National Space Grant Foundation

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eXploration Systems and Habitation (X-Hab) Academic Innovation Challenge – FY19 Solicitation

on behalf of

NASA Headquarters
Human Exploration & Operations Mission Directorate

Sponsored by:

The Advanced Exploration Systems (AES) Division

Release Date: February 14, 2018
Proposals Due: April 27, 2018
Anticipated Award Date: May 25, 2018
Program Website: https://www.spacegrant.org/xhab/

X-Hab 2019 Academic Innovation Challenge Solicitation

1. Funding Opportunity Description - Synopsis

The eXploration Systems and Habitation (X-Hab) 2019 Academic Innovation Challenge is a university-level challenge designed to develop strategic partnerships and collaborations with universities. It has been organized to help bridge strategic knowledge gaps and increase knowledge in capabilities and technology risk reduction related to NASA's vision and missions. *In 2016, the X-Hab Challenge scope was formally extended to include other areas of Exploration Systems as well as habitation topics*. The competition is intended to link with senior- and graduate-level design curricula that emphasize hands-on design, research, development, and manufacturing of functional prototypical subsystems that enable functionality for space habitats and deep space exploration missions. NASA will directly benefit from the challenge by sponsoring the development of innovative concepts and technologies from universities, which will result in novel ideas and solutions that could be applied to exploration.

The Advanced Exploration Systems (AES) Division will offer multiple awards of $15k - $50k each to design and produce studies or functional products of interest to the AES Division (see Section 3.2, *X-Hab Proposal Topic List*) as proposed by university teams according to their interests and expertise. The prototypes produced by the university teams (examples of which are shown in Figure 1) may be integrated into existing NASA-built operational prototypes. Universities interested in participating will submit X-Hab proposals, which will be reviewed by technical experts; subsequent down-selection will determine which projects will be funded. X-Hab university teams will be required to complete their products for evaluation by the AES Division in May 2019. Universities may form collaborations to perform as a single distributed project team.

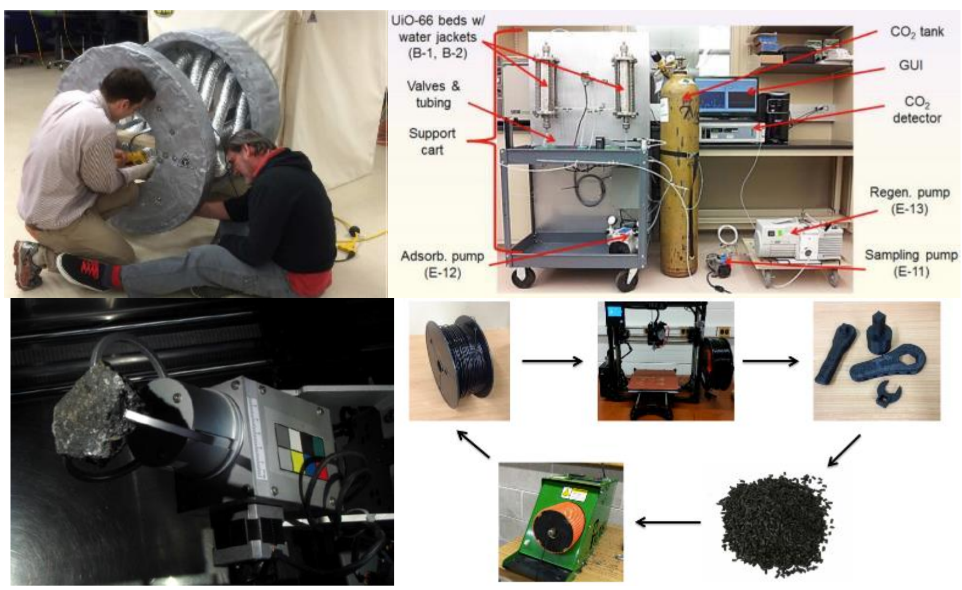

Figure 1: Previous X-Hab Projects (from top left, clockwise): Deployable Airlock, Closed Environment Air Revitalization System Based on Metal Organic Framework Adsorbents, Carbon-fiber/Fused Deposition Modeling Spacecraft Structural Fabrication System, Sample Handling System for GeoLab Glovebox (Image credit: NASA).

Students in the Critical Path: The X-Hab Academic Innovation Challenge has a unique approach to student involvement, in that the student team is placed in the NASA mission critical path for the product or technology that they develop alongside NASA researchers. Teams are required to go through a series of NASA-standard assessments as other NASA engineering products, including a System Definition Review (SDR), a Preliminary Design Review (PDR), and a Critical Design Review (CDR). With this approach, NASA is putting a great deal of responsibility on the students. This in turn gives the students a bigger stake in the development of space technologies that likely will form the basis for future systems and technologies that will be flown in space.

2. Eligibility

Proposals will be accepted from faculty who are U.S. citizens and currently teach an Accreditation Board for Engineering and Technology (ABET)-accredited engineering senior or graduate design, industrial design, or architecture curriculum teaming course at a university affiliated with the National Space Grant College and Fellowship Program, or other US accredited university. Multidisciplinary, multidepartmental, and/or multi-institutional teaming collaborations are highly encouraged.

Historically Black Colleges and Universities, Tribal Colleges, and other minority-serving educational institutions are particularly encouraged to apply. Proposals from women, members of underrepresented minorities groups, and persons with disabilities are highly encouraged.

In order to fully comply with the United States Department of Commerce, Bureau of Industry and Security (BIS) Export Administration Regulations (EAR), *participation in the X-Hab program by citizens of controlled countries, as defined in Part 768.1.d is prohibited*. This restriction applies to all faculty members, staff, students, consultants, and any other individual that participates in the X-Hab program. For the current “Controlled Countries” list, reference EAR Part 768.1d

3. Funding Opportunity Description - Details

3.1 Description

NASA’s multicenter AES Division is requesting proposals for the eXploration Systems and Habitation (X-Hab) 2019 Academic Innovation Challenge. The X-Hab Challenge is a university-based challenge to provide real world, hands-on design, research and development opportunities to university teams. Teams will design, manufacture, assemble, test, and demonstrate functional prototypical subsystems and innovations that enable increased functionality for human space exploration missions. The projects and products of the challenge will be evaluated by NASA subject matter experts currently working in the topic area and may be integrated into prototypes for the purpose of operational and functional evaluation opportunities. Alternatively, the products of the challenge may be used in other NASA studies or analyses of exploration architectures. In previous X-Hab rounds, products have been tested and evaluated at NASA’s Johnson Space Center (JSC), Marshall Space Flight Center (MSFC), Kennedy Space Center (KSC), NASA’s Desert Research and Technology Studies (D-RATS) analog field tests, and school campuses. The products and technologies produced by the universities for the X-Hab 2019 challenge will be improved upon for next-generation exploration systems, and may eventually provide the basis for future flight demonstrations and exploration missions.

NASA's AES Division is inviting university faculty who teach design courses to submit proposals for a two-semester design course based on a topic that is congruent with the faculty members' interests and the topic list provided in Section 3.2. Design projects are intended to stimulate undergraduate and graduate research on current NASA exploration activities and to bring forth innovative ideas that can be used to complement those currently under development at NASA field centers. Additionally, such academic involvement will provide a hands-on space systems project development experience to enhance the scientific, technical, leadership, and project management and participation skills for the selected student teams, thereby improving the prospects for graduates to pursue additional studies and to seek careers in the space industry. The design courses should be related to existing or planned exploration systems and missions.

The selected project teams will implement the design course during the fall 2018 and spring 2019 semesters. Applicants are required to apply a systems engineering approach in the design course. For reference, please see the NASA Systems Engineering Handbook NASA SP-2007-6105. Further, all teams must provide proof that the course has been approved to be taught at their institution and the selected professor must be available for technical assistance to the implementing university team in 2018-2019 academic year.

