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CONSTRUCTION OF A MARTIAN HABITAT USING IN-SITU MATERIALS FOR RADIATION SHIELDING

Abstract

With the current developments in the aerospace field, habitation on Mars has never been more feasible. This paper explores how to autonomously construct a radiation shielded habitat on Mars.There are many factors that complicate travelling to and building habitats on Mars. The first and foremost constraint concerns human physiological capabilities, that cannot withstand the biological effects of ionizing space radiation. Other challenges include the costliness and difficulty of carrying materials to Mars, as well as the 22 minutes transmission delay between Earth and Mars. As a result of the latter, it is impossible to run and control operations in real time, thus requiring autonomous construction for a habitat. Since mission characteristics limit the applicability of construction tools and methods, a specific mission scenario among those defined in DRA 5.0 by NASA was selected, and thus an appropriate material for radiation shielding.

Due to transportation limitations, only in-situ materials, present on the Martian surface, could be taken into consideration, i.e. regolith and water. Water was chosen as a better shield for space radiation, due to its highly hydrogenated structure. Four potential sources of water were subsequently identified (regolith, glacier ice, poly-hydrated sulfate minerals and phyllosilicate minerals), but since it is not possible to confirm the presence of the latter three without on-site data collection through rovers, regolith was eventually selected as the main source for water extraction. Employing four rassors, this regolith would be transported to ISRU plants, where water would be mechanically derived from the regolith using microwave technologies. Two possible energy generation systems were analyzed, solar and fission power, and a simultaneous use of both was deemed to be the most promising approach. Actual construction would start by sending one inflatable habitat module, pre-manufactured on Earth, to the surface of Mars. The envelope around this module would consist of water/ice bags. Via a centralized robotic arm, these bags are planned to be filled with the water extracted from the regolith. Once the construction process is finished, the end product will be a habitat that can accommodate a crew of six for 539 days on the Jezero Crater. The habitat is designed to keep the total equivalent dose of radiation exposure for the crew within the 0.40-0.50 Sievert range.