting Orbital Debris
5. NASA-STD-8719.14A, NASA Process for Limiting Orbital Debris
6. NPR 8715.3D, NASA General Safety Program Requirements
7. NPR 8705.4, Risk Classification for NASA Payloads
8. NPD 2521.1B, Communications and Material Review
9. NPR 2200.2D, Requirements for Documentation, Approval and Dissemination of Scientific and Technical Information
10. NASA Plan for Increasing Access to the Results of Scientific Research
11. Near Earth Network (NEN) Users' Guide Revision 4

Additional NASA and Federal Documents

All NASA Policy Directives (NPD) and NASA Procedural Requirements (NPR) documents referenced in this AO may be found in the NASA Online Directives Information System (NODIS) Library (http://nodis3.gsfc.nasa.gov/)

NPR 1600.1A, NASA Security Program Procedural Requirements
NPD 1360.2B, Initiation and Development of International Cooperation in Space and Aeronautics Programs
NPR 7150.2B, NASA Software Engineering Requirements
NPD 5101.32E, Procurement, Financial Assistance
NPD 8610.7D, Launch Services Risk Mitigation Policy for NASA-Owned and/or NASA-Sponsored Payloads/Missions
NPD 8610.23C Launch Vehicle Technical Oversight Policy

NASA technical standards documents may be found in the public access portion of the NASA Standards and Technical Assistance Resource Tool (START) (http://standards.nasa.gov/)

NASA-STD-8739.8, Standard for Software Assurance

NASA technical reports may be found on the NASA Technical Reports Server (NTRS) (http://ntrs.nasa.gov/search.jsp)

NASA/SP-2016-6105 Rev 2, NASA Systems Engineering Handbook

Managerial Cost Accounting Concepts and Standards for the Federal Government

The Federal Acquisition Regulations (FAR) may be accessed at https://www.acquisition.gov/browse/index/far . The following parts of the Federal Acquisition Regulations are referenced in this AO.

FAR 15.403-4, "Requiring certified cost or pricing data (10 U.S.C. 2306a and 41 U.S.C. 254b)"
FAR 22.808, "Complaints"
FAR 33.101, "Definitions"
FAR 52.219-8, "Utilization of Small Business Concerns"
FAR 52.219-9, "Small Business Subcontracting Plan"
FAR 52.222-26, "Equal Opportunity"

FAR 52.226-2, “Historically Black College or University and Minority Institution Representation”
FAR 52.227-14, “Rights in Data – General”
FAR 52.233-2, “Service of Protest”

The NASA FAR Supplement (NFS) may be accessed at http://www.hq.nasa.gov/office/procurement/regs/NFS.pdf. The following parts of the NASA FAR Supplement are referenced in this AO.

NFS 1815.208, “Submission, modification, revision, and withdrawal of proposals”
NFS 1835.016-70, “Foreign participation under broad agency announcements (BAAs)”
NFS 1852.227-70, “New Technology”
NFS 1852.233-70, “Protests to NASA”
NFS 1852.234-2, “Earned Value Management System”
NFS 1872.404, “Categorization”
NFS 1872.306, "Proposals submitted by NASA investigators”

NASA Procurement Information Circulars (PICs) may be accessed at http://www.hq.nasa.gov/office/procurement/regs/pic.pdf.

The Code of Federal regulations (CFR) may be accessed at http://www.gpo.gov/fdsys/. The following parts of the Code of Federal Regulations are referenced in this AO.

2 CFR 200.466, “Scholarships and student aid costs”
15 CFR Parts 730-774, “Export Administration Regulations”
22 CFR Parts 120-130, “International Traffic in Arms Regulations”

The United States Code (USC) may be accessed at https://www.govinfo.gov/. The following parts of the United States Code are referenced in this AO.

42 USC 4321 et seq., "National Environmental Policy Act (NEPA) of 1969, as amended"

Executive Orders may be accessed at http://www.archives.gov/federal-register/executive-orders/. The following Executive Orders are referenced in this AO.

Executive Order 11246, Equal employment opportunity (see http://www.archives.gov/federal-register/codification/executive-order/11246.html)

Executive Order 12114, Environmental effects abroad of major Federal actions (see http://www.archives.gov/federal-register/codification/executive-order/12114.html)

Homeland Security Presidential Directive HSPD-12 (see http://www.dhs.gov/homeland-security-presidential-directive-12)

APPENDIX E

REQUIREMENTS FOR SUBSEQUENT PHASES

This appendix provides references to documents that govern subsequent phases of mission development for selected investigations. These documents may contain requirements on selected missions; however, they do not place requirements on proposals submitted in response to this AO. Proposed investigations should be implementable within the program and project management environment that these documents describe. These documents may be found in the EVM-3 Library (Appendix D).

NPR 7120.5E, *NASA Space Flight Program and Project Management Requirements*
ESSP Program Plan
NPR 7123.1B, *NASA Systems Engineering Processes and Requirements*
NPR 8705.4, *Risk Classification for NASA Payloads*
NPR 8715.3D, *NASA General Safety Program Requirements*
SPD-19, *Meeting the 70% JCL Requirement in PI-led Missions*

APPENDIX F

COMPLIANCE CHECKLIST

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

Administrative	
1. Electronic proposal received on time	Requirement 1
2. Proposal on CD-ROM received on time	Requirement 2
3. Original signatures of PI and of authorizing official included	Requirement B-12
4. Meets page limits	Requirement B-4
5. Meets general requirements for format and completeness (maximum 55 lines text/page, maximum 15 characters/inch --approximately 12 pt font)	Requirement 106 Requirement B-1 Requirement B-2 Requirement B-3
6. Required appendices included; no additional appendices	Requirement B-54
7. Budgets are submitted in required formats	Requirement B-50
8. All individual team members who are named on the cover page indicate their commitment through NSPIRES	Requirement 88
9. All export-controlled information has been identified	Requirement 89
10. Restrictions Involving China acknowledged on Electronic Cover Page	Requirement 78
Scientific	
11. Addresses solicited science research programs	Requirement 3
12. Requirements traceable from science to instruments to mission	Requirement 5
13. Appropriate data archiving plan	Requirement 6
14. Baseline science mission and threshold science mission defined	Requirement 10
Technical	
15. Complete spaceflight mission (Phases A-F) proposed	Requirement 19
16. Team led by a single PI	Requirement 44
17. PI-Managed Mission Cost within AO Cost Cap or Adjusted AO Cost Cap, as applicable	Requirement 64
18. Contributions within contribution limit	Requirement 76
19. Co-investigator costs in budget	Requirement 58
20. Launch readiness prior to launch readiness date	Requirement 98
21. Includes table describing non-U.S. participation	Requirement 83
22. Includes letters of commitment from funding agencies for non-U.S. participating institutions	Requirement 80
23. Includes letters of commitment from all U.S. organizations offering contributions	Requirement 86
24. Includes letters of commitment from all major partners and non-U.S. institutions providing contribution of efforts of anyone on the Proposal Team.	Requirement 87

APPENDIX G

REQUIREMENTS CROSSWALK

This appendix is not used for this opportunity.

APPENDIX H

REPRESENTATIONS AND CERTIFICATIONS

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

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

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