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Human Exploration of the Moon and Cislunar Space (1)

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LUNAR PROPELLANT FACTORY MISSION DESIGN TO SUSTAIN FUTURE HUMAN
EXPLORATION

Abstract

The International Space Exploration Coordination Group (ISECG) Global Exploration Roadmap (GER) is the standard document reflecting the current focus of the main space agencies that envision space exploration missions beyond Low Earth Orbit (LEO), returning to the Moon and going to Mars in the upcoming years. The roadmap showcases the Moon as a stepping stone for further human space exploration, by setting up a sustainable space infrastructure on its surface and in orbit.

Inspired from this vision, we present the result of a phase A study about a lunar propellant factory near the Shackleton south-pole crater relying on In-Situ Resources Utilization (ISRU) to produce and sell Liquid Oxygen (LOX) on the moon surface and in orbit. The overall timeline of the mission is in line with the ISECG exploration roadmap Moon phase, based on realistic technologies of advanced-enough Technology Readiness Levels (TRL). It is a second iteration on the Lunar Propellant Outpost (LUPO) mission architecture, presented during IAC 2018. We preserved and reviewed the original building blocks (Habitats, Crew Mobility Elements, ISRU Facilities, and Lunar Spaceport) of the LUPO mission architecture, and further improved the mission design, supported by trade-off analysis on different mission scenarios. An extensive analysis and optimization has been performed on ISRU processes and surface electrical power management, the core of our infrastructure. The mission architecture includes a large permanent crew on the lunar surface, so radiation risk assessments and shielding, life support systems and habitat, as well as operations concepts, have been studied in depth, and a synthesis of all results is presented. The main aim of this iteration was to improve and refine the baseline infrastructural and technological design architecture of LUPO, add support for a large surface crew, and reflect on missions going beyond the Moon by providing refuelling services, with sustainability and economic viability in mind.

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