NASA understands that the funding awarded to manufacture some test articles may not be sufficient; thus, NASA may require teams to obtain supplemental sponsored or leveraged funding from university sources or industry partners in order to design, manufacture, assemble, test, and demonstrate a functional and operational test article. Any savings from reducing or waiving overhead costs at universities may count as leveraged funding in the proposals. Additionally, the supplemental funding may enable the teams to enhance the quality or scope of the proposed work. As part of this solicitation, universities are encouraged to seek additional, innovative sponsorships and collaborations (project teaming) with other universities and organizations (including institutional support, industry, space grant consortia, etc.) to meet the design requirements and test objectives. Each proposal must include a signed letter of commitment from the university faculty, collaborators, and their potential sponsor(s) to ensure their commitment to the project.

The following project review milestones will take place with participation from the NASA Project Team, for the awarded university projects (dates are approximate):

- 09 Oct 2018 – Requirements and System Definition Review (SDR)
- 13 Nov 2018 – Preliminary Design Review (PDR)
- 22 Jan 2019 – Critical Design Review (CDR)
- 12 March 2019 – Progress Checkpoint Review
- 07 May 2019 – Project Completion and Evaluation by NASA

Additional information on the listed reviews is found in Appendix E: *NASA Review Requirements and Checklists*

Interactions with NASA personnel are not limited to these meetings. Additional meetings for more technical interchange can be requested by the teams but are not required as a milestone.

3.2 X-Hab Proposal Topic List

Proposals addressing the following topics will be given priority consideration. Proposals that address other areas in direct support of the Advanced Exploration Systems Division will also be considered. Detailed topic descriptions are located in Appendix B.

Project Sponsor: *Advanced Exploration Systems Program*

- Project Title: *Inflatable/Deployable Crew-lock to Enhance Lunar Orbital Platform – Gateway Ground Test and Evaluation*

Project Sponsor: *AES In-Space Manufacturing (ISM) Project*

- Project Title: *Development of Novel Feedstocks for in-space Manufacturing Applications*

Project Sponsor: *AES Logistics Reduction Project*

- Project Title: *Deep Freeze for Deep Space: Passive Cold Food Storage*

Project Sponsor: *Human Research Program*

- Project Title: *Exploration Medical Architectural Design & Habitat Integration*

Project Sponsor: *Space Life and Physical Sciences*

- Project Title: *Autonomous Space Biology at the Lunar Orbital Platform - Gateway*

Project Sponsor: *AES Life Support Project*

- Project Title: *Computer Modeling of Spacecraft Temperature Swing Compressor and Storage System*
- Project Title: *Implement advanced sorbents such as supported-amine mesoporous silicas, metal organic frameworks (MOFs), and/or ionic liquids (ILs) in a CO_2 management unit*
- Project Title: *Self-cleaning membrane unit for long-duration Environmental Control and Life Support (ECLS)*

For reference information on the sponsoring projects at NASA, please refer to the NASA Techport database at http://techport.nasa.gov.

For specific Advanced Exploration Systems projects, visit here

For additional information on Space Life and Physical Sciences, visit here

3.3 Academic Innovation Challenge Background and Purpose

This announcement maps to NASA Strategic Plan Objective 2.3*: Optimize Agency technology investments, foster open innovation and facilitate technology infusion, ensuring the greatest national benefit.* NASA is dedicated to creating a capability-driven approach to technology and foundational research that enables sustained and affordable off-Earth human and robotic exploration. NASA has a long history of working with universities in pursuit of joint-interest research and technology development efforts. Drawing on talent from industry and academia, NASA delivers innovative solutions that dramatically improve technological capabilities for its missions, thereby benefiting the nation and humankind. Using innovative approaches to problem solving—such as challenges and collaborations—NASA seeks to stimulate innovators, thereby creating diverse pools of problem solvers that address NASA problems and advance technology development in a flexible way for technological breakthroughs.

The AES Division has five main objectives for the Academic Challenge:

1. Teams will learn by putting into practice the knowledge and skills they have gained throughout their years at their respective universities.
2. Teams will analyze and solve complex design and integration issues from an interdisciplinary perspective, exercising their innovation skills and initiative as they deal with conflicting requirements and make appropriate trade-offs.
3. Teams will develop skills in project planning, teamwork, leadership, critical thinking, and decision-making in an academic environment, but with an eye toward integration with NASA activities.
4. Teams will produce a test article and a final report that will be made widely available to space agencies, aerospace companies, and universities.
5. Teams' support under this program will adhere to NASA's commitments in its *Strategic Plan* to "maintain strong partnerships with academia" and to "engage and inspire students."

Pursuant to these objectives, NASA's AES Division focuses on advanced design, development, and demonstration of exploration capabilities to reduce risk, lower life cycle cost and validate operational concepts for future human missions to deep space. AES leads development of new approaches to project and engineering management, such as rapid systems development or alternative management concepts, open innovation, and collaboration. Specifically, AES Division activities are uniquely related to crew safety and mission operations in deep space, and are strongly coupled to future vehicle development. The activities fall under five primary domain areas: Crew Mobility Systems, Habitation Systems, Vehicle Systems, Foundational Systems, and Robotic Precursor Activities. NASA is also extending human presence deeper into space starting with the Moon for long-term exploration and utilization by first establishing a Lunar Orbital Platform -Gateway in cislunar space. The purpose of the X-Hab Academic Innovation Challenge is to leverage funding, capabilities, and expertise within and outside of NASA to overcome technology barriers and advance technology in these areas. Each of the topic areas is summarized below:

Crew Mobility Systems

Systems to enable the crew to conduct "hands-on" surface exploration and in-space operations, including portable life support systems, and extravehicular activity tools.

Habitation Systems

Habitation systems provide a safe place for astronauts to live and work in space and on planetary surfaces. They enable crews to live and work safely in deep space, and include integrated life support systems, radiation protection, fire safety, and systems to reduce logistics and the need for resupply missions.

Vehicle Systems

Vehicle systems include human and robotic exploration vehicles, including advanced in-space propulsion, extensible lander technology, modular power systems, and automated propellant loading on the ground and on planetary surfaces.

Foundational Systems

Foundational systems provide more efficient mission and ground operations and those that allow for more earth independence. These systems foster autonomous mission operations, *in situ* resource utilization, in-space manufacturing, communication technologies, and synthetic biology applications.

Robotic Precursor Activities

Robotic missions and payloads acquire strategic knowledge about potential destinations for human exploration. They inform systems development, including prospecting for lunar ice, characterizing the Mars surface radiation environment, radar imaging of near-Earth asteroids, instrument development, and research and analysis.

Lunar Orbital Platform – Gateway (Gateway)

Gateway will establish a platform to mature necessary short- and long-duration deep space exploration capabilities through the 2020s. The Gateway will be assembled in orbit around the Moon where it can also be used as a staging point for missions to the lunar surface and to destinations in deep space, providing a flexible human exploration architecture. Gateway can be evolved depending on mission needs (exploration, science, commercial and international partners), as there are various concepts for its configuration. Current analysis is that the initial functionality will include four main elements: a Power and Propulsion Element (PPE), a small habitation element, airlock element(s) to enable Extra-Vehicular Activities (EVA), utilization, and required logistics element(s).

3.4 Online Technical Interchange Forum

Prior to the proposal submission deadline, an online Technical Interchange will be posted for NASA AES Division representatives to answer questions about the project. Questions pertaining to this effort shall be submitted to xhab@spacegrant.org no less than four days prior to the deadline to have them included in the response. Answers will be published on the solicitation website.

