

**Broad Agency Announcement NNH15ZCQ001K**

**Next Space Technologies for Exploration Partnerships  
(NextSTEP)  
BROAD AGENCY ANNOUNCEMENT  
Amendment 1**

**PROPOSALS DUE  
December 12, 2014**

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**NATIONAL AERONAUTICS AND SPACE ADMINISTRATION  
Washington, DC 20546**

## Table of Contents

|            |                                                                               |           |
|------------|-------------------------------------------------------------------------------|-----------|
| <b>1</b>   | <b>FUNDING OPPORTUNITY DESCRIPTION .....</b>                                  | <b>3</b>  |
| <b>2</b>   | <b>AWARD INFORMATION.....</b>                                                 | <b>4</b>  |
| 2.1        | Funding Availability.....                                                     | 4         |
| 2.2        | Export Control.....                                                           | 4         |
| 2.3        | Intellectual Property .....                                                   | 5         |
| <b>3</b>   | <b>ELIGIBILITY INFORMATION .....</b>                                          | <b>5</b>  |
| 3.1        | Guidelines for Foreign Participation .....                                    | 6         |
| 3.2        | China Funding Restriction.....                                                | 6         |
| 3.3        | Corporate Resources .....                                                     | 7         |
| <b>4</b>   | <b>GENERAL INFORMATION FOR PARTICIPANTS.....</b>                              | <b>8</b>  |
| <b>5</b>   | <b>INSTRUCTIONS FOR PROPOSALS.....</b>                                        | <b>9</b>  |
| 5.1        | Proposal Submittal .....                                                      | 9         |
| 5.2        | Proposal Content.....                                                         | 10        |
| <b>6</b>   | <b>PROPOSAL REVIEW INFORMATION .....</b>                                      | <b>11</b> |
| <b>6.1</b> | <b>Process .....</b>                                                          | <b>11</b> |
| 6.1.1      | Compliance Check .....                                                        | 11        |
| 6.1.2      | Evaluation .....                                                              | 11        |
| 6.1.3      | Selection and Award .....                                                     | 12        |
| 6.1.4      | Selection Officials.....                                                      | 12        |
| 6.1.5      | Personnel.....                                                                | 12        |
| <b>6.2</b> | <b>Evaluation Criteria .....</b>                                              | <b>12</b> |
| <b>6.3</b> | <b>Process for Appeals .....</b>                                              | <b>12</b> |
| 6.3.1      | Ombudsman Program .....                                                       | 12        |
| 6.3.2      | Protests .....                                                                | 12        |
|            | <b>APPENDIX A: Advanced Propulsion .....</b>                                  | <b>14</b> |
|            | <b>APPENDIX B: Habitation Systems .....</b>                                   | <b>18</b> |
|            | <b>APPENDIX C: Small Satellites Addressing Strategic Knowledge Gaps .....</b> | <b>21</b> |
|            | <b>APPENDIX D: Price Proposal Format.....</b>                                 | <b>24</b> |

## 1 FUNDING OPPORTUNITY DESCRIPTION

NASA has increasingly embraced public-private partnerships for achieving its strategic goals and objectives for expanding the frontiers of knowledge, capability, and opportunities in space. The next step for human spaceflight is the development of deep space exploration capabilities to support more extensive missions in the proving ground around and beyond Cislunar space. An important part of NASA's strategy is to stimulate the commercial space industry while leveraging those same commercial capabilities through future contracts and public-private partnerships to deliver mission capabilities.

NASA's activities in enabling the pioneering of space are being driven by a set of guiding principles:

- Implementable in the ***near-term with the buying power of current budgets*** and in the longer term with budgets commensurate with economic growth;
- ***Exploration enables science*** and ***science enables exploration***
- Application of ***high Technology Readiness Level*** (TRL) technologies for near term missions, while focusing sustained investments on ***technologies and capabilities*** to address challenges of future missions;
- ***Near-term mission opportunities*** with a defined cadence of compelling and integrated human and robotic missions providing for an incremental buildup of capabilities for more complex missions over time;
- Opportunities for ***U.S. commercial business*** to further enhance the experience and business base
- ***Multi-use, evolvable*** space infrastructure, minimizing unique major developments;
- Substantial ***international and commercial participation***, leveraging current International Space Station and other partnerships.

This Umbrella Broad Agency Announcement (BAA) is seeking proposals in three areas for concept studies or technology development projects executed through fixed price contracts with milestone payments. The intent is that contracts resulting from this BAA will enable a public-private partnership for robust exploration and implementation of opportunities managed by the NASA Advanced Exploration Systems Division within the Human Exploration and Operations Mission Directorate. The BAA anticipates that the capabilities and technologies developed through this partnership also will provide significant commercial applications beyond NASA. In order to ensure the offerors have the incentive to develop commercial applications, NASA is requiring offerors provide corporate contributions. These three key long term capability areas identified could potentially significantly benefit future human space exploration. The three areas are:

1. Advanced propulsion systems. More specifically electric propulsion systems that demonstrate higher specific impulse, higher efficiency, and higher power for long duration deep space transportation systems. This is intended to look at capabilities that are beyond those previously considered under the Asteroid Redirect Mission BAA. Reference Appendix A: Propulsion Systems.

