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Incorporation of In-Situ Resource Utilization into Short Duration Human Lunar Exploration Missions

Gerald Sanders
NASA-JSC, Energy Systems Division, Houston, United States (gerald.b.sanders@nasa.gov, 2814832428)

Ever since the United States National Aeronautics and Space Administration (NASA) performed the first Lunar Architecture Team (LAT) study in 2005, the approach to incorporating In-Situ Resource Utilization (ISRU) into human lunar mission architectures has been to not assume ISRU products are available until after they have been demonstrated adequately to minimize mission risk. This approach has been taken not only for propulsion system use for lunar ascent or surface hopping, but also for reducing or eliminating life support, Extra Vehicular Activity (EVA) and power system consumable needs. While this approach to ISRU integration into lunar human mission scenarios was also utilized in the recently released International Space Exploration Coordination Group (ISECG) Reference Architecture for Human Lunar Exploration, the international participants in this effort were able to examine concepts for incorporating ISRU oxygen and water production systems into the early mission phase of the Global Point of Departure (GPoD) lunar architecture to better understand the impact of this delayed incorporation philosophy on the architecture and other element designs. Because the early phase of the GPoD involves short duration crewed missions with hardware that needs to be highly mobile, large amounts of consumables need to be delivered from Earth for regenerative fuel cell power systems and crew and EVA operations since regenerative life support system delivery is delayed. It was determined that delivery of an ISRU pilot system early in the architecture that could be moved to other locations and operate for the long durations between human missions could eliminate oxygen and water consumables delivered from Earth. The payload mass reduction benefits were further increased if mission power systems, processing hardware, and consumable storage associated with regenerative fuel cell power and gray water processing were shared with the ISRU pilot system. This paper will review the GPoD human lunar architecture and describe the various options examined and their benefits for incorporation of ISRU into the early mission short duration human mission phase of the GPoD.