AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

1. CONTRACT ID CODE	PAGE OF PAGES
	1

2. AMENDMENT/MODIFICATION NUMBER	3. EFFECTIVE DATE	4. REQUISITION/PURCHASE REQUISITION NUMBER	5. PROJECT NUMBER *(If applicable)*
0001	12/16/2016		

6. ISSUED BY CODE	7. ADMINISTERED BY *(If other than Item 6)* CODE
NASA Shared Services Center (NSSC) Building 1111, Jerry Hlass Road Stennis Space Center, MS 39529-6000	

8. NAME AND ADDRESS OF CONTRACTOR *(Number, street, county, State and ZIP Code)*

CODE | FACILITY CODE

(X)	
[X]	9A. AMENDMENT OF SOLICITATION NUMBER NNX17SBIRSTTR 9B. DATED *(SEE ITEM 11)* 11/17/2016
[ ]	10A. MODIFICATION OF CONTRACT/ORDER NUMBER 10B. DATED *(SEE ITEM 13)*

11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

[X] The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers [ ] is extended. [X] is not extended.

Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended, by one of the following methods: (a) By completing items 8 and 15, and returning ____________ copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or electronic communication which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If by virtue of this amendment you desire to change an offer already submitted, such change may be made by letter or electronic communication, provided each letter or electronic communication makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

12. ACCOUNTING AND APPROPRIATION DATA *(If required)*

13. THIS ITEM APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS. IT MODIFIES THE CONTRACT/ORDER NUMBER AS DESCRIBED IN ITEM 14.

CHECK ONE	
[ ]	A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: *(Specify authority)* THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NUMBER IN ITEM 10A.
[ ]	B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES *(such as changes in paying office, appropriation data, etc.)* SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(b).
[ ]	C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:
[ ]	D. OTHER *(Specify type of modification and authority)*

E. IMPORTANT: Contractor [ ] is not [ ] is required to sign this document and return __________ copies to the issuing office.

14. DESCRIPTION OF AMENDMENT/MODIFICATION (*Organized by UCF section headings, including solicitation/contract subject matter where feasible.)*

This Amendment is hereby issued to:

1. Revise by adding language to Focus Area 8: In-Situ Resource Utilization
2. Revise by adding language to Subtopic H1.02 Mars Soil Acquisition and Processing for in Situ-Water
3. Revise by adding language to Focus Area 18: Air Vehicle Technology

See Summary of Changes on SF30 Continuation Page.

Except as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect.

15A. NAME AND TITLE OF SIGNER *(Type or print)*		16A. NAME AND TITLE OF CONTRACTING OFFICER *(Type or print)* Ben Benvenutti	
15B. CONTRACTOR/OFFEROR *(Signature of person authorized to sign)*	15C. DATE SIGNED	16B. UNITED STATES OF AMERICA Ben Benvenutti *(Signature of Contracting Officer)*	16C. DATE SIGNED 12/16/2016

Previous edition unusable

STANDARD FORM 30 (REV. 11/2016)
Prescribed by GSA FAR (48 CFR) 53.243

SECTION SF 30 BLOCK 14 CONTINUATION PAGE

SUMMARY OF CHANGES

1. Revise **Focus Area 8 In-Situ Resource Utilization** by incorporating additional language.

FROM:

Focus Area 8: In-Situ Resource Utilization

Participating MD(s): HEOMD

As terrestrial explorers and settlers learned to use local resources for provisions, shelter, and fuel to stay alive and prosper, so too must future human explorers learn to live off the land and use the resources found in space. Known as In Situ Resource Utilization (ISRU), this approach to exploration involves any hardware or operation that harnesses and utilizes 'in-situ' resources (natural and discarded) to create products and services for robotic and human exploration. By using and converting local resources into products, less material needs to be launched from Earth. The ability to make life support consumables (oxygen, nitrogen, and water), propellants for ascent and space transportation vehicles, and fuel cell reactants for energy generation and storage have the biggest influence on launch mass, crew and mission risk, and cost in current human exploration mission plans. These products can be used to reduce Earth launch mass or lander mass by not bringing everything from Earth, reduce risks to the crew and/or mission by reducing logistics and providing increased self-sufficiency, and reduce costs by needing less launch vehicles to complete the mission and/or through the reuse of hardware and lander/space transportation vehicles.

The ISRU Focus Area in this year's solicitation will concentrate on how to acquire carbon dioxide and water from the Mars atmosphere and soil resources. Because understanding resource characteristics is extremely important to designing larger scale systems to extract and process these resources, the ISRU Focus Area will also emphasize the need for small payloads to perform this task on future lunar missions.