2. Habitation systems. Concepts and technology investigation for an initial habitation capability in cislunar space with extensibility for in-space transit habitation such as those being considered by NASA under its Exploration Augmentation Module(s) (EAM) or the capabilities that enable a potential use of commercial Low Earth Orbit (LEO) habitation capabilities coupled with government-provided exploration in-space habitation capabilities in cislunar space. Habitation capabilities that could be implemented in a modular way that could gradually built up the capabilities required for a deep space transit capability are of particular interest. This habitation capability (herein referred to as the EAM) will serve as the first foundational cornerstone of a future deep space transit capability and may include multiple elements over a phased build out as the architecture and a commercial and international partnership strategy is further refined. In this capacity, the EAM is expected to be used to augment planned cislunar missions as well as to provide the function of a proving ground for future systems in support of human exploration in deep space (beyond cislunar space). Reference Appendix B: Habitation Systems.
3. Small Satellite Missions addressing Strategic Knowledge Gaps (SKG). Secondary payloads on Exploration Mission 1 (EM-1) that address SKGs for future human exploration and may additionally address commercial interests such as in-situ resource prospecting. Reference Appendix C: Strategic Knowledge Gap Small Satellites.

## 2 AWARD INFORMATION

### 2.1 Funding Availability

NASA reserves the right to select for award multiple, one, or none of the proposals in response to this Announcement. NASA reserves the right to negotiate, with selected offerors, cost/price terms and any other terms, as appropriate. The overall number of awards will be dependent upon funding availability and evaluation results. Additional information on the anticipated awards and funding levels for each thrust is contained in the respective appendices. **Awards under the BAA are subject to the availability of funding. NASA may not make any awards to those selected until NASA receives the fiscal year 2015 appropriations or may choose to only award in specific areas and reserve the remaining awards pending the final appropriations for the fiscal year. Any reduced appropriations or continuing resolution may affect NASA's ability to award selected offerors in all any or all of the three areas.**

### 2.2 Export Control

Performance of activities under this Announcement may require access to data that is subject to export control regulations. Any entity proposing for a contract under this BAA in order to be considered for award shall comply with all U.S. export control laws and regulations, including the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 through 130, and the Export Administration Regulations (EAR), 15 CFR Parts 730 through 799, and must demonstrate their compliance and process in the performance of this contract.

## 2.3 Intellectual Property

**Data Rights:** The objective of a contract awarded under this BAA is to provide recipients with the incentive to develop commercial applications of technologies developed through the partnership. Data exchanged between NASA and a recipient will generally be freely exchanged without restriction as to its disclosure, use or duplication. However, a recipient's proprietary data that is exchanged or developed will be protected from disclosure provided it is clearly marked as such. Further, data produced by NASA that would be a trade secret or commercial or financial information that would be privileged or confidential had the data been obtained from the nongovernmental partner, may be protected from disclosure for up to 5 years.

If a respondent chooses to submit business sensitive, proprietary, or otherwise confidential information as part of its proposal, it must be clearly and conspicuously marked.

**Invention Rights:** Recipients that are Small Businesses or nonprofit organizations may elect to retain title to their inventions 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.

Accordingly, the resulting contracts will contain the clauses at 14 CFR 1274.905, Rights in Data, and either 14 CFR 1274.912, Patent-Rights – Retention by Large Business or 14 CFR 1274.913, Patent-Rights- Retention by Large Business in lieu of the corresponding FAR clauses.

## 3 ELIGIBILITY INFORMATION

This solicitation topic is open to non-Government U.S. institutions (companies, universities, nonprofit organizations) and foreign institutions. NASA civil servants, Jet Propulsion Laboratory (JPL) employees, national laboratories, and Federally Funded Research and development Centers (FFRDCs) shall not be proposed as a Prime Contractor on any effort associated with this announcement but may participate as a team member. Proposals from foreign organizations must comply with Section 3.1, Guidelines for Foreign Participation. Exceptions or amendments to the eligible participants and partnerships for each solicitation topic are specified in the appendices to this Umbrella Announcement.

### **3.1 Guidelines for Foreign Participation**

The NASA FAR Supplement clause 1835.016-70(a) foreign participation under BAAs policy provides guidelines for this activity. NASA seeks the broadest participation in response to broad agency announcements, including foreign proposals or proposals including foreign participation. NASA's policy is to conduct research with foreign entities on a cooperative, no-exchange-of-funds basis (see NPD 1360.2, Initiation and Development of International Cooperation in Space and Aeronautics Programs). NASA does not normally fund foreign research proposals or foreign research efforts that are part of U.S. research proposals and will not do so pursuant to this BAA. Rather, cooperative research efforts are implemented via international agreements between NASA and the sponsoring foreign agency or funding/sponsoring institution under which the parties agree to each bear the cost of discharging their respective responsibilities. NASA funding may not be used for subcontracted foreign research efforts.

All foreign proposals must be typewritten in English and comply with other submission requirements stated in the Announcement. All foreign proposals will undergo the same evaluation and selection process as those originating in the U.S. All proposals must be received before the established closing date. Sponsoring foreign government agencies or funding institutions may, in exceptional situations, forward a proposal without endorsement if endorsement is not possible before the announced closing date. In such cases, the NASA sponsoring office should be advised when a decision on endorsement can be expected.

NASA's Office of International and Interagency Relations (OIIR), in consultation with other interested NASA offices, will review for eligibility for selection all foreign proposals and U.S. proposals with foreign participation to ensure consistency with all applicable statutes (including the Iran, North Korea, and Syria Nonproliferation Act, P.L. 106-178, as amended), regulations, Executive Orders, and policies governing export control, nonproliferation, trade, and foreign policy.

Should a foreign proposal or a U.S. proposal with foreign participation be selected, NASA's OIIR will arrange with the sponsoring foreign agency or funding/sponsoring institution for the proposed participation on a no-exchange-of-funds basis, in which NASA and the non-U.S. sponsoring agency or funding/sponsoring institution will each bear the cost of discharging their respective responsibilities.

### **3.2 China Funding Restriction**

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. Grant Information Circular 12-01A instructs NASA, when issuing new BAAs, to add the "Assurance of Compliance – China Funding Restriction" to the current proposal requirements set forth at 14 CFR § 1260.10 (c)(1).

