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DESIGN CONSTRAINTS AND IMPROVEMENTS ASSOCIATED WITH RADIATION HAZARD IN SPACE HABITATS

Abstract

The success of human space exploration and long-term habitation requires integrated protection means for many hazards that are associated with spaceflight. This paper presents research towards the development of interdisciplinary and comprehensive design methodology starting with the analysis of space radiation impacting the design of habitats. Galactic Cosmic Rays and Solar Energetic Particle events are considered a major challenge for human space exploration and have been troubling scientists and engineers who work in the space industry. During the Apollo era, the space radiation hazard was not well known yet and therefore, data were not gathered regarding the effect of ionising radiation on astronauts before and after space flight. The International Space Station (ISS) is orbiting in Low Earth Orbit (LEO) 420 km (261 miles) above sea level, which is within the protective embrace of Earth's magnetosphere. Yet, the ISS has a module with an additional layer of polyethylene to reduce the radiation and, in case of SEPs or Solar Particle Events, the crew uses water bottles on board to build temporary protective shielding. However, radiation protection measures in habitats on the Moon or Mars must be more robust and efficient than in the ISS as the average radiation dose measured on the surface of the Moon by Chang'E 4 was 1369 μSV/day, approximately 2.6 times of what is measured in orbit, and 624 μSV/day on the surface of the Mars, based on data from the Mars Science Laboratory's Curiosity Rover. Presented in this paper research is based on available information on radiation dosage on moon and Mars surfaces and the overview of current radiation protection measures in relation to their potential for combination, their structural or material complexity and co-dependence. These measures include shielding, shorter transit time, dietary and pharmacological means. Even well-known design solutions for radiation protection require either certain redundancy or a combination of two or more different protective systems and/or technologies to minimise health hazards for the crew. This paper concludes with an evaluation of potential combinations of radiation mitigation methods and a summary of structural and operational implications and/or improvements of different radiation protection means integration configurations.