Schedule:

Questions are due by April 3, 2018.
Responses will be posted on April 10, 2018

3.5 Pertinent Dates

Proposal Phase

14 Feb	2018	Date of Announcement and Release of RFP
03 Apr	2018	Questions for online Technical Interchange due
10 Apr	2018	Responses to submitted questions published online
27 April	2018	Proposal due
25 May	2018	Award announcements

Award Phase

Summer - Fall 2018	Design phase
Sept 2018	Kickoff meetings
09 Oct 2018	Requirements and System Definition Review
13 Nov 2018	Preliminary Design Review
22 Jan 2019	Critical Design Review
12 March 2019	Progress Checkpoint Review
07 May 2019	Project Completion and Evaluation by NASA

3.6 Documentation and Deliverables

3.6.1 Project Documentation

For successful project completion, award recipients will provide the following deliverables:

1. Work Plan and Implementation Schedule by the SDR. milestone
2. Participation in Milestone Progress Reviews (WebEx and telecon) through the project execution
3. Report on Educational Outreach activity prior to Project Completion
4. Demonstration articles for X-Hab developmental studies prior to Project Completion
5. Technical Final Report prior to Project Completion. Universities must comply with the U.S. export requirements by submitting their final presentation/report to their University Export Control Office (ECO) for review prior to submission to NASA. If it is determined that export controls do not apply to the final presentation/report, the ECO will note the outcome and recommend that the final presentation/report be approved/accepted. A Scientific and Technical Information/Document Availability Authorization (STI/DAA) form NG1676B using the NASA Electronic Forms site (https://nef.nasa.gov/) should be

prepared for the final report submission to formally archive the final report for the NASA project sponsor.

3.6.2 Formal Review Activities and Requirements

As noted elsewhere, submitted projects will undergo formal NASA review and assessment. Descriptions of the individual review components, their purposes, and checklists to help teams prepare for the reviews are found in Appendix E: *NASA Review Requirements and Checklists.*

3.7 Period of Performance

The period of performance for this award will be August 1, 2018, to May 31, 2019. The contract for the awarded teams may be extended to facilitate participation in testing as appropriate.

3.8 Facilities and Equipment

Facilities and equipment needed to conduct this X-Hab 2019 Academic Innovation Challenge are the responsibility of the proposing project team and respective universities. No unique facilities, U.S. Government-owned facilities, industrial plant equipment, or special tooling is required.

4. Proposal and Submission Information

4.1 Proposal Format and Content

Proposals should be single-spaced, formatted to fit on standard 8½" x11" paper, no smaller than 12-point font, with one-inch margins throughout. All proposals must be prepared in the following sequence of sections:

A. **Title Page** (not included in the page count) - Title of the X-Hab 2019 Academic Innovation Challenge project, university name, name and contact information of proposing faculty member(s) (address, university affiliation, email address, and phone number), and the local Space Grant Consortium faculty affiliation (if applicable).
B. **Body of Proposal** (12 pages maximum)
   - *Proposal Synopsis* – Description of the X-Hab 2019 Academic Innovation Challenge work plan, design challenge to the students, and scope of the proposed effort.
   - *Significance* – Description of the need and relevance of the proposed design project for NASA, and how this course will benefit the university.
   - *Content* – Description of the course outline, framework, and the faculty outline. Applicants should describe the involvement of appropriate computer-aided tools in their design and analysis solutions. Applicants should describe how a systems engineering process will be applied. Applicants should propose a preliminary notional concept for the proposed study or test article with the understanding that the design should occur during the fall semester.
   - *Administration* – Description of project administration approach including the facilitation of cross-campus or other partnership collaborative efforts.
   - *Mechanisms for Integration* – Description of how the X-Hab prototype will be integrated and tested at the affiliated university in the 2018-19 academic year.

Describe how the X-Hab work will be performed during regular courses. Describe the feasibility of implementing the project team with other universities, if applicable.
- *Diversity* – Demonstrate efforts to attract a diverse group of student participants, including underrepresented and underserved minorities, women, and students with disabilities, along with multiple academic disciplines. Some applicable disciplines include engineering, industrial design, and architecture curricula.
- *Educational Outreach Plan* – Provide a plan to engage K-12 students from the local community though presentations, team involvement, mentoring, etc. Note that NASA also has public relations specialists that will be available for assistance.
- *Assessment Plan* – Provide a plan that describes the evaluation approach for the design course, lessons learned, and potential impacts.
- *Past Performance* – Demonstrate successful implementation of design courses that have met ABET quality standards. Demonstrate experience with a systems engineering process.
- *Resources (Sponsors)* – Include sponsorships, leveraging opportunities, unique capabilities, matching funds, and in-kind support. Also may include collaborations with other universities.

C. **Schedule** (not included in the page count) – Present a one-page overview of the proposed schedule. This should include the deliverables, expected dates of tangible outcomes, travel dates, and date of final report to NASA.

D. **Budget** (not included in the page count) –Note that total requested NASA funding cannot exceed the funding level associated with the project title. Specific information should be given for salary, detailed expenses for supplies and materials for the course and for the project, and expenses for workshops and travel. Specific information should be given pertaining to supplemental funding by sponsors.

E. **Collaboration** – Showing estimated expenditures. Reduction or full waiver of indirect costs are encouraged and may be considered to be a university contribution to the project.

F. **Appendix** (not included in the page count):
- *Mandatory* – Confirmation of support for the proposal must include signed documents from the university faculty, collaborators, and their potential sponsor(s) to ensure their respective commitment to the project.
- *Mandatory* – Include a signed confirmation from the university, stating that the X-Hab 2019 Academic Innovation Challenge will be implemented during the 2018-2019 academic year and will comply with all pedagogical requirements.

4.2 Proposal Evaluation Criteria

The X-Hab Challenge is divided into two phases. Phase 1 solicits proposals that will be evaluated for selection and Phase 2 is the project execution of the selected teams, the actual challenge. Both phases will be evaluated based on appropriate predetermined evaluation criteria.

Phase 1 Evaluation Criteria

The following criteria will be used in the Phase 1 proposal evaluation process:

Logistics
- Identify project title.
- Identify project team.

- Identify the principal investigator (PI).
- Identify a vision, mission, and concept of operations.
- Identify the problem statement, functional and performance requirements.
- Identify a work plan, integration testing plan, milestone schedule, and experience.
- Identify faculty institution and provide confirmation of commitment in appendix.
- Identify a research assistant to provide leadership to the student project team (optional).
- Identify affiliated Space Grant Consortium (if applicable), sponsor, or affiliations.
- Identify NASA technical expert and provide signed statement of commitment in Appendix (optional).
- Identify manufacturing, assembly, and pretesting capabilities and facilities.
- Identify a preliminary notional concept of the demonstration article, with the understanding the final design will occur during the fall semester.

Merit

- Demonstrate alignment with NASA Human Exploration and Operations Mission Directorate objectives.
- Describe work plan to implement and integrate project into university activities.
- Demonstrate alignment with ABET quality standards.
- Include systems engineering process in the course.
- Include appropriate computer-aided design and analysis tools in the course.
- Provide evidence of past performance of design courses that meet ABET quality standards.
- Provide feasibility of project teaming implementation with other universities.

Contribution to NASA Strategic Goals

- **Content:** Demonstrate ability to develop a meaningful, challenging, realistic hands-on Human Exploration and Operations Mission Directorate-relevant design project.
- **Continuity:** Demonstrate ability to create interest within NASA while connecting and preparing students for the workforce.
- **Diversity:** Demonstrate effort to attract a diverse group of student participants, including underrepresented and underserved minorities, women, and students with disabilities, along with multiple academic disciplines. Disciplines could include (but are not limited to) engineering, industrial design, and architecture curricula.
- **Education Outreach:** Demonstrate efforts to engage K-12 students in the local community.
- **Evaluation:** Provide assessment plan, including appropriate quantitative metrics and qualitative outcomes.
- **Budget:** Provide adequate, appropriate, reasonable, and realistic budget.

