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POTENTIAL DESIGN CRITERIONS AND CONSTRAINTS FOR A LUNAR SETTLEMENTS: CONSIDERATIONS FOR THE NEXT DECADE

Abstract

The possibility of establishing a future settlement on the lunar surface is gradually becoming a reality. Here, future lunar bases' long-term viability, habitability, and security are crucial factors in manned missions. In this context, inspired by recent technological advances and based on scientific literature, we describe and outline the design and strategies for a potential lunar base to begin development in the next decade. The suggested project takes the name of Prosperity Lunar Station (PLS). PLS is a lunar settlement design for long-term human habitation, scientific research, and resource utilization. The proposed station consists of two primary habitats: Lunar Habitat 1 (HAB1) at the equator (Oceanus Procellarum) and Lunar Habitat 2 (HAB2) at the South Pole (Shackleton's Crater). In order to provide astronauts with optimal protection and ideal space, the architectural design focuses on creating self-assembling modules and geodesic domes, which are shapes that offer good structural efficiency and protection. These models were selected for their ability to assemble in low gravity and withstand extreme temperature fluctuations and micrometeorite impacts. Robotic exploration is the first stage of the station's development which is followed by resource collection, autonomous building, and finally, human habitation. The structural design prioritizes radiation shielding, micrometeorite protection, and modular expansion using 3D-printed materials. To provide a closed-loop system for the generation of food, water, and oxygen, the Environmental Control and Life Support Systems (ECLSS) will employ a hybrid method that combines physicochemical and bioregenerative technology. Greenhouse modules will support vital crops, while yeast and fungal cultivation will meet the crew's nutritional requirements. We also present potential strategies to maintain economic viability. The station will facilitate commercial endeavors such as space tourism, scientific research, and lunar mining. Manned lunar outposts, laboratories, and small settlements such as the suggested PLS are expected to play a crucial role in understanding how human communities could

live sustainably beyond Earth, offering valuable lessons for future Mars missions. By leveraging sustainable technologies and fostering multidisciplinary and international collaboration, lunar settlements such as PLS will contribute to the advancement of space exploration while offering new opportunities for scientific discovery and commercial ventures. Our design serves as a potential roadmap for lunar habitation, advancing human spaceflight and contributing towards the foundation for a multi-planetary future.