The Department of Defense and Full-Year Appropriation Act, Public Law 112-10 Section 1340(a) and the Consolidated and Further Continuing Appropriation Act of 2012, Public Law 112-55, Section 539 state that:

(1) NASA is restricted from using funds appropriated in the Acts to enter into or fund any grant or cooperative agreement of any kind to participate, collaborate, or coordinate bilaterally with China or any Chinese-owned company, at the prime recipient level and at all sub recipient levels, whether the bilateral involvement is funded or performed under a no exchange of funds arrangement.

(2) Definition: "China or Chinese-owned Company" means the People's Republic of China, any company owned by the People's Republic of China, or any company incorporated under the laws of the People's Republic of China.

(3) The restrictions in the Acts do not apply to commercial items of supply needed to perform a grant or cooperative agreement.

(4) By submission of its proposal, the offeror represents that the offeror is not China or a Chinese-owned company, and that the proposer will not participate, collaborate, or coordinate bilaterally with China or any Chinese-owned company, at the prime recipient level or at any sub recipient level, whether the bilateral involvement is funded or performed under a no-exchange of funds arrangement.

NASA anticipates this restriction will be contained in future appropriation acts. Active Procurement Information Circular (PIC) 12-01A instructs Contracting Officers to add certification NFS 1852.225-72 entitled "Restriction on Funding Activity with China – Representation" as well as NFS clause 1852.225-71 entitled "Restriction on Funding Activity with China" in all contract awards.

### **3.3 Corporate Resources**

Offerors are required to show a minimum of 50% corporate contribution, made within the last five years, that is directly relevant to the proposed effort. Offerors shall describe how they intend to meet this eligibility requirement in Section II of the proposal. An appendix to the proposal shall provide documentation in an attachment showing proof of corporate contribution.

Corporate contribution may be in the form of direct labor, travel, consumables or other in-kind contributions. Also, other reasonable forms of corporate contribution may include investments in special facilities or equipment, tooling or other prior private investment, including Independent Research and Development (IRAD) are deemed acceptable for this effort. For this BAA, state and local government contributions may be included with private corporate resources.

The value of participation by federally funded government funded participants and/or the use of federal government facilities shall be added to the price to the government for determining whether the 50% required corporate contribution has been met.

Criteria and procedures for the allowability and allocability of cash and non-cash

contributions shall be governed by FAR Parts 30 and 31, and NFS Parts 1830 and 1831 NASA reserves the right to hold due diligence discussions to make reasonable determinations regarding corporate contributions.

#### **4 GENERAL INFORMATION FOR PARTICIPANTS**

- Agency:** National Aeronautics and Space Administration
- Announcement Title:** NextSTEP Broad Agency Announcement
- Responsible Office:** Advanced Exploration Systems Division  
Human Exploration and Operations Mission Directorate  
NASA Headquarters  
Washington, DC 20546
- Proposal Due Date:** Proposals are due December 12, 2014.
- Notice of Intent:** To assist in the planning of the proposal evaluation process, NASA strongly encourages the submission of a Notice of Intent (NOI) to propose by all prospective offerors. Notices of intent are due by November 10, 2014. The NOI should contain the following information: name, address, telephone number, e-mail address, and institutional affiliation of the offeror, and the solicitation topic in which you intend to propose. NOIs shall be submitted electronically to the Point of Contact e-mail address below. **Please note that NOIs are strongly encouraged, but are not required. Not submitting an NOI will not impact the selection process.**
- Proposal Submittals:** Proposals shall be submitted electronically in Adobe pdf format to the Point of Contact e-mail address below. Hard copies will not be accepted.
- Point of Contact:** All questions shall be directed to the following NASA official no later than 5pm EST November 21, 2014:
- Jason Crusan  
Director, Advanced Exploration Systems  
Human Exploration and Operations Mission Directorate  
NASA Headquarters  
E-mail: [HQ-NextSTEP-BAA@mail.nasa.gov](mailto:HQ-NextSTEP-BAA@mail.nasa.gov)
- Industry Forum:** A NextSTEP Partnership virtual opportunity forum will be held electronically on November 6, 2014, and proposers will

have a chance to ask questions about this Announcement. The meeting agenda and related information will be posted on the below Web site.

**Web Site for Reference Information: [www.nasa.gov/nextstep](http://www.nasa.gov/nextstep)**

This solicitation constitutes a BAA as contemplated by Federal Acquisition Regulation (FAR) Part 35 and NASA FAR Supplement (NFS) Part 1835.

NASA will not issue paper copies of this Announcement. The Announcement, associated Appendices, related documents, and other information may be obtained and downloaded from the above Web site. Proposers are encouraged to refer regularly to this site for updates and other information. Responses to submitted questions concerning the Announcement will be posted periodically on this Web site.

## **5 INSTRUCTIONS FOR PROPOSALS**

### **5.1 Proposal Submittal**

Proposals shall be submitted electronically in Adobe pdf format to the Point of Contact e-mail address above. Hard copies will not be accepted. Proposals responding to any of the appendices must comply with the following requirements.

| <u>Proposal Section</u>                               | <u>Page Limitations</u> |
|-------------------------------------------------------|-------------------------|
| Title Page                                            | 1                       |
| Executive Summary (Section I)                         | 1                       |
| Proof of Eligibility (Section II)                     | 3                       |
| System Concept & Technical Approach (Sections III-IV) | 15                      |
| Capabilities (Section V)                              | 2                       |
| Data Rights (Section VI)                              | 1                       |
| Price Proposal (Section VII)                          | No limit                |
| Attachments                                           | No limit                |

#### *Attachments*

Quad chart overview of the proposal  
Resumes of Key Personnel  
Draft Statement-of-Work  
Proposed Technical and Payment Milestones  
Additional Documentation on Corporate contribution

A page is defined as one side of a sheet, 8 1/2" x 11" with at least one-inch margins on all sides, using not smaller than 12-point font, with the exception of tables and figures, which may use 8-point font. Pages in excess of the page limits for each section will not be evaluated.

