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PROVING GROUND CAPABILITIES NEEDED FOR LUNAR IN SITU RESOURCE UTILIZATION (ISRU) & CONSTRUCTION CONCEPTS OF OPERATION

Abstract

Incorporating any new technology or system into a human exploration mission or architecture requires development well in advance of the mission to eliminate technology, cost, and schedule risk concerns. It is often stated that technologies need to be at a Technology Readiness Level (TRL) of 6, i.e. 'system/subsystem model or prototype demonstration in a relevant environment (ground or space)', by Authority To Proceed or by the Preliminary Design Review for the mission at the latest. New game changing capabilities for sustained human exploration of space involves the search for, acquisition, and processing of resources on the Moon and Mars into mission consumables and usable products, known as In Situ Resource Utilization (ISRU), and the ability to utilize in situ resources in the construction of roads, structures, and surface infrastructure. These capabilities have the potential to greatly reduce the cost and risk of human exploration while enabling sustained lunar surface and commercial operations. However, ISRU and surface construction systems are complex and must operate in extremely harsh environments, with abrasive regolith or pervasive dust, for long-periods of time, with potentially limited opportunities for maintenance and repair by humans. The complexity of these capabilities and operations also means that there are a limited number of companies that can design, build, and operate end-to-end systems on their own. The majority of the technologies being developed for these systems are by small companies and at the component or subsystem level. With the overarching strategy of NASA's Space Technology Mission Directorate to enable industry to implement ISRU and surface infrastructure for Artemis and space commercialization, it is therefore important to establish processes and capabilities to promote and foster collaborations among large and small companies involved in ISRU and surface infrastructure development. For ISRU and infrastructure systems and capabilities to be used in Artemis missions and future commercial lunar surface operations, a coordinated framework with virtual/physical integration and testing locations, or 'Proving Grounds', needs to be established and operated on a regular basis and open to all. This paper will discuss the ISRU and surface construction near and long-term concepts of operations, and review operations and lessons-learned from the previous ISRU analog field tests. From this information, requirements and capabilities will be proposed to support and enable the integration and testing of ISRU and construction systems with industry, academia, and international agencies, as well as what facilities and organizations could help establish these Proving Grounds.