# Amendment 1 to Notice Of Funding Opportunity (NOFO) NNH21ZHA002C

# Released October 30, 2020

# Amendment Dated November 03, 2020

# Replace existing appendix E with the below appendix E

# Appendix E: KSC Exploration Systems and Development

**I. Research Project Info**

1)   Research Title: Gas Separation for Sabatier Reactor and other systems

2)   Research Overview: Separate products (CH4 and H2O) from the reactants (H2, CO2) for the Sabatier reaction. The product will come from a reactor at ~350 degrees C. The separation can happen at elevated temperatures or cooler temperatures. The system should be able to operate autonomously (no maintenance) for up to 18 months.

3)   Organization: NASA, UB-E

4)   Contact: Elspeth Petersen, Elspeth.petersen@nasa.gov, 321-867-3757

5)   Mission Directorate(s) [Involved / Connected]: STMD

6)   Intellectual property rights: -N/A

a.     Company information

b.   Desired process

**7)**Additional Information: N/A

**II. Research Project Info**

1. Research Title: Need improved VOC scrubbing techniques (addresses Space Crop Production Gap 1.B.2.b.1)
2. Research Overview:  NASA has determined gaps in the area of VOC scrubbing for plant growth and crewed environments. While large-scale technology exists for VOC scrubbing in oil and gas and other industrialized applications, we require an effective small-scale VOC scrubber that could operate within limited space using limited power input and be positioned within a controlled environment plant growth chamber or crew quarters.
3. Organization: NASA, UB-A
4. Contact: NASA-KSC, UB-A
5. Mission Directorate(s) [Involved / Connected]: SMD (BPS), HEOMD (AES SCLT Habitation Systems and HRP)
6. Intellectual property rights: Negotiable

a.       Company information

b.       Desired process

1. Additional Information: N/A

**III. Research Project Info**

1. Research Title: Spaceflight-compatible Recycling of non-edible Biomass (addresses Space Crop Production Gap 1.D.1.0.1)
2. Research Overview:  NASA has determined gaps in the area of inedible biomass recycling. Crop plants produce excess biomass that must be broken down into useful components. Finding methods of improving these processes of waste conversion to useful soil-like substrates, biochar, or materials that could be used by the crew for biofuels or additive manufacturing.
3. Organization: NASA, UB-A
4. Contact: NASA-KSC, UB-A
5. Mission Directorate(s) [Involved / Connected]: SMD (BPS), HEOMD (AES SCLT Habitation Systems and HRP)
6. Intellectual property rights: Negotiable

a.       Company information

b.       Desired process

1. Additional Information: N/A

**IV. Research Project Info**

1. Research Title: Pressure level effects on plant physiology for spaceflight candidate crops (addresses Space Crop Production Gap 2.A.4.b.1)
2. Research Overview:  NASA has determined gaps in the area of pressure level effects on the plant physiology of spaceflight-relevant candidate crops. Plant physiology studies need to be conducted within controlled environment growth chambers with variable pressure that are hospitable to plant growth. With this funding line appropriate chambers could be grown, and studies conducted using applicable candidate crops.
3. Organization: NASA, UB-A
4. Contact: NASA-KSC, UB-A
5. Mission Directorate(s) [Involved / Connected]: SMD (BPS), HEOMD (AES SCLT Habitation Systems and HRP)
6. Intellectual property rights: Negotiable

a.       Company information

b.       Desired process

1. Additional Information: N/A

**V. Research Project Info**

1. Research Title: Improving Ethylene Sensor Technology for Space Crop Production (addresses Space Crop Production Gap 1.A.1.a.1)
2. Research Overview:  NASA has determined gaps in the area of ethylene sensing to support space crop production for future exploration missions. We have a need for an ethylene sensor that is small enough to fit within the small confines of a growth chamber, drawing limited power, with data logging capability and remote operation. The material involved would need to be able to withstand periodic wetting and drying events and operate in elevated humidity.
3. Organization: NASA, UB-A
4. Contact: NASA-KSC, UB-A
5. Mission Directorate(s) [Involved / Connected]: SMD (BPS), HEOMD (AES SCLT Habitation Systems and HRP)
6. Intellectual property rights: Negotiable