**Proposals received by the Government after the published date and time for receipt will not be accepted.**

## **5.2 Proposal Content**

Respondents must provide enough detail in the proposal for NASA to make informed assessments against the criteria as required for each Appendix to this Announcement.

All proposals must contain the information organized in the following outline format:

**Title Page:** Include any Notice of Restriction on Use and Disclosure of Proposal Information. An optional graphic image may be included. Also, include the following information:

- The title and number of this Announcement.
- Organization name and address.
- Point of Contact name, title, e-mail address, and phone number.

**Section I:** Executive Summary: Describe the proposal's prominent and distinguishing features.

**Section II:** Proof of Eligibility: Provide information showing that the Respondent is an eligible participant as stipulated in this Announcement. Explain how the required cost-sharing or matching resources will be satisfied.

**Section III:** System Concept: The offeror shall describe the system concept and its functions, how it addresses the objectives and requirements in this Announcement, and its maturity (Technology Readiness Level, if appropriate).

**Section IV:** Technical Approach: The offeror shall describe the approach and schedule for designing, analyzing, and testing the proposed system concept, including the plans to mature key technologies.

**Section V:** Capabilities: The offeror shall provide evidence of existing capabilities for designing and developing space-qualified systems applicable to the objectives of this Announcement.

**Section VI:** Intellectual Property: The offeror shall describe the approach for data rights and inventions, and how they meet the objectives outlined under Section 2.3, Intellectual Property.

**Section VII:** Price Proposal: The price proposal shall include the overall firm fixed price for the concept study or capability/technology development project. The offeror shall provide total direct labor hours by skill mix, travel, and subcontracts in accordance with the format set forth in Appendix D. Offerors should reference corporate resources described in Section II (Eligibility).

**Attachments:**

- *Quad chart:* The proposal shall contain a quad chart summarizing the proposed objectives, team, major milestones, and funding requirements. A template of the chart will be posted with this Announcement.
- *Resumes:* Resumes may be included for key personnel. In general, resumes should be limited to no more than 2 pages each.
- *Draft Statement-of-Work:* The offeror shall provide a draft statement-of-work that includes a work breakdown structure and a description of the major tasks, and products.
- *Proposed Technical and Payment Milestones:* The offeror shall provide a list of proposed capability/technology development and demonstration milestones. Each milestone shall include a descriptive title, objective success criteria, and planned achievement dates (month and year). Milestones should represent significant technical and business progress in the program. At least one milestone per calendar quarter is recommended. The proposal shall also include payment milestones with a title, associated objective success criteria, payment amount, and planned dates for completion of the milestone.
- *Corporate Resources documentation:* This attachment should include documents showing verifiable evidence of the corporate contributions that are being proposed.

**6 PROPOSAL REVIEW INFORMATION**

NASA reserves the right to select for negotiations all, some, or none of the proposals received in response to this Announcement.

**6.1 Process****6.1.1 Compliance Check**

All proposals will be screened to evaluate whether they comply with the eligibility criteria (Section 3) and proposal instructions (Section 5) of this Announcement. Proposals that do not comply may be declared noncompliant and rejected without further review. NASA reserves the right to conduct due diligence exchanges with offerors regarding compliance with the eligibility criteria, including how an offeror satisfies the corporate contribution requirement.

**6.1.2 Evaluation**

A NASA Evaluation Panel will evaluate proposals deemed compliant according to the evaluation criteria described in Section 6.2. The Evaluation Panel will summarize the strengths and weaknesses of each proposal and assign an overall consensus rating (Excellent, Very Good, Good, or Poor). NASA may ask about a specific point or points in a proposal and conduct fact finding or due diligence activities. These activities may result in a request for a revised proposal. NASA has the ability to determine the appropriate method for any such communications, e.g., be in writing, virtual, or person.

### **6.1.3 Selection and Award**

Upon selection, final contract terms and conditions will be negotiated. Contract performance shall not begin until the contract is signed by both parties.

### **6.1.4 Selection Officials**

The Director for the Advance Exploration Systems Division for the Human Exploration and Operations Mission Directorate will make selections.

### **6.1.5 Personnel**

NASA may use contractor support personnel to provide technical, business, and investment expertise when evaluating proposals. Any support contractor involved in the evaluation process will be bound by appropriate nondisclosure agreements to protect proprietary and competition sensitive information and must have accepted limitations on future contracting.

## **6.2 Evaluation Criteria**

NASA will use the following evaluation factors, with each factor having equal weight:

**Factor 1 - Relevance:** The Government will evaluate the ability of the proposal to meet the objectives stated in the appendix of this BAA for which the proposal was submitted.

**Factor 2 – Technical Merit:** The Government will evaluate the quality, depth, and thoroughness of the proposed technical approach and the organization's capabilities and the qualifications of key personnel.

**Factor 3 - Price:** The Government will evaluate the overall price reasonableness of the firm fixed price to the Government, Also an analysis will be done on the corporate contribution to ensure that it properly aligned with the proposed effort,

## **6.3 Process for Appeals**

### **6.3.1 Ombudsman Program**

The NASA Procurement Ombudsman Program is available under this solicitation as a procedure for addressing concerns and disagreements. The clause at NASA FAR Supplement (NFS) 1852.215-84 ("Ombudsman") is incorporated into this solicitation. The cognizant ombudsman is: Director, Contract Management Division, Office of Procurement, NASA Headquarters, Washington, DC 20546-0001.

