Paper ID: 75961
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34th IAA SYMPOSIUM ON SPACE AND SOCIETY (E5)
Space Architecture: Habitats, Habitability, and Bases (1)

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ARCHITECTURAL APPROACH FOR EVALUATION OF RADIATION SHIELDING INTEGRATION IN SPACE HABITATS

Abstract

NASA HRP considers developing radiation protection for human space flight and surface habitation as one of the critical technologies for successful deep space exploration. Although the danger of radiation exposure is recognized as a potential show-stopper for deep space exploration, and radiation effects on humans are now understood better than before, shielding strategies for different stages of space flight and habitation are still not addressed in a fully comprehensive manner. Habitats and all space structures planning and design are guided by essential requirements and constraints associated with safety, manufacturing and assembly procedures, propellant and construction costs, maintenance, crew and/or passenger satisfaction. This paper reviews radiation shielding options for space habitats and discusses their feasibility in relation to habitability needs, including the potential for outside viewing in distinct types of space habitats. Typically, radiation protection depends on the thickness of the exterior structure that consists of a pressurized shell, multilayer insulation (MLI) and any applied radiation shielding material. The mass of the external protection shell is the primary factor of radiation shielding effectiveness. Nevertheless, using materials with low atomic numbers (e.g. B (5), C (6), and H2O) helps to lower secondary radiation hazards. Water, which is rich in hydrogen that has the lowest atomic number, can also be used for other mission needs. Other materials, including biomaterials, can be considered when their inclusion in the structure is possible and appropriate. The paper presents a comprehensive strategy for radiation shielding selection that includes investigation of complications associated with a type of space habitat structure, mission needs, duration, destination, and crew requirements. The approach presented in the paper aims to establish an evaluation methodology for defining the feasibility of the integration of diverse radiation shielding types into habitat structures. The paper summarizes by reviewing radiation shielding proposals with selected case studies including: water, regolith, hydrogen-rich polymers, biotechnology, polyethylene/boron nitride composites, and active strategies.