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MISSION ARCHITECTURE FOR A MANNED MARS POLAR RESEARCH BASE

Abstract

Mars ice caps contain valuable information concerning the planet's climate, hydrological systems and are a great candidate in the solar system to search for past or present life traces. This analysis proposes to establish a manned Mars Polar base near the northern polar cap. The mission's objective is two-fold. The first is that of drilling into the ice and analyzing the samples in-situ. The second is that of preparing for a long-term presence of humans on Mars. After having analyzed the requirements of the mission and the in-situ resource utilization possibilities in the Northern Martian region using a systems engineering approach, a design for the base is proposed. Furthermore, a complete scenario from the launch of the first elements of the habitat to the safe return of the first generation crew with the expected durations of each phase is described. The design of an interplanetary transfer vehicle and use of a Mars orbit to surface crane system is also described. During the first phase, the habitat structure and in-situ resource utilization equipment is sent to Earth. The deployment of the core and additional inflatable spaces and the construction of a protective ice dome strategy are established. The proposed strategy for in-situ resource utilization is also detailed. During the second phase, the crew is sent to Mars, complete the surface mission and return to Earth. A key aspect of this analysis is the verification of the scenario with respect to the technology readiness level of the different technologies selected for this mission. Solutions have been proposed to maintain the security of the crew when technologies that are currently in an early stage of development are required for the mission. A trade-off scenario utilizing a rocket with a larger payload capacity but lower technology readiness level has also been developed in order to be able to propose an optimal mission regarding crew security. In conclusion, a two phase scenario is confirmed as an optimal solution, allowing to test mission and life critical technologies during the first phase, without endangering the mission, and also to reduce the mass budget as the utilization of in-situ found resources can be maximized. The first generation mission is expected to be completed within an eight-year period from the first launch.