### **6.3.2 Protests**

Only prospective offerors seeking contract awards under this solicitation have the right to file a protest, either at the Government Accountability Office (GAO) or with the Agency, as defined in FAR 33.01. The provisions at FAR 52.233-2 ("Service of Protest") and NFS 1852.233-70 (Protests to NASA") are incorporated into this solicitation. 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, Mail Stop 5G70  
Washington, DC 20546-0001

## **APPENDIX A: Advanced Propulsion**

### **1 Funding Opportunity Description**

#### **Description Of Solicitation Topic:**

There is no single chemical or electric propulsion (EP) technology that will provide the required capabilities for all missions or mission types. The requirements for in-space propulsion vary widely due to their intended application. NASA is interested in furthering the development of high power EP systems in order to lay the ground work for future lifetime testing and eventual technology demonstration missions of the EP systems. Currently, the state-of-the-art for Solar Electric Propulsion (SEP) systems employed by NASA in space is <5kW. The Asteroid Redirect Mission (ARM) BAA solicited proposals for concepts developing SEP systems in the 40 kW class. With this BAA, NASA is seeking to advance the technology for the extensibility of EP systems to much higher powers to broaden the envelope of power sources and mission architectures.

The major technical challenges for In-Space Propulsion Systems identified in NASA Technology Roadmap TA2 are based on perceived mission need or potential impact on future in-space transportation systems. These challenges were categorized into near- (present to 2016), mid- (2017–2022), and far-term (2023–2028) time frames, representing the point at which Technology Readiness Level (TRL) 6 is expected to be achieved. Support for these technologies needs to begin well before the listed time horizon, which is the purpose of this BAA.

NASA is interested in 50 to 300 kW per thruster EP systems for a variety of mission concepts that could include Earth-orbiting tugs, Earth-cislunar tugs, Earth-Mars Cargo Transfer, Earth-Mars Human Transfer, and other human exploration missions. As the space vehicles for these types of missions increase in mass and power demands, it is highly desired to keep the number of EP thrusters onboard the spacecraft to a minimum.

The EP thrusters NASA would like to develop should be able to operate over a broad power and specific impulse range to allow for maximum mission flexibility. They should be capable of high thrust at a lower specific impulse of ~2000s but also be capable of propellant efficient operations at a higher specific impulse of ~5000s. To meet the needs of a variety of mission concepts, the engines should have an in-space lifetime goal of >50,000 hours and an operational (thrusting) goal of >10,000 hours. The engines should have an operational end-to-end total system efficiency goal of greater than 60% (the thruster efficiency alone will be higher). The High Power (50 kW to 300 kW per thruster) class EP engine should be scalable to MW levels as stated in NASA Roadmap TA2. The goal for the specific mass for the total flight propulsion system (including Power Processing Unit (PPU) - if required, thermal control system, avionics, propellant management system, engine structural frame, etc.) should be less than 5 kg/kW. This does not include the mass of the solar arrays or other power source, propellant, propellant storage vessels, or the engine gimbal assembly attached to the spacecraft.

The design of the EP engine should also be extensible to continuous operation at 200 to 300kW.

This research and development BAA is focused on furthering the development of High Power EP engine technologies and includes the following objectives by the time the effort is completed:

- The EP engine system, including its PPU(s), if required, internal thermal control systems, and propellant management systems should be at TRL 5
- The EP engine system must demonstrate a minimum of 100 hours continuous lifetime testing after reaching TRL 5 with the following operational constraints:
  - Maintain thermal steady state for the full 100 hours
  - Total system input power must be a minimum of 100 kW for the full 100 hours
  - Must be operated with TRL 5 PPU(s), if required. If a Direct Drive power system is to be utilized, the EP engine system must be operated with the expected voltage and current profiles. In other words, the EP engine system must demonstrate its tolerance and performance with the full range of expected fluctuations in voltage and current.

Other supporting systems such as the EP engine structural support/frame, external heat rejection system, crew interfaces and control, and propellant storage can be at a lower TRL since these are either fairly well known, will be similar to existing space flight hardware, or are being developed separately.

The proposals shall provide a detailed technical approach for the design, analysis, fabrication, assembly and laboratory testing in a relevant environment of an operational High Power EP engine system. The proposals must also include the cost of any necessary support facilities development, modifications, and operations to test the engine in if NASA is expected to fund it. The proposals shall include what diagnostics will be performed. For example, measurements may include, but are not limited to: thrust, total input power, input voltage/current, propellant flow, thermal performance of the thruster and cooling system(s), coolant flow(s), facility pressure, overall thruster system efficiency, thruster component erosion, etc.

The proposals shall include the schedule for developing the High Power EP engine, all its supporting systems, and the test facility as well as operational testing up for a minimum of 100 hours at 100 kW. The proposals may consider lifetime use and repurposing of EP systems through in-space refueling or refurbishment of lifetime limited components.

Depending on the results from the initial development, NASA may decide to award a follow-on contract option for further development of the High Power EP system. A proposed statement-of-work for the further development option shall be developed during the initial development phase.

**Reporting Requirements:** The resultant contract awards will include the following nominal deliverable requirements with potential follow-on efforts to further improve the technology:

| Month  | Deliverable                                                                                                                                                     |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | Kickoff meeting at a TBD NASA Center or NASA Headquarters                                                                                                       |
| 6      | Technical Interchange & Status Meeting at winning Proposer's facility                                                                                           |
| 12     | Technical Interchange & Status Meeting at NASA Headquarters                                                                                                     |
| 18     | Technical Interchange & Status Meeting at winning Proposer's facility                                                                                           |
| 24     | Technical Interchange & Status Meeting at NASA Headquarters                                                                                                     |
| NLT 30 | Test Readiness Review for 100 hours at 100kW thermal steady state test at winning Proposer's facility                                                           |
| 36     | Final technical report and accompanying briefing at NASA Headquarters; Provide statement-of-work, schedule, and cost estimate for optional further development. |

## 2 Award Information

**Period of Performance:** NASA desires a nominal period of performance of three years but may award follow-on efforts for additional technology development up to 5 years total. The period of performance will be divided into multiple phases with no phase exceeding 12 months. The period of performance for the initial phase will start as of the authorization to proceed effective date.

