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CONCEPT OF OPERATIONS FOR SUSTAINING A LONG TERM LARGE CREW MISSION PERFORMING ISRU AND EXPERIMENTS ON THE LUNAR SURFACE

Abstract

The next steps of the International Space Exploration Coordination Group (ISECG) Global Exploration Roadmap (GER) envision a return to cislunar space and on the Moon surface with crewed missions in the upcoming years. As a stepping stone for further human exploration beyond the moon, a lot of new activities like In-Situ Resource Usage (ISRU), surface mobility, human surface operations, and human-robotic cooperation, need to be performed there. Acquiring experience by validating these scenarios before going beyond is crucial, and the Moon provides rather safe conditions, offering a reasonable emergency return time, and near-real-time telecommunications.

This study is carried out within the framework of the 11th edition of the international Specializing Master programme in SpacE Exploration and Development Systems (SEEDS) of 2018/19. As a second iteration on last year's Lunar Propellant Outpost (LUPO) mission architecture, presented during IAC 2018, we present a program aiming to produce and commercialize Liquid Oxygen (LOX) on the lunar surface and in-orbit. Extensive use of ISRU for propellant production is made, and frequent crew shifts and transfers are scheduled, with a permanent crew on the surface. It is a large initiative, designed to fit in the timeline of the GER and pursue its objectives of using the Moon to prepare for going beyond, involving over 50 launches over 20 years.

Operating and maintaining such a big infrastructure with humans in the loop comes with unique opportunities and constraints. The introduction of a large permanent crew on the Moon surface was a requirement of this 2nd iteration, and it had a huge impact on the mission design. Trade-offs are performed between alternative operations scenarios, taking into account cost concerns. We present several in-depth analyses on ground segment operations and planning, logistics, and mission planning. Some of these studies were conducted in partnership with experts from ALTEC and other entities during our stay in the ROCC facilities (future operation center of ESA's ExoMars Rover). To be executed in compliance with the high safety requirements applicable to human spaceflight missions, such architecture requires careful planning. Once on the lunar surface, supporting a large crew, monitoring their habitat, and managing their mobility elements, is a key factor to make the program succeed. Reflecting on these operations constraints had a huge impact on our initial architecture and mission design, and we highlight these points in our paper.