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NASA REQUIREMENTS DEVELOPMENT FOR LUNAR IN-SITU SURFACE CONSTRUCTION OF INFRASTRUCTURE

Abstract

In situ resources offer an opportunity to reduce the amount of items brought from Earth when exploring moons and planets. Utilizing those resources requires energy that comes with a cost. In the case of human missions to Mars, trading surface power for launch mass is beneficial for propellant and consumables required to sustain human pioneering and settlement on the planet's surface. However, In Situ Resource Utilization (ISRU) can mean far more than propellant production and consumables replacement for missions beyond Low Earth Orbit. NASA's Systems Capability Leadership Team for ISRU created a work breakdown structure based on functions identified in roadmaps pertaining to human exploration. That WBS includes Prospecting, Extraction, Processing, Construction, Manufacturing, and Energy. Over the years, NASA has developed some capabilities and technologies for prospecting, extraction, and processing carbon dioxide and water on Mars into propellants and life support consumables. However, that is a small subset of the ISRU needs that are coming to light with NASA's push to return to the Moon for extended periods of time. For instance, astronauts require shielding from Galactic Cosmic Rays and nuclear radiation and protection from the low temperatures and pressures in Space. Surface assets including crew, landers, and ascent modules can be damaged by surface ejecta during landing and launch operations on the Moon and Mars. Creating shielding, berms, and pads requires movement of large volumes and stabilization of regolith in the context of a civil engineering construction project. Because of the multidisciplinary nature of the aerospace systems needed for human exploration, SCLT on ISRU created an ISRU Construction Integrated Steering Group that combines expertise among several NASA Principal Technologists and Capabilities Leaders for exploring options, assessing opportunities, and developing requirements for construction and manufacturing on the Moon and Mars. NASA's new program to develop Lunar landers for small, mid, and large payload deliveries to the Lunar surface leading to human missions by 2025 spawned an investigation into plume surface interactions caused by the lander during descent and ascent. The trade space to resolve this issue includes regolith stabilization via landing pad construction techniques and lander nozzles characteristics due to vehicle systems design. Some data exists from the Apollo missions but more is required for the missions ahead. The purpose of this paper is to outline an approach for developing requirements that can guide systems designs while taking advantage of flight opportunities in NASA's plans to return to the Moon.