**Award Date:** Award is anticipated on or about Feb, 2015. The price proposal should be based on this anticipated award date. **NASA may not make any awards to those selected until NASA receives the fiscal year 2015 appropriations or may choose to only award a portion of those selected and reserve the remaining awards pending the final appropriations for the fiscal year. Any reduced appropriations or continuing resolution may effect NASA's ability to award selected offerors.**

**Funding Allocation:** NASA anticipates individual award amounts between \$500K and \$4M per year across 1 to 3 potential multi-phased efforts in this thrust area not to exceed a 5 year period. Contracts shall be firm fixed price with milestone payments. NASA may select phases or the entire proposed effort. The Government's obligation to make awards is contingent upon the availability of appropriated funds from which payments can be made and the receipt of proposals that NASA determines are acceptable.

## 3 Eligible Participants

No change from umbrella BAA.

## 4 General Information

No change from umbrella BAA.

## 5 Instructions For Proposals

No change from umbrella BAA.

**6 Proposal Review Information**

No change from umbrella BAA.

## **APPENDIX B: Habitation Systems**

### **1 Funding Opportunity Description of Solicitation Topic**

#### **Description of Solicitation Topic:**

Orion is the first component of human exploration beyond low Earth orbit and will have a capability of sustaining a crew of 4 for 21 days in deep space and returning them safely to Earth. After Orion, the next step for human spaceflight is the development of capabilities to augment the Orion capsule, to initially sustain a crew of 4 for up to 60 days in cislunar space. These initial capabilities will be accomplished with the development of the Exploration Augmentation Module (EAM). The EAM will serve as a foundational component of a future in-space habitation capability and may include multiple elements as the architecture is further refined. In this capacity, the EAM is envisioned to augment planned cislunar missions for longer durations, improved habitation and broader cislunar environment human capabilities as well as provide the function of a proving ground for future systems in support of human exploration in deep space (beyond cislunar space). In addition, the EAM may be used to augment the Asteroid Redirect Mission (ARM) facilitating extensive sampling and In-situ Resource Utilization (ISRU) testing. The EAM, if pre-positioned at the Asteroid Return Vehicle (ARV) orbit, would provide additional habitable volume for logistics stowage and for the crew. Extra Vehicular Activity (EVA) and science equipment would be stowed on the EAM for use by the crew. The EAM will contain an airlock function to provide EVA capabilities. The initial EAM, an upgraded version, or a result of aggregation of multiple modules, might support in-space transit to the Mars vicinity or serve as a Mars vehicle assembly point. The EAM will be stationed at the Mars mission aggregation point (nominally the Lunar Distant Retrograde Orbit/DRO) and could serve as the initial aggregation node for the in-space stages and habitats as they are assembled into the mission stack. Initial EAM operations could occur in the early-mid 2020's timeframe.

The type of missions that could be supported by the initial delivery of the EAM include:

- Long Duration Exploration Systems Testing
- Automation, Tele-operations, and Robotics
- Human Assisted Sample Return
- In Situ Resource Utilization (ISRU) Demonstration Missions
- Human Research in Deep Space
- Logistics Support
- General Science

NASA is seeking proposers to provide concept studies, technology investigation and concepts of operations to help define the architecture or subsystems of an EAM design or the capabilities to enable extended habitation in a modular way that would gradually build up the capabilities for a deep space transit capability that will address areas of mutual interest by leveraging available capabilities.

This BAA solicits proposals for EAM concept studies, technology investigation and concepts of operations that address one or more of the objectives under the three (3) areas listed below:

### **Transportation**

Under Transportation, the concept studies could include the following elements:

- Include the flexibility to dock with the ISS for development, outfitting, and/or testing prior to use in the lunar vicinity such as in Distant Retrograde Orbit (DRO).
- Operate in lunar DRO by itself, with and without crew and in conjunction with any combination of the ARV, Orion and logistics resupply spacecraft.
- Provide for attitude control, power and thermal management
- Consider the potential of using the initial EAM element(s) for a Mars Transit Spacecraft

### **Habitation**

Under Habitation, the concept studies could include:

- Provide habitable volume for crew and logistics.
- Along with Orion, provide for an initial crew of four a stay of 30-60 days in DRO.
- Enhancements and testing of exploration Environmental Control and Life Support Systems (ECLSS), such as atmosphere revitalization and monitoring, water processing, lighting, and fire detection

### **Operations & Environment**

Under Operations and Environments, the concept studies could include:

- Have an operational lifetime in cislunar space of at least 10 years.
- Provide airlock capability for cislunar missions and operate as an independent spacecraft if other vehicles are not present.
- Have the facility to support two crew-members in conducting multiple 8 hour Extra-vehicular Activities (EVAs) without depress of the pressurized module or Orion.
- Support test and/or use options of exploration EVA capability and Airlock capability
- Have the ability to support visiting vehicles to dock (Orion, logistics resupply, Asteroid Redirect Vehicle, etc.)

Depending on the results from the initial studies, NASA may decide to award follow-on contract options for further development of a ground test article and physical mock-up and the manufacturing of the proposed subsystem or Protoflight EAM. A proposed statement-of-work for the further development option shall be developed during the initial study phase.

