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EDEN ISS – FROM A SIMULATION TESTBED TO AN ADVANCED EXPLORATION DESIGN CONCEPT FOR A GREENHOUSE FOR MOON AND MARS

Abstract

In recent years, mission simulations have been conducted world-wide and nearly every year new simulation platforms, sites and habitats are opened up. These activities substantially contribute to the advancement of preparations for future human moon and Mars missions. Numerous papers are being published about the outcomes of these simulations, only few lessons learnt extrapolate the findings and demonstrate how a refined mission, procedure or habitat design might look like. This paper takes the EDEN ISS project as example to demonstrate how findings from greenhouse tests and a 12-month mission simulation in Antarctica can inform the design for a future lunar or Martian exploration greenhouse and presents design solutions. EDEN ISS, a four-year EU-H2020 project coordinated by the German Aerospace Center Bremen, is a Ground Demonstration of Plant Cultivation Technologies for Safe Food Production in Space. EDEN ISS project partners developed an advanced nutrient delivery system, a high-performance LED lighting system, a bio-detection and decontamination system and food quality and safety procedures and technologies. A mobile two-container-sized greenhouse test facility was built to demonstrate and validate different key technologies and procedures necessary for safe food production within a (semi-)closed system. EDEN ISS is currently installed next to the German Neumayer Station III in Antarctica and serves as an over-winter-test-bed for providing fresh vegetables to the crew's diet. Intermediate findings from the Antarctic test include engineering, technology and crew experience facts and will inform the extra-terrestrial greenhouse design. The design study discussed in this paper investigates the feasibility and design for future greenhouses, implemented in planetary outposts integrating lessons learnt for architectural aspects, system performance, crop yield, crew acceptance and contamination. For

integrating the scientific outcomes into an advanced design of a greenhouse, the inflatable technology developed by EDEN ISS partner Thales Alenia constitutes the main structure for the concept design. Concurrent engineering, used as methodology, supports the synthesis of the findings and at the same time ensures the reflection of this information in the design proposals. Project partner LIQUIFER Systems Group contributes to the design activities in in the areas of human factors and architecture to co-create an EDEN ISS derived greenhouse design concept for moon and Mars.