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PHOBOS BASE: CONCEPT OF OPERATIONS AND ARCHITECTURE FOR A PERMANENT
HUMAN PRESENCE ON THE MARTIAN MOON PHOBOS

Abstract

This paper is based on the ongoing work that is being done for the 2017 AIAA Student Design Competition-Human Spaceflight: Phobos Base. One of humanity's major challenges when travelling to Mars is represented by the existence of an atmosphere around the red planet. Even though the Martian atmospheric density is only about 1% of that of Earth, the entry, descent and landing (EDL) process for large payloads is still particularly challenging. Perhaps a first approach to missions to Mars is represented by creating a "gateway to Mars" through its closest and largest of moons, Phobos. This paper discusses the multiple interplanetary transfers from Earth to Mars needed to deploy and construct Phobos Base, which represents the first step in establishing a crewed infrastructure for exploration, transportation, and logistical support in cis-Martian space. This paper includes details regarding the approach and landing procedures needed upon arrival onto the Martian moon, and the role of robotics during the beginning of the assembly process, and the human-robot interaction for further base expansion once the first crew arrives. In this paper, equal importance is given to the concept of operations needed to deploy and

construct the base as well as the architecture of the base itself, such as the schematic site plan of the base including the locations of airlocks, connections, nodes and structural utility routing as well as rendered drawings of the base. Regenerative environmental control and life support systems (RECLSS), in-situ resource utilization (ISRU), and plans for resupply missions from Earth are key components of the base design and are necessary to make the interplanetary outpost feasible, reusable, and sustainable. Two of the most important aspects of Phobos Base are crew safety, by ensuring that enough radiation shielding is provided by both the base and infrastructure created with the use of the moon's material and that microgravity countermeasures are considered, and planetary protection, by ensuring that infrastructures to avoid contamination are included in the design. Technology readiness levels (TRL) of critical technologies needed to create Phobos Base as well as the budget constraints of space agencies such as NASA and ESA are considered in the schedule of events. Phobos Base represents a permanently crewed interplanetary infrastructure capable of sustaining exploration of cis-martian space and supporting future mission to the surface of red planet and beyond.