**Reporting Requirements:** The resultant contract awards will include at least the following nominal deliverable requirements:

| Month    | Deliverable                                                                                                                                                                             |
|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Mar 2015 | Kickoff meeting at a TBD NASA Center or NASA Headquarters                                                                                                                               |
| Jun 2015 | Technical Interchange & Status Meeting at winning Proposer's facility                                                                                                                   |
| Sep 2015 | Technical Interchange & Concept Review at NASA facility                                                                                                                                 |
| Nov 2015 | Technical Interchange & Status Meeting at Proposer's facility                                                                                                                           |
| Feb 2016 | Final Concept Studies, Concepts of operations, and accompanying briefing at NASA Headquarters; Provide statement-of-work, schedule, and cost estimate for optional further development. |

## 2 Award Information

**Period of Performance:** Period of performance for the contracts may be up to 5 years over multiple phases with no phase exceeding 12 months. The period of performance for the initial phase will start as of the authorization to proceed effective date.

**Award Date:** Award is anticipated on or about Feb, 2015. The price proposal should be based on this anticipated award date. **NASA may not make any awards to those selected until NASA receives the fiscal year 2015 appropriations or may choose to only award a portion of those selected and reserve the remaining awards pending the final appropriations for the fiscal year. Any reduced appropriations or continuing resolution may effect NASA's ability to award selected offerors.**

**Funding Allocation:** Individual award amounts up to \$500K – \$1M for the initial phase of efforts not to exceed a 12 month period. Contracts shall be firm fixed price with milestone payments. The Government's obligation to make awards is contingent upon the availability of appropriated funds from which payments can be made and the receipt of proposals that NASA determines are acceptable.

## 3 Eligible Participants

No change from umbrella BAA.

## 4 General Information

No change from umbrella BAA.

## 5 Instructions For Proposals

No change from umbrella BAA.

## 6 Proposal Review Information

No change from umbrella BAA.

## **APPENDIX C: Small Satellites Addressing Strategic Knowledge Gaps**

### **1 Funding Opportunity Description**

#### **Description of Solicitation Topic:**

The National Aeronautics and Space Administration (NASA) Human Exploration and Operations Mission Directorate (HEOMD) anticipates making launch opportunities for a limited number of small satellites available on Exploration Mission One (EM-1), currently planned for not earlier than late calendar year 2017. This BAA thrust area intends to provide integration and a launch opportunity for 6U CubeSat payloads as secondary payloads on EM-1.

A CubeSat is a type of space research nanosatellite. The base CubeSat dimension is 10x10x11 centimeters (one “Cube” or “1U”). CubeSats supported by this Launch Initiative include only 6U form factors. CubeSats of typically have a mass of 1.33 kilograms per 1U Cube. A 6U CubeSat typically has a mass of 12 kg. The maximum mass compatible with the EM-1 dispenser is 14 kg.

Through the Asteroid Redirect Mission (ARM) BAA (NNH14ZCQ002K), NASA is studying potential future commercial and international partnership opportunities for launch of secondary payloads on the ARM robotic spacecraft and its launch vehicle, in 2019 or later. Those payloads may address commercial interests such as asteroid resource prospecting, demonstration of planetary defense capabilities, or Strategic Knowledge Gaps (SKGs) for future human exploration. This BAA is not for missions to be included on the ARM robotic segment launch opportunity. This announcement is limited to only those to be launched on EM-1.

The SKGs represent the unknown environments or availability of resources at potential destinations that could impact the design of human spaceflight systems. NASA uses the SKGs to guide the planning of robotic precursor missions. The ARM BAA secondary payload concepts are focused on the SKGs relevant to Near Earth Asteroids (NEAs). This BAA seeks to sponsor payloads that potentially address the broader set of SKGs for the Moon and Mars and that could benefit from a launch on the EM-1 mission.

The SKGs can be found at: <http://www.nasa.gov/exploration/library/skg.html>.

The objectives of this thrust of the BAA are to select proposals for development and delivery of secondary payload missions for EM-1. There are no specific NASA mission requirements for the solicited payloads but they must address the SKGs. The EM-1 launch is the next opportunity to boost CubeSat payloads to cislunar space or beyond and provides a unique high value launch opportunity to enable science, technology demonstration, exploration, and commercial applications in deep space. It is anticipated that there could be significant commercial benefit from the use of this opportunity.

Proposals shall describe the secondary payload concept, the relevancy to commercial interests, SKGs, and the capabilities of the partner organization to provide space flight

hardware. The proposals shall also outline the approach for the development of the payload. NASA will work with selected partners to define interface requirements and payload accommodations on the primary vehicle.

**Reporting Requirements:** The resultant contract awards will include at least the following nominal deliverable requirements. The offeror shall include other technical milestones and deliverables in the proposal as instructed in section 5 of this BAA:

| Month    | Deliverable                                                           |
|----------|-----------------------------------------------------------------------|
| 1        | Kickoff meeting at a TBD location                                     |
| 6        | Technical Interchange & Status Meeting at winning Proposer's facility |
| 12       | Technical Interchange & Status Meeting at NASA Headquarters           |
| 18       | Technical Interchange & Status Meeting at winning Proposer's facility |
| 24       | Technical Interchange & Status Meeting at NASA Headquarters           |
|          | Test Readiness Review                                                 |
| Jun 2018 | Deliver flight payload to NASA for integration to EM-1 vehicle        |

## 2 Award Information

**Period of Performance:** Period of performance for the contracts may be up to 5 years over multiple phases including both development and operation of the payload. The period of performance for the initial phase will start as of the authorization to proceed effective date.