4.3 Proposal Submission

Electronic copies of proposals must be received no later than **midnight, Pacific Daylight Time, Friday, 27 April 2018**. *Late proposals will not be considered.* The proposal will be submitted online at https://spacegrant.net/proposals/xhab/

Applicants will be advised by electronic mail when selections are made. It is anticipated that the award will be announced on 25 May 2018.

Appendix A: Budget Summary

From ________________ To __________________ *(performance period)*

	Funds Requested from Sponsor	Proposed Cost Sharing (if any)
1. Direct Labor	$ _______________	________________
2. Other Direct Costs:		
a. Subcontracts	$ _______________	________________
b. Consultants	$ _______________	________________
c. Equipment	$ _______________	________________
d. Supplies	$ _______________	________________
e. Travel	$ _______________	________________
f. Other	$ _______________	________________
3. Indirect Costs	$ _______________	________________
4. Other Applicable Costs	$ _______________	________________
5. Total	$ _______________	________________
6. Total Estimated Costs	$ _______________	

Budget Narrative

If the proposal contains cost sharing separate budget narratives should be included for the funds requested from the sponsor and the proposed cost sharing.

1. **Direct Labor** (salaries, wages, and fringe benefits): List numbers and titles of personnel, number of hours to be devoted to the grant, and rates of pay.

2. **Other Direct Costs**:
   a. **Subcontracts** - Describe the work to be subcontracted, estimated amount, recipient (if known), and the reason for subcontracting this effort.
   b. **Consultants** - Identify consultants to be used, why they are necessary, the number of hours they will spend on the project, and rates of pay (not to exceed the equivalent of the daily rate for Level IV of the Executive Schedule, exclusive of expenses and indirect costs.)
   c. **Equipment** - List separately and explain the need for items costing more than $1,000. Describe basis for estimated cost. General-purpose equipment is not allowable as a direct cost unless specifically approved by the sponsor.
   d. **Supplies** - Provide general categories of needed supplies (*e.g.,* office supplies, lab supplies, etc.), the method of acquisition, and estimated cost.
   e. **Travel** - List proposed trips individually and describe their purpose in relation to the award. Also provide dates, destination, and number of people where known. Include where appropriate airfare, hotel, per diem, registration fees, car rental, etc.)
   f. **Other** - Enter the total direct costs not covered by 2.a through 2.e. Attach an itemized list explaining the need for each item and the basis for the estimate.

3. **Indirect Costs** - Since the project is related to academic course work and not research, the indirect cost rate should not exceed your university's negotiated rate for that category. Waived indirect cost is encouraged.

4. **Other Applicable Costs** - Enter the total of other applicable costs with an itemized list explaining the need for each item and basis for the estimate.

5. **Total –** The sum of lines 1 through 4.

6. **Total Estimated Costs –** The sum of the funds requested from the sponsor and the proposed cost sharing (if any).

Appendix B: X-Hab Topic Details

Project Sponsor: AES, Gateway, Transport Activity
Funded by NASA's Advanced Exploration Systems (AES) Lunar Orbital Platform - Gateway (Gateway) and Transport Activity.
https://www.nasa.gov/directorates/heo/aes/index.html

NASA's proposed Gateway will serve as a key asset to enable future human exploration. Astronauts will visit the Gateway in cis-Lunar space and utilize the facility to demonstrate new exploration capabilities, to conduct innovative science, and to learn how to live and operate for extended periods in deep space. NASA is currently planning a series of ground test activities to evaluate the functionality of proposed NASA and commercial Gateway concepts. These activities will include simulated operations, in which crews will conduct mission activities using analog elements that represent the planned Gateway elements. These tests will measure the efficiency and effectiveness of various Gateway concepts and ultimately provide information to refine the design. https://www.nasa.gov/nextstep

Project Title: Inflatable/Deployable Crew-lock to Enhance Gateway Ground Test and Evaluation

Scope of the challenge:
Inflatable/deployable structures are being researched at NASA and in industry to provide habitable modules for future space exploration missions. One of the proposed Gateway elements is an inflatable crew-lock, which allows crew to egress from a pressurized to an unpressurized environment. This project seeks the design, fabrication and delivery of a full-scale, low-pressure (0.1-0.5 psig) inflatable/deployable crew-lock structure that demonstrates the volume, operation and outfitting of a crew-lock for use in NASA Gateway ground test efforts. Note that an equipment lock is not included or desired for this call.

Description:
In order to support extravehicular activities (EVAs) for vehicle repairs or deployment of external hardware on the Gateway (and other future vehicles), a crew-lock is necessary to allow crew to transition from the atmospheric pressure in their habitat to the vacuum of space. As part of the upcoming ground demonstration of the Gateway, an analog simulating a 2-person inflatable / deployable crew-lock is desired to facilitate mission simulation activities. The concept should consider and address the following key areas:

- Foldability and deployability (controlled deployment)
- Erectable/deployable internal/external structure to maintain geometry when depressed
- Hatch integration
- IVA/EVA handrails that are stowable with the crew-lock but provide enough stiffness to react astronaut loads and torques for maneuvering.
- Internal/External attachment points for equipment, crew tethers, and outfitting.
- Simulates typical outfitting and systems (functional analogs preferred)
- Robust enough for extended simulation activities
- Concept of operations and human factors design

Expected Product (delivery item/concept):

A. Deliver a design briefing and report describing the crew-lock design and operation. Should detail the structural design, with analytical results and computer-aided design (CAD) drawings, required subsystem hardware, mass properties, a leakage rate assessment, details of the interface with the habitat, and be sufficient to prove engineering feasibility.

Designs should meet NASA-defined packaged and deployed volume, mass, power, and dimensional constraints.

B. Deliver a full-scale, crew-lock analog to NASA Johnson Spaceflight Center (JSC) (funding should be reserved in the project for this travel and shipping), which can be deployed and used in Gateway ground test simulations. Analog crew-lock will meet basic safety requirements specified by JSC facility managers to be placed in NASA custody to support test operations.

Expected Result (knowledge gained):
The project sponsors will gain a demonstration analog of a crew-lock, which will add to the fidelity and value of mission simulation activities. Additionally, sponsors will learn from novel design approaches to improve requirement sets for future crew-lock designs.

Relevance to Exploration:
Development of an inflatable/deployable crew-lock is directly applicable and relevant to NASA's human exploration plans for the Gateway as defined by the AES division within HEOMD. Specifically, this element allows for manifesting of an EVA capability with launch of a separate crew-lock structure and has currently been proposed by commercial partners. The technology for inflatables and EVA capabilities are found in TA12: Materials, Structures, Mechanical Systems, and Manufacturing and TA06: Human Health, Life Support, and Habitation Systems, respectively. Technology Readiness level for such a system is a 5 or 6.

Level of Effort for student team:
Space vehicle design and analysis, pressure vessel design, mechanisms, CAD, basic fabrication including soft good structures, human factors analysis, and a turnover data package will be required of student teams. A multi-disciplinary team may be required.

Level of effort for NASA team:
NASA project mentors will be supplied by the AES Gateway; specifically, NextSTEP and LaRC/JSC inflatable structures program staff. NASA will provide detailed requirements and discipline expertise in habitation element design, structures, life support, EVA, and human factors. NASA will also provide safety and ground testing support to teams.

Suggestion for seed funding:
$50k (including delivery of article and team travel). Proposers are encouraged to seek additional funding from their institutions, industry, space grant consortiums, and others.

