NASA SBIR 2017 Phase I Solicitation

H1.01 Mars Atmosphere Acquisition, Separation, and Conditioning for ISRU

Lead Center: JSC

Participating Center(s): ARC, GRC, JPL, KSC, LaRC, MSFC

Technology Area: TA7 Human Exploration Destination Systems

Innovative technologies and approaches are sought related to ISRU processes associated with collecting, separating, pressurizing, and processing gases collected from the Mars atmosphere. State of the art (SOA) technologies for these ISRU processes either do not exist, are too small of scale, or are too complex, heavy, inefficient, or consume too much power. 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 collection and compression of Mars atmosphere gases for subsequent processing into oxygen and possibly fuel. Based on redundancy and production margin assumptions (40% of total production rate), carbon dioxide in the Mars atmosphere must be acquired and compressed to a minimum of 103.4 KPa (15 psi) pressure and up to a desired 517.1 KPa (75 psi) at a rate of 0.6 kg/hr for oxygen and fuel production and 2.7 kg/hr for oxygen production alone. Multiple units are allowed, but should be justified based on overall mass, power, thermal, and/or operation duration requirements. Understanding the change in mass, power, volume, and complexity as a function of outlet pressure is also an important factor in selection. Since carbon dioxide is the main gas of interest, techniques and technologies that separate the carbon dioxide from the other gases in the Mars atmosphere before, during, or after compression are considered beneficial in the selection process. Proposers should consider but not be limited to past work on Mars atmosphere collection, separation, and compression technologies such as carbon dioxide freezing, rapid cycle adsorption pumps, and mechanical compressors. For concepts that separate carbon dioxide from other Mars gases at Mars atmosphere pressures, proposers must include an active flow device to ensure the remaining gases do not prevent further separation and collection of the carbon dioxide. Proposals should consider the impact on atmosphere flow to overcome flow resistance due to filtration devices that will need to be placed at the inlet. 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. Since downstream carbon dioxide processing technologies are performed at a minimum of 400°C, cooling of the compressed gas to below this temperature is not required for downstream operations.

Technologies are sought for separation of nitrogen and argon from the Mars atmosphere during or after Mars carbon dioxide separation and compression. Mars atmosphere gas flow rates, pressures, and temperatures are as specified above for Mars atmosphere/carbon dioxide compression. 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. All proposals need to identify the State of the Art of applicable technologies and processes. At this time, it is not known whether the nitrogen and argon will be stored as a pressurized gas or a cryogenic liquid, so it should be noted which storage option is more beneficial for the proposed technology.