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MARS-LUNAR GREENHOUSE (M-LGH) PROTOTYPE FOR BIO REGENERATIVE LIFE SUPPORT SYSTEMS IN FUTURE PLANETARY OUTPOSTS

Abstract

Future human-based exploration of the solar system will require architecting, constructing and deploying missions on planetary bodies that last for years. Indeed Mars and Lunar outposts require oxygen generation and atmosphere revitalization which represent a critical component for sustainable long-term space missions. Whereas initial shorter duration Lunar mission (about 60 day) may rely on meals supplied from Earth as well as on a conventional physico-chemical support systems, Bio-regenerative Life Support Systems (BLSS) may be necessary for permanent outposts (e.g. greater than 6 months). BLSS uses plant-based biological processes to support the desired number of astronauts. As a complex, multi-component system, BLSS include 1) atmosphere revitalization, 2)water recycling, 3)food (vegetables) production, 4)organic waste recycling and 5)Power generation. In this paper, we describe an on-going effort called Mars-Lunar Greenhouse (M-LGH) and we will focus on the current development status and path forward. Funded by NASA Steckler Phase III Program, the team has designed and constructed a set of four cylindrical innovative 5.5 m long by 1.8 m diameter membrane M-LGHs with a cable-based hydroponic crop production system in a controlled environment that exhibits a high degree of future Lunar and/or Mars mission fidelity. Based on NASA crop production area estimates, the M-LGH prototype has been conceived to support a four person crew with 100% of their atmosphere and water recycling, and 50% of their total daily dietary caloric intake. The M-LGH target goal is to provide data on biomass production utilizing NASA targeted crops in a poly-culture cropping system. Moreover, as we operate the system at full capacity, the goal is to complete an analysis of system dynamics, including water recycling, air revitalization, food production and energy usage per unit of production. Additionally,, in this paper, we will describe the design and construction of two additional major components that are being integrated into the M-LGH, i.e. the Fresnel-Based Solar Concentrator Power System (SCPS) and the Composing system.