Project Sponsor: AES In-Space Manufacturing (ISM) Project
https://www.nasa.gov/content/aes-domains

Project Title: Development of Novel Feedstocks for in-space Manufacturing Applications

Scope of the Challenge:
Development of recyclable and/or regolith-based feedstocks for in-space manufacturing fused filament fabrication processes

Description:
The in-space manufacturing (ISM) project at NASA Marshall Space Flight Center seeks to develop the processes, skills, and certification framework to provide an on-demand manufacturing capability for long duration exploration missions. The ISM project currently makes use of two fused filament fabrication systems on ISS: the 3D Printing in Zero-G technology demonstration mission printer and the Additive Manufacturing Facility (AMF), a commercial facility developed and operated by Made in Space. An integrated fused filament fabrication (FFF) printer and recycler, the Refabricator developed by Tethers Unlimited, is expected to be operational on the International Space Station in late 2018. Currently there is a substantial gap between the properties of the thermoplastics commonly used in FFF 3D printing systems and the aerospace metals traditionally used in critical space systems. Although FFF processes are strongly compatible with operation in the microgravity environment and within ISS volume, power, and safety constraints, their material envelope is currently limited to thermoplastic materials which are not comparable to aerospace metals in terms of strength or fatigue. The existence of this material gap makes it difficult to fully use these capabilities to produce parts for sparing and repair of critical systems. This project will focus on the development of higher strength feedstocks compatible with the FFF process. Emphasis will be given to development of feedstocks, which incorporate simulants of planetary in-situ materials (such as regolith), and/or materials that would otherwise represent nuisance/discarded materials on space missions. Materials produced under this effort must be in the form of filament feedstock and compatible with standard FFF systems. Post-processing or heat treatment techniques developed to strengthen the material must be adaptable to the microgravity environment of ISS and must preserve the characteristic dimensions of the part to the greatest extent possible.

Expected Product (delivery item/concept):
As part of this project, teams should develop and demonstrate the use of feedstocks, which will narrow the gap between the properties of materials, produced using FFF techniques and conventional metals. Teams must perform materials characterization activities throughout the course of the project, including mapping of feedstock processing/manufacturing conditions to material outcomes and a robust assessment of the properties of parts and coupons manufactured using the developed feedstocks. Teams must also provide capability demonstration coupons or “challenge builds” of parts that represent a sparing or palliative repair scenario. These will be defined during the project and may also be tested at the component level.

Desired properties for feedstocks are tensile strength of at least 200 MPa, specific strength of at least 100 kN-m/kg, Poisson's ratio of 0.20-0.45, and fracture toughness of at least 5 MPa/m$^{1/2.}$

Expected Result (knowledge gained):
Outcomes of this work are:

- Development and implementation of new materials in FFF systems that represent a significant improvement over current material options
- Materials testing and characterization to quantify material improvement over traditional FFF techniques or FFF manufactured material in the as-built condition
- Capability demonstration coupons made with developed material(s)
- Proposed design approach for integrating methods developed into current or future ISM payloads for FFF as well as ground based machines and processes

Relevance to Exploration:
This project focuses on expanding the material envelope for FFF systems. This process is readily compatible with systems on the ISS, but its applicability for critical space systems and repair scenarios is limited by the current material envelope. The project also overlaps with insitu resource utilization, as regolith simulants are encouraged to be incorporated into, or become the starting material for, the material mixes developed. The addition of electronic materials (e.g., dielectric materials) is also encouraged to broaden the utility of additively manufactured items. Feedstocks developed under this work may be considered for future in-space manufacturing systems and applications. This project is relevant to NASA technology roadmap TA 7 (human exploration destination systems) and TA 12 (materials and manufacturing).

Level of Effort for student team:
Student teams should have experience in 3D printing with FFF, filament manufacturing, materials testing and characterization, and designing for additive manufacturing. If in-house equipment does not exist, some of it may be purchased under the seed funding provided.

Level of effort for NASA team:
The NASA team will assist with materials selection and defining a work plan to achieve outcomes that are of benefit to NASA and have a clear infusion point for NASA projects and programs. NASA personnel will participate in all design reviews and serve as a resource for the student team throughout the course of the project.

Suggestion for seed funding: $25k. Proposers are encouraged to seek additional funding or other contributions from their institutions, industry, space grant consortiums, and others.

Project Sponsor: AES, HRP, HHC, Langley Habitation Design
Advanced Exploration Systems (AES) Logistics Reduction Project
Human Research Program (HRP) Human Health Countermeasures (HHC)
Langley Habitation Design
https://www.nasa.gov/directorates/heo/aes/index.html

The first human journey to Mars and back will likely take years, and the food supply carried along must remain nutritious and palatable. NASA researchers are working on the best way to accomplish this, which may include refrigerating or freezing some of the food.
https://www.nasa.gov/content/space-food-systems

Project Title: Deep Freeze for Deep Space: Passive Cold Food Storage

Scope of the Challenge:
Using the natural cold environment of space, design a cold food storage system that can preserve frozen food for use by the crew of a deep space habitat.

Description:
Since traditional freezers are often massive, require significant power, have moving parts and potentially hazardous fluids, NASA is calling for the design of a lightweight, passively cooled capability to store frozen and/or refrigerated food on the way to Mars. The food will need to be accessed by the crew periodically (~weekly) from their habitat and must interface well with the environmental control and life support system (ECLSS). The food must remain at proper constant temperature until thawed for use. The method of achieving temperature control and potential problems with frost build up should be addressed, as well as the operational concept from pre-launch until the end of the Mars mission. Ground support equipment can be assumed, but the food may have to sit on the Launchpad for many days. For the purpose of this study, frozen food capacities of 2 m^3 to 8 m^3 should be addressed. The passive deep freeze may be incorporated into a portion of the crew's primary metallic habitation module or into a separate smaller structure that connects to the habitation module. In either case, mechanical and thermal interfaces between the freezer and habitat must be considered, as well as the thermal environments created by the sun and deep space.

Expected Product (delivery item/concept):
Preliminary designs for the passive cold food storage system should include computer aided design (CAD) drawings, mass properties, details of the interface with the habitat, and thermal analysis results sufficient to prove engineering feasibility. It should be clear from the preliminary design whether the passive cold food storage system is an integrated component of the habitat or a separate, attached module. A concept of operations for loading, transporting, storing and retrieving the frozen food should be described, pointing out crew and/or robotic involvement. Mockups and/or prototypes of the cold food storage system are encouraged. Low-mass/low power systems are desired.

Expected Result (knowledge gained):
The project sponsors will gain proof-of-concept and quantitative characteristics of the passive food storage concept for comparison to other mission possibilities such as an active refrigerant-based freezer system. Candidate design features and materials may also be identified which will warrant additional study and demonstration, which may lead to additional partnerships on future proposals with participating universities.

Relevance to Exploration:
One exploration knowledge gap is how to create an acceptable food system for 5 years. On-going research is investigating the efficacy of cold stowage and other options, but the cold stowage system itself has not been designed. ISS has some cold stowage capabilities, but none is suitable for a Mars transit vehicle due to mass, power and volume constraints. Technology area 6.1.4 Habitation calls for “Minimizing the logistical burden associated with providing safe, palatable, and nutritional food supplies over mission durations lasting years.”

Level of Effort for student team:
Mechanical design, thermal analysis, CAD

Level of effort for NASA team:
NASA mentors supplied by AES Logistics Reduction project. NASA personnel will participate in all design reviews and serve as a resource for the student team throughout the course of the project.

Suggestion for seed funding:
$15k. Project budget should account for design and development of the prototype and a demonstration visit for the prototype at the Johnson Space Center. Proposers are encouraged to seek additional funding from their institutions, industry, space grant consortiums, and others.

Project Sponsor: Human Research Program (HRP) Exploration Medical Capability (ExMC): *https://www.nasa.gov/hrp*

Project Title: Exploration Medical Architectural Design & Habitat Integration

Scope of the challenge:
A typical Mars mission sends a crew to Mars and back on a ~1000-day mission. This includes about 250 days outbound, 500 days on the surface, and 250 days on the return. The in-space transfer habitat is in ~0g unless it is rotated to generate an artificial gravity, and the surface habitat is on Mars at ~1/3g. One of the most significant considerations in manned exploration class missions is the requirement to keep the crew safe, healthy and able to complete their assigned tasks. The scope of this challenge is, given a list of medical conditions and equipment, to identify how the prevention/diagnosis/treatment/management of these conditions can be supported through architectural design in a transit habitat, within the constraints of that environment. Consideration of how this Exploration Medical Capability would be transitioned to / in common with required capabilities for a surface habitat and mobile exploration units is also of interest.