TO:

Focus Area 8: In-Situ Resource Utilization

Participating MD(s): HEOMD

As terrestrial explorers and settlers learned to use local resources for provisions, shelter, and fuel to stay alive and prosper, so too must future human explorers learn to live off the land and use the resources found in space. Known as In Situ Resource Utilization (ISRU), this approach to exploration involves any hardware or operation that harnesses and utilizes 'in-situ' resources (natural and discarded) to create products and services for robotic and human exploration. By using and converting local resources into products, less material needs to be launched from Earth. The ability to make life support consumables (oxygen, nitrogen, and water), propellants for ascent and space transportation vehicles, and fuel cell reactants for energy generation and storage have the biggest influence on launch mass, crew and mission risk, and cost in current human exploration mission plans. These products can be used to reduce Earth launch mass or lander mass by not bringing everything from Earth, reduce risks to the crew and/or mission by reducing logistics and providing increased self-sufficiency, and reduce costs by needing less launch vehicles to complete the mission and/or through the reuse of hardware and lander/space transportation vehicles.

The ISRU Focus Area in this year's solicitation will concentrate on how to acquire carbon dioxide and water from the Mars atmosphere and soil resources. Because understanding resource characteristics is extremely important to designing larger scale systems to extract and process these resources, the ISRU Focus Area will also emphasize the need for small payloads to perform this task on future lunar missions.

Since ISRU can be performed wherever resources may exist, ISRU systems will need to operate in a variety of environments and gravities and need to consider a wide variety of potential resource physical and mineral characteristics. ISRU hardware for Mars missions must be desired to operate continuously (day and night) for very long durations (480 days), and to environments specified in the table below. Proposers will need to address design and operation implications for yearly and day/night changes in surface pressure and temperature in the table below.

Mars Environment	Min	Max.
Surface Pressure	~700 Pa (0.1 psi)	~1000 Pa (0.14 psi)
	Up to 10% variation in day/night pressure	
Surface Temperature	−153 °C (120 K) at poles	~20 °C (293 K) at equator
	Up to 100 K change in day/night temperature	
Water content in hydrated soils	1.5%	10%
Water content in icy soils	10%	90%

2. Revise **Subtopic H1.02 Mars Soil Acquisition and Processing for in Situ-Water** by incorporating additional language.

FROM:

H1.02 Mars Soil Acquisition and Processing for In-Situ Water
Lead Center: JSC
Participating Center(s): ARC, GRC, JPL, KSC, LaRC, MSFC

Innovative technologies and approaches are sought related to ISRU processes associated with excavating and processing soils on Mars to remove, collect, and clean in-situ water for subsequent use in oxygen and fuel production or delivery to the habitat for life support and radiation shielding usage. Proposals must consider and address operating life issues for Mars surface applications that can last for up to 480 days of continuous (day/night) operation. All proposals need to identify the State of the Art of applicable technologies and processes. Hardware to be delivered at the conclusion of Phase II will be required to operate under Mars surface pressure, atmosphere constituent, and temperature conditions. Therefore, thermal management during operation of the proposed technology will also need to be specified in the Phase I proposal. Requirements and specifications for Mars surface conditions and soil properties can be found in the ISRU Topic Description. Phase I proposals for innovative technologies and processes must include the design and test of critical attributes or high risk areas associated with the proposed technology or process. Proposals will be evaluated on mass, power, complexity, and the ability to achieve hardware specifications below.

Technologies are sought for excavation and transfer of hydrated and icy Mars soils. For hydrated soils, the excavated soil can be delivered to a centralized soil processing plant or processed on the excavation rover itself. The amount of water content in the hydrated Mars soil can vary from as low as between 1.5 and 2% on the surface at almost all locations on Mars to above 10% depending on the location and mineral. The concentration of water may also increase below a desiccated layer of soil at the surface, so technologies for excavation and transfer need to consider soil properties and water content as a function of depth and minerals and should be applicable to a range of landing sites where icy soils do not exist. The need to excavate down to at least 0.5 meters should be considered. The amount of water content in icy Mars soil can vary greatly as a function of depth and latitude. Based on analysis of Mars orbital data, proposers should assume a minimum of 10% by weight of water/ice up to 90%. Due to human landing and ascent considerations, Mars water based resources should be constrained between +/1 50 deg. latitude. Based on the potential high water content by mass in icy soils, it is expected that icy soil excavated will be either processed in-situ or on the excavation rover itself. Proposers should also assume that up to 0.5 m of soil may exist above icy soils and that excavation down to at least 1 meter is required. Proposers should note the impact on concept mass, power, and complexity for excavation down to 3 meters. Proposals should consider water loss due to hardware temperature, material agitation, and duration of soil exposure to the environment before transfer to soil processing systems. Note requirements for the mobility platform associated with hydrated soil excavation and transfer will be included in the H8 Robotic Systems Topic.