**Award Date:** Award is anticipated on or about Feb, 2015. The price proposal should be based on this anticipated award date. **NASA may not make any awards to those selected until NASA receives the fiscal year 2015 appropriations or may choose to only award a portion of those selected and reserve the remaining awards pending the final appropriations for the fiscal year. Any reduced appropriations or continuing resolution may effect NASA's ability to award selected offerors.**

**Funding Allocation:** NASA does not have a predetermined level of award amounts for these efforts. NASA expects high commercial benefits from these payloads and therefore does not expect significant levels of funding to be awarded. Contracts shall be firm fixed price with milestone payments. NASA's intent is to select respondents who will deliver a flight certified CubeSat payload compatible with the EM-1 vehicle and meeting the requirements specified above. The Government's obligation to make awards is contingent upon the availability of appropriated funds from which payments can be made and the receipt of proposals that NASA determines are acceptable.

## 3 Eligible Participants

No change from umbrella BAA.

## 4 General Information

No change from umbrella BAA.

## **5 Instructions For Proposals**

No change from umbrella BAA.

## **6 Proposal Review Information**

**Evaluation Criteria:** The proposals will be evaluated for the same three factors defined in the umbrella BAA, however for this thrust the third factor, Price, will place additional emphasis on corporate resources contributed to the development of the payload. The following criterion supersedes the criteria defined in the main body of this BAA:

**Price:** The Government will evaluate the overall price reasonableness of the firm fixed price to the Government. An analysis will be done on the corporate contribution to ensure that it properly aligned with the proposed effort. A proposal will be assessed with a more favorable score in this evaluation factor for higher levels of corporate resource contributions.

## APPENDIX D: Price Proposal Format

| FIRM FIXED PRICE                                                         |                      |          |
|--------------------------------------------------------------------------|----------------------|----------|
| ELEMENTS                                                                 |                      | 6 months |
| <b>Direct Labor Price from Labor Template</b>                            |                      | \$ -     |
| <b>Overhead (List)</b>                                                   |                      |          |
| 1. (Name & Description of Base)                                          | Overhead Rate        | 0.00%    |
|                                                                          | Overhead Price       | \$ -     |
| 2. (Name & Description of Base)                                          | Overhead Rate        | 0.00%    |
|                                                                          | Overhead Price       | \$ -     |
| <b>Total Overhead Price</b>                                              |                      | \$ -     |
| <b>Subcontract Price</b>                                                 |                      |          |
| 1. (Subcontractor Name);(provide detailed description of work proposed)  |                      | \$ -     |
| 2. (Subcontractor Name); (provide detailed description of work proposed) |                      | \$ -     |
| <b>Total Subcontract Price</b>                                           |                      | \$ -     |
| <b>'Other Direct Costs (ODCs)'</b>                                       |                      |          |
| 1. ODCs from ODC Breakdown Section (following page)                      |                      | \$ -     |
| 2. Travel (provide separate breakdown of proposed travel price)          |                      | \$ -     |
| 3. Other ODCs; (provide description)                                     |                      | \$ -     |
| <b>Total Price for Other Direct Costs</b>                                |                      | \$ -     |
| <b>G&amp;A Price</b>                                                     |                      |          |
| 1. (Description of G&A Base)                                             | G&A Rate             | 0.00%    |
|                                                                          | <b>G&amp;A Price</b> | \$ -     |
|                                                                          | <b>Subtotal</b>      | \$ -     |
| 1. (Description of Profit Base)                                          | Profit Rate          | 0.00%    |
|                                                                          | <b>Profit</b>        | \$ -     |
| <b>Total Price</b>                                                       |                      | \$ -     |

| LABOR PRICE BREAKDOWN              |          |             |             |             |
|------------------------------------|----------|-------------|-------------|-------------|
| Labor Category Name                | WYEs     | Labor Hours | Labor Rate  | Labor Price |
|                                    | 0.00     | 0.00        | \$0.00      | \$0.00      |
|                                    | 0.00     | 0.00        | \$0.00      | \$0.00      |
|                                    | 0.00     | 0.00        | \$0.00      | \$0.00      |
|                                    | 0.00     | 0.00        | \$0.00      | \$0.00      |
|                                    | 0.00     | 0.00        | \$0.00      | \$0.00      |
|                                    | 0.00     | 0.00        | \$0.00      | \$0.00      |
|                                    | 0.00     | 0.00        | \$0.00      | \$0.00      |
|                                    | 0.00     | 0.00        | \$0.00      | \$0.00      |
|                                    | 0.00     | 0.00        | \$0.00      | \$0.00      |
|                                    | 0.00     | 0.00        | \$0.00      | \$0.00      |
|                                    | 0.00     | 0.00        | \$0.00      | \$0.00      |
|                                    | 0.00     | 0.00        | \$0.00      | \$0.00      |
|                                    | 0.00     | 0.00        | \$0.00      | \$0.00      |
|                                    | 0.00     | 0.00        |             | \$0.00      |
|                                    |          |             |             |             |
|                                    |          |             |             |             |
|                                    |          |             |             |             |
| OTHER DIRECT COSTS PRICE BREAKDOWN |          |             |             |             |
| Item Name & Description            | Quantity | Unit Price  | Total Price |             |
|                                    | 0.00     | 0.00        | \$0.00      |             |
|                                    | 0.00     | 0.00        | \$0.00      |             |
|                                    | 0.00     | 0.00        | \$0.00      |             |
|                                    | 0.00     | 0.00        | \$0.00      |             |
|                                    | 0.00     | 0.00        | \$0.00      |             |
|                                    | 0.00     | 0.00        | \$0.00      |             |
|                                    | 0.00     | 0.00        | \$0.00      |             |
|                                    | 0.00     | 0.00        | \$0.00      |             |
|                                    | 0.00     | 0.00        | \$0.00      |             |
|                                    | 0.00     | 0.00        | \$0.00      |             |
|                                    | 0.00     | 0.00        | \$0.00      |             |
|                                    | 0.00     | 0.00        | \$0.00      |             |
|                                    |          |             | \$0.00      |             |