Description:
A VR model of a representative deep space transit vehicle will be provided. The Medical Capability designed for this environment should address provided conditions' prevention/diagnosis/treatment/long term management strategies according to provided data, for four crewmembers in a 250-day outbound and 250-day inbound transit mission, with 500 days on surface.

Expected Product (delivery item/concept):
Habitat conceptual designs demonstrating integration of architectural and ambient features required to support exploration class medical requirements. These designs should minimally be documented as a requirements list and provided as VR models successfully integrated into a provided VR model of proposed habitat, and within a proposed VR habitat that meets given specifications. We are also interested in your ideas for transitioning design requirements into evaluation criteria for other workstation designs. As such, enterprising teams that undertake to develop physical mockups of a medical workstation may show advantages in demonstrating how these could be evaluated.

Expected Result (knowledge gained):
Students will gain understanding of exploration class habitat constraints, medical capability requirements for astronaut crews in long duration space exploration, and the conditions that affect these explorers.

Relevance to Exploration:
Crew safety and functional readiness is crucial to manned space exploration. Ensuring that the transit habitat effectively supports the crew medical requirements is therefore of utmost import.

Level of Effort for student team:
Primary disciplines should be in the area of medicine, bioengineering, architecture, space architecture, industrial design, aerospace engineering, and other related branches of design and engineering. Research should be led as a senior-level capstone, or graduate student project with support from undergraduates.

Level of effort for NASA team:
NASA ExMC and habitation team consultation support available. NASA personnel will participate in all design reviews and serve as a resource for the student team throughout the course of the project.

Suggestion for seed funding:
$20k from ExMC/Human Research Program. Proposers are encouraged to seek additional funding from their institutions, industry, space grant consortia, and others.

Project Sponsor: Space Life and Physical Science Research and Applications
https://www.nasa.gov/directorates/heo/slpsra

Project Title: Autonomous Space Biology at the Lunar Orbital Platform - Gateway (Gateway)

Scope of the challenge:
Development of autonomous robotic systems and test equipment for the Gateway so multiple science investigations can be conducted during crewed and vacant periods, remotely monitored and controlled from Earth, to fully utilizing this platform. (Examples – How would a small automated food production system or a microbiology monitoring system at the Gateway operate? If multiple runs of a seed germination test were conducted, what equipment would be needed and how would it operate? If assuring the Gateway was biologically safe for a new crew, what would be tested for and how would the test setup work, etc.)?

- Development of a modular, scalable infrastructure to support the conduction of multiple science investigations in parallel with or without crew intervention for the Gateway.
- Development of a distributed, fault tolerant architecture to support the continuous operation of parallel science experiments with or without crew intervention.

Description:
The Gateway will provide a unique research location with high levels of background radiation outside the influence of Earth's magnetic field. The Gateway will be periodically visited by crew during which time a great many activities will be conducted. Investigations that can be set to run without crew interaction after initial installation and setup will be of great value. Investigations that can be either autonomously or remotely controlled will permit important scientific discovery and the knowledge to enable exploration of deep space. All proposed Gateway equipment must operate in zero gravity conditions.

To achieve this vision, sensors need to be developed and configured to provide needed system data. This data must be used by an operating program to understand current conditions and generate commands for future actions. Actions delivered to the experiment must control valves, electronics, and manipulators to effect change. The system both hardware and software must include fault tolerance and deal with the time delays created by the distance for earth and the orbital locations.

Expected Product (delivery item/concept):
The expectation would be to see an operating system that can control a complex integrated system at a remote location, with several failure modes, based on data that was collected and stored before download or delayed by transit time and commands either locally generated or also restricted by transit conditions. The integrated system should be operational with command and decision-making logic tree although it may be in a breadboard state.

Expected Result (knowledge gained):
At the Gateway and at other deep space destinations the capability to perform remote automated operations will be a key driver. The capability to build systems with the latest technology will enable rapid forward progress. Questions associated with performance and reliability can only be answered by designing, building, and testing integrated systems. New technologies are most easily embraced by developers who do not have a long history with existing equipment and methods.

Relevance to Exploration:
Explain the context for how improving the knowledge and capability in this area will improve NASA's capacity for space exploration. Identify strategic knowledge gap, Technology Area, and/or Technology Readiness Level.

Level of Effort for student team:
The team will need expertise in sensor and mechanical systems, electrical and electronic systems, software development, and the integration of those systems into an operating product.

Level of effort for NASA team:
The NASA team will support five 2-hour telecoms with the University team including kickoff meeting, SDR, PDR, CDR, and completion presentation and a site visit of one day for two team members. NASA personnel will serve as a resource for the student team throughout the course of the project.

Suggestion for seed funding:
The sponsor will provide up to $25k for this project, which needs to support a demonstration visit to KSC for at least 2 members of the team. Proposers are encouraged to seek additional funding or other contributions from their institutions, industry, space grant consortiums, and others.

Project Sponsor: AES
Advanced Exploration System Life Support Project
https://www.nasa.gov/content/life-support-systems

Project Title: Computer Modeling of Spacecraft Temperature Swing Compressor and Storage System

Scope of the Challenge:
To develop a computer model of the Temperature Swing Adsorption and Storage System for spacecraft.

Description:
On the International Space Station (ISS), the Carbon Dioxide Removal Assembly (CDRA) removes carbon dioxide (CO_2) from cabin air. The Temperature Swing Compressor and Storage (TSAC) system is a lower mass, solid state technology which can receive the low-pressure CO2 output from the CDRA, and compress, store, and deliver this CO_2 to the Sabatier system for further processing[1]. Two current TSAC designs for spacecraft are the Air-Cooled TSAC (AC-TSAC) and the Thermally-Coupled TSAC (TC-TSAC). The AC-TSAC consists of two identical adsorbent beds that function as the CO_2 compressor and storage device. The TC-TSAC is integrated into a next generation CDRA design and leverages the thermal swing of the CO_2 removal process to more efficiently provide CO_2 compressor capability.

Computer modeling is needed to model the different TSAC technologies based on CO_2 input, operating parameters, and CO_2 output. This model can be used to predict TSAC operating parameters, validate experimental data, and help determine optimal operation.

Parameters for the TSAC:

- Input gas: carbon dioxide >99% purity
- Input gas pressure: 3-5psia
- Input flow rate: 30 scfm
- Output gas pressure: 18-20 psia
- Sorbent used: 13X or 5A zeolite
- Operating temperature: based on sorbent used (e.g. 280˚C)
- CO2(g) removal capacity: 4.16kg/day
- Mode of operation: constant and transient CO_2 input
- Operation cycles: 24 hrs a day using two identical beds
- Cycle time: 60-144 minutes half-cycle

Expected Product (delivery item/concept):
The deliverables include computer model results using the relevant software (e.g. ASPEN or COMSOL) of a variety of different design and operating parameters. The results will take into account the theoretical results as well as validation results from experimental data (experimental NASA Ames Research Center will provide the experimental data). A data package will be provided with the computer model and results to document the software deliverable to Ames Research Center.

Expected Result (knowledge gained):
The modeling results would provide the relevant data for future TSAC systems modification and design. In addition, the data will be used for trade studies between different TSAC configurations for short and long-term missions.

Relevance to Exploration:
To date, there have been short and long term experimental tests on TSAC systems, but these data have not been used along with modeling to provide a better understanding of the various parameters. Therefore, modeling results will improve TSAC system development such as transient operation and scalability for longer missions (e.g. Mars). In addition, the modeling results will provide a reference baseline to aid in bringing the TSAC technology to the next TRL level.