Technologies are sought for processing of hydrated and icy Mars soils to extract water. Soil processing for water extraction needs to consider the range of water content in Mars soils and water extraction rates defined below. Proposals for soil processing also need to define potential water loss due to valve/enclosure sealing for closed soil reactors or losses due to exposure to the surrounding environment or soil for open soil reactors. Proposals need to consider what other volatiles and contaminants are released due to soil processing/heating. Proposed solutions that perform in a non-continuous fashion are acceptable, as long as they achieve the same total production quantities on a daily or weekly basis. Understanding the change in mass, power, volume, complexity, and contaminant release as a function of water content in the soil, heating temperature, and heating method are important factors in selection. Power needed for the proposed technology operation should be differentiated between electrical and thermal, and consideration should be given on how the thermal management system and the Mars environment could minimize the need for electrical-to-thermal energy conversion.

Based on past and recent human Mars exploration mission studies, to meet ascent propellant production rates with margin, approximately 1.6 kg/hr of water must be collected and cleaned for subsequent processing. At this time, 3 soil processing units for extraction of water from Mars soils is baselined for human Mars missions. Multiple excavation and processing units are allowed, but should be justified based on overall mass, power, thermal, and/or operation duration requirements. Proposers can submit combined excavation and soil processing technologies.

Technologies are sought for the separation, collection, and cleaning of water released from soil processing of hydrated and icy Mars soils. Separation of contaminants from water can be performed in the vapor phase during release or after collection, but technologies need to be regenerative. Separate and multiple technologies for collection, separation, and cleanup can be proposed for any one or all of the functions (separation, collection, and cleaning) All must operate in conjunction with the soil processing reactors for the soil/water production rates, contaminants, and mission durations specified above. It is encouraged that proposers for soil processing of Mars soils also consider including technologies requested below for water separation, collection, and cleanup since the two technology needs can be highly interconnected. Multiple units are allowed, but should be justified based on overall mass, power, thermal, and/or operation duration requirements. Water will need to be clean enough to be fed to a proton exchange membrane (PEM) water electrolysis unit.

TO:

H1.02 Mars Soil Acquisition and Processing for In-Situ Water
Lead Center: JSC
Participating Center(s): ARC, GRC, JPL, KSC, LaRC, MSFC

Innovative technologies and approaches are sought related to ISRU processes associated with excavating and processing soils on Mars to remove, collect, and clean in-situ water for subsequent use in oxygen and fuel production or delivery to the habitat for life support and radiation shielding usage. Proposals must consider and address operating life issues for Mars surface applications that can last for up to 480 days of continuous (day/night) operation. All proposals need to identify the State of the Art of applicable technologies and processes.

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Proposals for ISRU hardware for Mars material excavation, transfer, and processing for the extraction of water need to consider physical, mineral, and volatile characteristics and variations for hydrated and icy soils, as well as the types of volatiles and contaminants released during heating. Information on potential Mars water-based resources and mineral properties can be found in the recent Mars Water In-Situ Resource Utilization (ISRU) Planning (M-WIP) Study posted at https://mepag.jpl.nasa.gov/reports/Mars_Water_ISRU_Study.pdf, and information on what volatiles and contaminants are released due to soil processing/heating can be found in "Volatile, Isotope, and Organic Analysis of Martian Fines with the Mars Curiosity Rover" by Leshin et al., For example, besides water, varying amounts of CH_3Cl, HCN, SO_2, HCl, and H_2S were released as a function of temperature. Further research and evaluation of mineral properties, constituents, and potential contaminants based on different hydrated and icy soil minerals is highly recommended and should be addressed in proposals.

3. Revise **Focus Area 18: Air Vehicle Technology** by incorporating additional language.

FROM:

Focus Area 18: Air Vehicle Technology
Participating MD(s): ARMD

This focus area includes tools and technologies that contribute to meeting metrics derived from a definitive set of Technical Challenges responsive to the goals of the National Aeronautics Research and Development (R&D) Policy and Plan, the National Aeronautics R&D Test and Evaluation (T&E) Infrastructure Plan (2011), and the NASA Aeronautics Strategic Implementation Plan (2015).

TO:

Focus Area 18: Air Vehicle Technology
Participating MD(s): ARMD

This focus area includes tools and technologies that contribute to meeting metrics derived from a definitive set of Technical Challenges responsive to the goals of the National Aeronautics Research and Development (R&D) Policy and Plan, the National Aeronautics R&D Test and Evaluation (T&E) Infrastructure Plan (2011), and the NASA Aeronautics Strategic Implementation Plan (2015). In 2012 ARMD introduced more focused solicitations by rotating some of the subtopics every other year. The reduction in the scope of some of our solicitations does not imply a change in interest in a given year. For example, in 2014 we solicited proposals for quiet performance with an emphasis on propulsion noise reduction technology, then in 2015 we focused our quiet performance subtopic on airframe noise reduction. In 2016 we returned to quiet performance – propulsion noise reduction technology.

End of Summary of Changes