a.       Company information

b.       Desired process

1. Additional Information: N/A

**VI. Research Project Info**

1. Research Overview:  Research Title: Seed Handling Approaches for Space Crop Production (addresses Space Crop Production Gaps 2.C.1.a.2, 2.C.1.a.4, and 2.C.1.a.1)
2. Research Overview: NASA has gaps in the area of seed handling to support space crop production for future exploration missions. We have a need for a sacrificial seed container, possibly 3-D printed, where seeds could be planted/inserted in a correct orientation, and early germination and growth could occur. There would be a desire to periodically submerge or hydrate this container with water or nutrient solution, and a desire for the container to be consumed by the plant or broken down as the plant grows. There is interest for a seed coating or seed container to provide benefits to survival for seeds that might be stressed by the space environment (e.g. lack of natural convection, space radiation). There is also interest in new approaches to seed sanitization for long duration storage, and seed-specific radiation protection.
3. Organization: NASA, UB-A
4. Contact: NASA-KSC, UB-A
5. Mission Directorate(s) [Involved / Connected]: SMD (BPS), HEOMD (AES SCLT Habitation Systems and HRP)
6. Intellectual property rights: Negotiable

a.       Company information

b.       Desired process

1. Additional Information: N/A

# Amendment 2 to NOFO NNH21ZHA002C

# Replace existing appendix D, pg 28 with this appendix D to correct numbering.

# Appendix D: NASA SMD Biological and Physical Sciences (BPS)

1. **Program:**

Physical Sciences – Materials Science

1. **Research Title:**

Extraction of Materials from Regolith

1. **Research Overview:**

With NASA’s renewed efforts to put astronauts on the moon and to develop a persistent human presence on the moon, the ability to utilize in-situ resources is paramount to the success of these future missions. Extraction of materials (e.g. metals, glasses and water ice) from extra-terrestrial regolith is necessary for NASA to be successful in the long term. The extracted materials could be used as feedstock for additive manufacturing processes, to construct habitats and/or other structures, to build infrastructure, for example, roads, walls, and landing pads, or to fabricate tools or other hardware. The water ice from regolith material could be used to augment life support systems for extended stay missions or produce liquid hydrogen and liquid oxygen for propellant production.

1. **Research Focus:**

The goal of this NASA Physical Sciences Program research emphasis is to develop and increase understanding of extraction techniques to generate useful materials (e.g. metals, glasses, water ice) from Lunar or Martian regolith.

Proposed studies are expected to generate and test specific hypotheses to the extent possible in a terrestrial lab. Investigations should be proposed that would study one or more of the following topics:

1. Refinement of existing techniques to extract materials from regolith.
2. Development of new techniques for extraction of materials from regolith.
3. Studies of the extracted material to determine its properties or to investigate novel ways of utilizing it to support NASA’s exploration goals.

It is expected that regolith simulant, or equivalent, will be used for the proposed experiments. For example, crushed basalt could potentially be used in lieu of Lunar regolith simulant. Proposals are encouraged to use existing hardware.

More information on NASA’s exploration goals can be found in the Decadal Survey (<http://www.nap.edu/catalog/13048.html>), specifically Translation to Space Exploration Systems (TSES) number 16 (TSES16).

1. **BPS Contact:**
2. Name: Michael SanSoucie
3. Organization: NASA MSFC / EM41
4. Work Phone: 256-544-5269
5. Email: michael.p.sansoucie@nasa.gov
6. **Additional Information:**

All publications that result from an awarded EPSCOR study shall acknowledge NASA Biological and Physical Sciences (BPS).

# Amendment 3 to NOFO NNH21ZHA002C

# Replace existing paragraph on pg 4 that says:

*Was*:

* Jurisdictions may submit one proposal per each NASA office, i.e., if there are four participating offices, the Jurisdiction may submit a maximum of four proposals. *Please include the appendix letter for the NASA office the applicant is proposing to support (i.e. SMD Planetary i.e. one of the NASA SMD Divisions: Planetary, Earth Sciences, Biological and Physical Sciences, or the CSCO) or NASA Center in the proposal title.* This will make it much easier for proposals to be sent to the correct NASA office for review/evaluation.

*Change to:*

* Each jurisdiction may submit one proposal per appendix.

# Amendment 4 to NOFO NNH21ZHA002C

# Replace existing paragraph on pg 4 that says:

*Was*:

* Proposers are encouraged to contact the research task point of contact (POC) listed under the “Inquires” section of this solicitation on pages XX to XX for clarification/information on the requested research.

*Change to:*

* Proposers are encouraged to contact the research task point of contact (POC) listed under the “Inquires” section of this solicitation on pages 6 to 7 for clarification/information on the requested research.

# Amendment 5 to NOFO NNH21ZHA002C

# Replace existing Section 1.2 first paragraph sentence on pg 8 that says:

*Was*:

Proposers may resubmit proposals from previous R3 solicitations or submit proposals for renewal(s) of existing award(s).

*Change to:*

Proposers may resubmit proposals from previous R3 solicitations or submit proposals for renewal(s) of existing award(s) if allowed by the appendix POC listed under Inquires. Proposers should contact the POC for concurrence.