Level of Effort for student team:
This project could provide a project topic for an individual Master or PhD student or a student group with expertise in life support systems technologies project for at least the two semesters in the X-Hab period of performance.

Level of effort for NASA team:
The NASA Ames Research Center Air Revitalization group will provide the university team with TSAC modeling input properties and experimental data in addition to data related to NASA life support systems. NASA personnel will participate in all design reviews and serve as a resource for the student team throughout the course of the project.

Suggestion for seed funding:
The recommended seed funding for modeling is $30k. Proposers are encouraged to seek additional funding from their institutions, industry, space grant consortia, and others.

Project Sponsor: AES
Advanced Exploration System Life Support Project
https://www.nasa.gov/content/life-support-systems

Project Title: Implement advanced sorbents such as supported-amine mesoporous silicas, metal organic frameworks (MOFs), and/or ionic liquids (ILs) in a CO_2 management unit

Scope of the Challenge:
Develop a prototype unit to either scrub dry CO_2 from air at 2650 ppm or thermally compress pure CO_2 for delivery to processor.

Description:
An onboard station for an Environmental Control and Life Support System requires a cyclic process for scrubbing CO_2 and a mechanical compressor to deliver the product to a CO_2 processor. This process is energy intensive and prone to mechanical failure. Both a more energy efficient scrubber and a thermal compressor promise to reduce power required. One issue is new materials are unproven or untested in these applications. This project is to develop simple test units as proof of concept using new active materials including MOFs, ILs, and/or amine impregnated silicas.

Expected Product (delivery item/concept):
The final product will be able to scrub CO_2 at 2650 ppm with potential for scale-up or modularity or be able to store and compress pure, dry CO_2 for processing. It is recommended to plan for a demonstration on campus for the final product evaluation or to budget for a plan to do the demonstration at a participating NASA center.

Expected Result (knowledge gained):
Alternative methods to existing energy intensive unit operations.

Relevance to Exploration:
Reduced energy use and mass/volume.

Level of Effort for student team:
Build a small system to either scrub CO_2 from air or to store produced dry, pure CO_2 then delivering it for processing.

Level of effort for NASA team:
Support with guidance for sourcing of materials, fouling agents, and limitations.

Suggestion for seed funding:
$30k. Proposers are encouraged to seek additional funding from their institutions, industry, space grant consortia, and others.

Project Sponsor: AES
Advanced Exploration System Life Support Project
https://www.nasa.gov/content/life-support-systems

Project Title: Self-cleaning membrane unit for long-duration ECLS

Scope of the Challenge:
Develop a method and approach for testing commercial membrane units for humidity or CO_2 control against fouling and trial methods for recuperating the membrane performance

Description:
An onboard station for an Environmental Control and Life Support System requires a cyclic process for drying air prior to scrubbing CO_2. This process is energy intensive due to the high quantity of water and large flow of air. A membrane separator promises to reduce the energy required and provide constant water removal.
One issue with membranes is fouling which reduces performance over time. This project is to replicate the fouling and try to mitigate it on a commercial membrane product

Expected Product (delivery item/concept):
The final product will be able to replicate the fouling of a fresh membrane and/or remove fouling to restore partial membrane performance.

Expected Result (knowledge gained):
The system will simulate the conditions that become significant only with long-duration use. Recovering from fouling is not simple and any successful method would need to be achievable within the scope of a space mission. It is recommended to plan for a demonstration on campus for the final product evaluation or to budget for a plan to do the demonstration at a participating NASA center.

Relevance to Exploration:
Reduced energy use and mass/volume. Recovery or membranes would ensure long-duration mission success.

Level of Effort for student team:
Research and replicate reported methods for fouling and recovering membranes (or try new ideas). Build an airflow test stand and handle chemicals.

Level of effort for NASA team:
Support with guidance for sourcing of materials, fouling agents, and limitations. NASA personnel will participate in all design reviews and serve as a resource for the student team throughout the course of the project.

Suggestion for seed funding:
$30k. Proposers are encouraged to seek additional funding from their institutions, industry, space grant consortia, and others.

Appendix C: Standard Education Grant or Cooperative Agreement

This award is made under the authority of 51 U.S.C. 20113 (e) and is subject to all applicable laws and regulations of the United States in effect on the date of this award, including, but not limited to 2 CFR Part 200 and Part 1800.

The following provisions of the Federal Code of Regulations are incorporated by reference

Location	Title	Date
Appendix A to 2 CFR Part 170	Reporting Subawards and Executive Compensation	Dec. 26, 2014
2 CFR 175.15	Trafficking in persons.	Dec. 26, 2014
2 CFR 182	Government-wide requirements for Drug-Free Workplace	Dec. 26, 2014
1800.900	Terms and Conditions	Dec. 26, 2014
1800.901	Compliance with OMB Guidance on Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal awards.	Dec. 26, 2014
1800.902	Technical publications and reports.	Dec. 26, 2014
1800.903	Extensions.	Dec. 26, 2014
1800.904	Termination and enforcement.	Dec. 26, 2014
1800.905	Change in principal investigator or scope.	Dec. 26, 2014
1800.906	Financial management.	Dec. 26, 2014
1800.907	Equipment and other property.	Dec. 26, 2014
1800.908	Patent rights.	Dec. 26, 2014
1800.909	Rights in data.	Dec. 26, 2014
1800.910	National security.	Dec. 26, 2014
1800.911	Nondiscrimination.	Dec. 26, 2014
1800.912	Clean air and water.	Dec. 26, 2014
1800.913	Investigative requirements.	Dec. 26, 2014
1800.914	Travel and transportation.	Dec. 26, 2014
1800.915	Safety.	Dec. 26, 2014
1800.916	Buy American encouragement.	Dec. 26, 2014
1800.917	Investigation of research misconduct.	Dec. 26, 2014
1800.918	Allocation of risk/liability.	Dec. 26, 2014

Unless otherwise specified, the terms and conditions in 2 CFR 1800.900 to 1800.918 and the requirements in 2 CFR 170, 175, and 182 apply and are incorporated by reference. To view full text of these requirements, terms, and conditions go to https://prod.nais.nasa.gov/pub/pub_library/srba/index.html

Provisions listed above are contained in the Code of Federal Regulation (14 CFR Part 1260). The CFR can be accessed electronically at: http://www.gpoaccess.gov/cfr/index.html or copies are available in most libraries and for purchase from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402. Provisions incorporated by reference have the same force and effect as if they were given in full text. The full text provision can be found via the NASA Grant and Cooperative Agreement Handbook web site: http://prod.nais.nasa.gov/pub/pub_library/grcover.htm. OMB Circulars referenced in the provisions can be assessed electronically at: http://www.whitehouse.gov/omb/circulars/ or may be obtained from the Office of Administration, Publications Unit, New Executive Office Building, Washington, D.C. 20503. An index of existing OMB Circulars is contained in 5 CFR 1310.

Appendix D: Certifications and Assurances

CERTIFICATION REGARDING DEBARMENT, SUSPENSION, AND OTHER RESPONSIBILITY MATTERS PRIMARY COVERED TRANSACTIONS

This certification is required by the regulations implementing Executive Order 12549, Debarment and Suspension, 34 CFR Part 85, Section 85.510, Participants' responsibilities. The regulations were published as Part VII of the May 28, 1988 Federal Register (pages 19160-19211). Copies of the regulations may be obtained by contacting the U.S. Department of Education, Grants and Contracts Service, 400 Maryland Avenue, S.W. (Room 3633 GSA Regional Office Building No. 3), Washington, D.C. 20202-4725, telephone (202) 732-2505.

A. The applicant certifies that it and its principals:

(a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;
(b) Have not within a three-year period preceding this application been convicted or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State, or Local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;
(c) Are not presently indicted for or otherwise criminally or civilly charged by a government entity (Federal, State, or Local) with commission of any of the offenses enumerated in paragraph A.(b) of this certification; and
(d) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State, or Local) terminated for cause or default; and

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

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

(a) The prospective lower tier participant certifies, by submission of this proposal, that neither it nor its principles is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any Federal department of agency.
(b) Where the prospective lower tier participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

____
Organization Name

____
Printed Name and Title of Authorized Representative

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Signature Date

____
Printed Name of Principal Investigator/Program Director

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Proposal Title

CERTIFICATION REGARDING LOBBYING

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

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

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

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

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

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Organization Name

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Printed Name and Title of Authorized Representative

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Signature Date

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Printed Name of Principal Investigator/Program Director

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Proposal Title

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

The ____

(Institution, corporation, firm, or other organization on whose behalf this assurance is signed, hereinafter called "Applicant.")

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

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

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

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Organization Name

____

Printed Name and Title of Authorized Representative

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Signature Date

____

Printed Name of Principal Investigator/Program Director

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Proposal Title

Appendix E: NASA Review Requirements and Checklists

NASA follows a strict adherence to a formal review process, as described earlier. The SDR, PDR, and CDR activities are further explained below, providing rationale, objectives, the information to be provided, and success criteria.

System Design Review (SDR)

The SDR examines the proposed system architecture/design and the flow down of Level 1 requirements to all functional elements of the system. SDR is conducted to prepare for, and assess readiness for the Preliminary Design phase.

SDR Objectives:

1. Ensure a thorough review of the team, processes, and products supporting the review.
2. Ensure the products meet the success criteria.
3. Ensure issues raised during the review are appropriately documented and a plan for resolution is prepared.

SDR Results of Review

As a result of successful completion of the SDR, the system and its operation are well enough understood to warrant proceeding to PDR. Approved specifications for the system, interfaces, and preliminary specifications for the design of appropriate functional elements may be released.

SDR Agenda (each academic team to present):

1. Identify Team Members.
2. Review Vision, Mission, Goal and Objectives of Project.
3. Review System Architecture (includes system definition, concept and layout).
4. Review Level 1 Requirements.
5. Review Traceability of requirements “flow down”.
6. Review Work Breakdown Structure (WBS).
7. Review preferred system solution definition including major trades and options. CAD model of physical components of system if available.
8. Review preliminary functional baseline.
9. Review draft concept of operations.
10. Review preliminary system software functional requirements.
11. Review risk assessment and mitigations approach.
12. Review analysis tools to be used.
13. Review Cost and schedule data.
14. Review software test plan (approach).
15. Review hardware test plan (approach).

SDR Success Criteria:

1. Systems requirements (based on mission as described by NASA) are understood, defined, and form the basis for preliminary design.
2. All requirements are allocated, and the flow down (subsystems, etc.) is adequate.
3. The requirements process is defined and sound, and can reasonably be expected to continue to identify and flow detailed requirements in a manner timely for development of project, post SDR.
4. The technical approach is credible and responsive to the identified requirements.
5. Technical plans have been updated, as necessary, from initial proposal.

6. Trades have been identified, and those planned prior to PDR/CDR adequately address the trades/options.
7. Any significant development or safety risks are identified, and a process exists to manage risks.
8. The ConOps is consistent with any proposed design concepts and is aligned with the Level 1 requirements.
9. Review demonstrates a clear understanding of customer and stakeholder needs.

Preliminary Design Review (PDR):

The PDR should demonstrate the establishment of a functionally complete preliminary design solution (i.e., a functional baseline) that meets project goals and objectives. It should define the project in enough detail to establish an initial baseline capable of meeting the project needs.

During the PDR, the team should demonstrate that activities have been performed to establish an initial project baseline, which includes a formal flow down of the project-level performance requirements to a set of system and subsystem design specifications. The technical requirements should be sufficiently detailed to confirm schedule and cost estimates for the project are being met. While the top-level requirements were baselined at SDR, the PDR should identify any changes resulting from the trade studies and analyses since SDR.

In general, teams should devote significant effort to discussing interface requirements and operational requirements (including test support, training products, repair products). The team should thoroughly define design and production requirements (if possible) during the PDR. PDR products should include comprehensive system and element requirements documentation, interface documentation, and technology validation.

PDR Objectives:

1. Ensure a thorough review of the team, processes, and products supporting the review.
2. Ensure the products meet the success criteria.
3. Ensure issues raised during the review are appropriately documented and a plan for resolution is prepared.

PDR Results of Review
As a result of successful completion of the PDR, the system and its operation are well enough understood to warrant proceeding to CDR. Approved specifications for the system, interfaces, and specifications for the design of appropriate functional elements may be released.

PDR Agenda (each academic team to present):
1. Review and updates of any documents developed and baselined since SDR.
2. Review a matured ConOps.
3. Review of any updates to any engineering specialty plans.
4. Review risk management plan.
5. Review cost and schedule data.
6. Review top-level requirements and flow down to the next level of requirements since SDR.
7. Review any design-to specifications (hardware and software) and drawings, verification and validation plans, and interface documents at lower levels. A CAD model is required at PDR stage for all physical components of the system.
8. Review any trade studies that have been performed since SDR and their results.

9. Review any performed design analyses and report results.
10. Review any engineering development tests performed and report results.
11. Review and discuss internal and external interface design solutions (and any interface control documents needed). This includes interface information provided by NASA since SDR.
12. Review system operations.
13. Review any potential safety issues (or data) including test identification and test readiness criteria as applicable.
14. Select a baseline design solution.

PDR Success Criteria:

1. Systems requirements (based on mission as described by NASA) are understood and defined and form the basis for preliminary design.
2. All requirements are allocated, and the flow down (subsystems, etc.) is adequate.
3. The requirements process is defined and sound, and can reasonably be expected to continue to identify and flow detailed requirements in a manner timely for development of project, post PDR.
4. The technical approach is credible and responsive to the identified requirements.
5. Technical plans have been updated, as necessary, from the System Design Review.
6. Trades have been identified and executed, and those planned for PDR have been completed with appropriate rationale.
7. Any significant development or safety risks are identified, and a process exists to manage risks.
8. Plans are defined to address Test Readiness Criteria if applicable.
9. The ConOps is consistent with any proposed design concepts and is aligned with the Level 1 requirements.
10. Review demonstrates a clear understanding of customer and stakeholder needs.

Post-PDR, Pre-CDR Activities

Design issues uncovered in the PDR should be resolved so that final design can begin with unambiguous design-to specifications. From this point on, almost all changes to the baseline are expected to represent successive refinements, not fundamental changes.

Critical Design Review (CDR)

The team should finalize all their designs for the CDR, after having selected a preferred alternative among the trade studies. The intent of the CDR during the X-Hab milestone process is to finalize the products seen in the SDR and PDR products and to reflect the changes and maturation since the earlier reviews but not to repeat the content seen earlier.

CDR Agenda (each academic team to present):

1. Review and updates of any documents developed and baselined since PDR.
2. Review a finalized ConOps.
3. Review of finalized engineering specialty plans.
4. Review finalized risk management plan.
5. Review finalized cost and schedule data.
6. Review top-level requirements and flow down to the next level of requirements since PDR.
7. Review finalized design-to specifications (hardware and software) and drawings, verification and validation plans, and interface documents at lower levels. A CAD model is required at CDR stage for physical components of the system.

8. Review finalized design analyses and report results.
9. Review finalized engineering development tests performed and report results.
10. Review and discuss finalized internal and external interface design solutions (and any interface control documents needed). This includes interface information provided by NASA since PDR.
11. Review finalized system operations.
12. Present the finalized baseline design solution that will be built.

Once the CDR is completed, the majority of the design work should be over and the teams will concentrate on testing, building, procuring, and assembling the finalized system. The Checkpoint Review is a progress discussion to help the team along with the assembly and construction of the product. As noted earlier, teams may request additional meetings for technical interchange, but they are not required as a milestone.